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·SMITHSONIAN·INSTITVTION·WASHINGTON·1846·

SMITHSONIAN INSTITUTION

UNITED STATES NATIONAL MUSEUM

PROCEEDINGS

OF THE

UNITED STATES NATIONAL MUSEUM

VOLUME 54

WASHINGTON
GOVERNMENT PRINTING OFFICE
1919

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The present volume is the fifty-fourth of this series.

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William deC. Ravenel,
Administrative Assistant to the Secretary,
in charge of the United States National Museum.

April 30, 1919.

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TEXT FIGURES.

CHITONS TAKEN BY THE UNITED STATES FISHERIES STEAMER "ALBATROSS" IN THE NORTHWEST PACIFIC IN 1906.

By S. Stillman Berry,

Scripps Institution for Biological Research, La Jolla, California.

A small series of chitons taken in the course of the Northwest Pacific Expedition of the United States Fisheries Steamer *Albatross* during the summer of 1906 was kindly transferred to the writer by Dr. Harold Heath, of Stanford University, for study and report, and forms the subject matter of the present paper. Though rich neither in species nor in individuals, the fact that our knowledge of the chiton fauna of this region is slight and the fortunate circumstance that the specimens were kept in alcohol render the material noteworthy. The collection comprises in all some 45 specimens. These are referable to 11 species, of which the 4 named below are described as new:

Leptochiton diomedeae, new species.
Ischnochiton (*Lepidozona*) *amabilis*, new species.
Ischnochiton (*Lepidozona*) *interfossa*, new species.
Ischnochiton (*Lepidozona*) *pilsbryanus*, new species.

Family LEPIDOPLEURIDAE.

Genus LEPTOCHITON Gray 1847.

LEPTOCHITON DIOMEDEAE, new species.

Plate 1, figs. 1–3; plate 2.

Description.—Shell rather small, elliptical, the shell and girdle together approximately twice as long as broad. Insertion plates lacking. Valves moderately elevated, sharply arcuate. Anterior valve with a concave anterior slope due to the apical region rising more abruptly than the slightly flaring marginal region; posterior margin broadly $\wedge$-shaped in outline when the valve lies in its normal position. Median valves with small but sharp and rather prominent beaks, their anterior margins only slightly arcuate except the second valve, where the tegmentum extends well forward mesially. Tail valve lower and a trifle narrower than the head valve, the flaring margin rendering the posterior slope distinctly concave; central area mildly convex, the anterior margin arcuate; mucro a little in front of the center.

Anterior valve with a sculpture comprising a large number of small, sharp, conical granules of ovate outline, very closely placed with a greater or less quincuncial arrangement, so that there often appear evidences of a secondary ranking of the granules in series oblique to the lines of growth. Intermediate valves with distinct lateral areas, the mesial regions of the latter somewhat sunken, but their anterior margins raised to form a pseudo-rib; finer sculpture of lateral areas very similar to that of the head valve; central areas everywhere except in the immediate vicinity of the beaks covered with a copious fine file-like sculpture of crowded, but distinct and rarely overlapping pustules like those described except that toward the sides they show a quite definite arrangement in longitudinal lines (these lines being roughly continuous with the less definite and more oblique series of the lateral areas in a manner not brought out in the drawing). The posterior valve corresponds in sculpture to the remainder of the shell (pl. 1, fig. 1).

Interior of head valve simple, but quite heavily calloused near the margin. Intermediate valves with sutural laminae well separated, broadly triangular, acute in front, and attached beneath the tegmentum in such a way that the latter projects over somewhat at the base and there is a notch giving a false appearance of slitting at the sides; anterior sinus broad at the base, not quite as wide as the adjoining laminae. Posterior valve with a rather heavy callus at the margin and another supporting the sutural laminae which are shorter and have more rounded margins than those of the intermediate valves (pl. 2, fig. 2).

Girdle with a dorsal armature of small, close-set spines, usually very even in size, but occasionally both at the margin and elsewhere a few scattered dagger-like spines, two or three times the length of the commoner ones, may be noted (pl. 1, fig. 3; pl. 2, fig. 5). With rather frequent exceptions all the spines show an outward trend. No striation can be detected with such magnification as I have been able to use. The spinelets of the ventral surface differ in their close palisading, smaller size, more conical outline, and even greater uniformity for any given region of the girdle (pl. 2, fig. 4).

Radula with large, strongly bidentate second laterals, medians small and mushroom-like in outline, first laterals small. My preparation of the radula did not prove satsfactory and the drawing merely serves to indicate the main features (pl. 2, fig. 6).

Color (in alcohol) a light yellowish brown without mottlings, Interior of valves white.

The ctenidia are posterior in position and number about 12 on each side.

Maximum length of type, 15 mm.; width, 8 mm.

Type.—Cat. No. 215625, U.S.N.M. [S. S. B. 95].

Type-locality.—Station 4967, 244–253 fathoms, brown mud, etc., bottom temperature 45.9° F., off Shio Misaki Light, Japan.

Remarks.—This little species is fairly large for a *Lepidopleurus*, but offers no particularly striking characters. The three recognizable Japanese members of the genus, *L. hakodatensis* Thiele, *L. japonica* Thiele, and *L. assimilis* Thiele, are all from much shallower water and differ entirely in the possession of broad, striated girdle scales little resembling the smooth, narrow spinelets of the present form. The radula of the latter is also distinctive, possibly showing most resemblance to that of *L. hakodatensis* as figured by Thiele.

Family CALLOCHITONIDAE.

Genus TONICELLA Carpenter, 1873.

TONICELLA SUBMARMOREA (Middendorff, 1846).

1846. *Chiton submarmoreus* MIDDENDORFF, Bull. Phys.-Math., Acad. Sci. Petersburg, vol. 6, No. 8.
1848. *Chiton submarmoreus* MIDDENDORFF, Mem. Acad. Sci. St. Petersburg, vol. 6, p. 98.
1886. *Tonicella submarmorea* DALL, Proc. U. S. Nat. Mus., vol. 9, p. 210.
1892. *Tonicella submarmorea* PILSBRY, Man. Conch. (1), vol. 14, p. 42, pl. 10, figs. 16–24.

Three specimens were taken between tides at Nikolski, Bering Island, June 15, 1906 [S. S. B. 116]. Two of these are entered as Cat. No. 215626, U.S.N.M.

The species has already been recorded from Bering Island by Dall.

Genus SCHIZOPLAX Dall 1879.

SCHIZOPLAX BRANDTII (Middendorff, 1847).

1848. *Chiton Brandtii* MIDDENDORFF, Mem. Acad. Sci. St. Petersburg, vol. 6, p. 128.
1848. *Chiton Brandtii* MIDDENDORFF, Bull. Phys.-Math., Acad. Sci. St. Petersburg, vol. 6, No. 8, pp. 117–118.
1879. *Schizoplax Brandtii* DALL, Proc. U. S. Nat. Mus., vol. 1, pp. 2, 296, 328, pl. 1, fig. 8 (dentition).
1884. *Schizoplax brandtii* DALL, Proc. U. S. Nat. Mus., vol. 7, p. 344.
1892. *Schizoplax brandtii* PILSBRY, Man. Conch. (1), vol. 14, p. 47, pl. 11, figs. 32–37.

One specimen taken between tides at Nikolski, Bering Island, June 15, 1906 [S. S. B. 117].

The species has already been listed from Bering Island by Dall.

Family ISCHNOCHITONIDAE.

Genus ISCHNOCHITON Gray, 1847.

Subgenus ISCHNORADSIA Shuttleworth, 1853.

ISCHNOCHITON (ISCHNORADSIA) ALBRECHTI (Schrenck, 1863).

Plate 1, figs. 4–5; plate 3, figs. 1–2.

1863. *Chiton Albrechti* SCHRENCK, Bull. Phys.-Math., Acad. Sci. St. Petersburg, vol. 5, p. 511.

1867. *Chiton Albrechti* SCHRENCK, Reisen u. Forsch. Amur-Lande, vol. 2, Zool., p. 283, pl. 13, figs. 7–17.

1892. *Ischnochiton* (*Ischnoradsia*) *albrechti* PILSBRY, Man. Conch. (1), vol. 14, p. 147, pl. 19, figs. 70–74.

Material.—This fine chiton is represented in the collection by two large alcoholic specimens [S. S. B. 83], taken at Mororan, Island of Yesso, Japan, July 6, 1906, during one of the shore expeditions. One of these is entered as Cat. No. 215627, U.S.N.M.

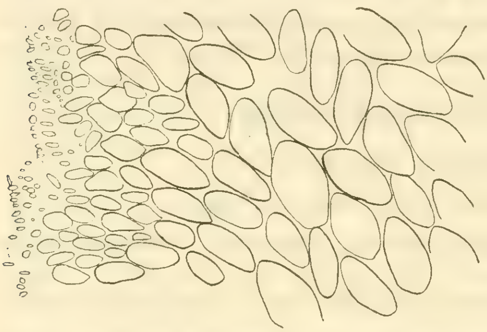


FIG. 1—ISCHNOCHITON ALBRECHTI [83], PORTION OF GIRDLE SEEN FROM ABOVE; CAMERA DRAWING FROM A MOUNT IN BALSAM; × 28.

Remarks.—The shell and girdle characters have been well described by Pilsbry, but figures of the radula are now given for the first time (pl. 3, fig. 2). The latter is well developed in this species, the powerful second laterals being armed with a strong, long, entire cutting edge, and the third laterals having a conspicuous basal process.

Even in the valves of a single individual great variation appears in the number of insertion plates. The specimen dissected shows the following formula: Anterior valve, 17; intermediate valves, respectively, 2–3, 2–2, 1–2, 2–2, 2–3, 2–3; posterior valve, 13 slits. The branchiae number 47–49 on each side, extending practically the entire length of the foot.

ISCHNOCHITON (ISCHNORADSIA) HAKODADENSIS Carpenter, 1892.

Plate 1, figs. 6–7; plate 3, figs. 3–5; plate 4, figs. 1–3.

1892. *Ischnochiton* (*Ischnoradsia*) *hakodadensis* PILSBRY, ex Carpenter MSS., Man. Conch. (1), vol. 14, p. 147, pl. 19, figs. 64–66.

?1910. *Ischnochiton hakodadensis* THIELE, Revis. Syst. Chitonen, vol. 2, pp. 111, 112, pl. 8, fig. 44 (dentition).

A medium-sized chiton offering several quite puzzling features was taken rather abundantly by the shore expeditions of the *Albatross* both at Hakodate, Japan, and at Mororan, a port somewhat farther to the north. The specimens exhibit great variability, not only in color, but in the number of radial riblets (from 5 to 11) and marginal slits, but after much study I am unable to do otherwise than refer the entire series to *I. hakodadensis.* Not only was Carpenter's original material from Hakodate, but a considerable degree of variation similar in character to that remarked upon is recognized in the excellent description by Pilsbry, while furthermore the mounted radulae taken at random from the material before me show very little variation.

Superficially the shell of *I. hakodadensis* is so generally similar to that of *I. albrechti* that I was not prepared for the striking differences to be found in their radulae. Although seemingly a much less powerful affair than the strong radula of *albrechti*, that of the present species is in many respects so much more complicated that I have not yet been able satisfactorily to elucidate all its details, nor can I secure preparations offering a reasonable coincidence with the sketches of two of the teeth given by Thiele. The latter divergence is possibly explicable on the assumption that the specimens which we have independently referred to the same species are not really conspecific. Here the major laterals are strongly bicuspid, with the inner cusp conspicuously the larger and longer, and bear a conspicuous winglike expansion just below the crown but so narrowly attached at its base and hence so easily broken away that it is not always readily observable in dissected radulae and therefore does not show in most of my camera sketches (pl. 3, figs. 4, 5).

The valves of one of the specimens from Hakodate are slitted as follows: Anterior valve, 19; intermediate valves, respectively, 2–2, 3–3, 2–2, 2–2, 2–3, 2–2; posterior valve, 15 slits; interior bluish or brownish white. A Mororan specimen shows the formula: Anterior valve, 14; intermediate valves, 3–2, 2–3, 3–3, 3–3 (or 4?), 2–2, 2–3; posterior valve, 14 slits; interior deep slate blue.

The beautiful zigzag sculpture of flattened overlapping pointed pustules, which covers the central areas of young specimens, is usually eroded to the pitted appearance characteristic of the adults. It should be added that the girdle scales of my specimens seen *in situ* from above under a relatively high magnification are very weakly striate, not smooth, as described by Pilsbry, though in some of my mounted preparations the striae are almost impossible to distinguish (pl. 1, fig. 7; pl. 3, fig. 3).

The ctenidia number 28–32 on each side.

Material examined.

No. specimens.	Locality.	Collector.	Author's register.	Museum number.
11	Hakodate, Japan	*Albatross*, 1906	[85]	Cat. No. 215629, U.S.N.M.
9	Mororan, Japan	do	[84]	Cat. No. 215628, U.S.N.M.

Subgenus LEPIDOZONA Pilsbry, 1892.

Primarily because of certain differences observed in the radulae, Thiele removes the *Lepidozona* group of chitons from *Ischnochiton*, and this accomplished finds no recourse except to unite them bodily with *Callistochiton*. With such a disposition of the group the investigations which I have thus far made do not lead me to concur, even though I can as yet suggest no better arrangement. It would not be surprising if *Lepidozona* should later on require elevation to generic rank, but for the present it is perhaps best to leave it where originally placed by Pilsbry.

ISCHNOCHITON (LEPIDOZONA) AMABILIS, new species.

Plate 3, figs. 6–7; plate 4, figs. 4–7; plate 5; figs. 1–4.

Description.—Animal small, elevated, rather elongate; maximum transverse diameter about three-fifths the length, or of shell alone about two-fifths the length.

Anterior valve rounded, conical; its frontal slope nearly straight, becoming slightly convex on the sides. Interior smooth, marked by about 12 sharp radial lines exactly corresponding to the slits at the margin; teeth slightly roughened at the edge and with rather coarse vertical striations on their outer surfaces (pl. 5, figs. 1–2).

Median valves elevated, beaked very slightly or even scarcely at all, the slopes distinctly convex. Sutural laminae short and broad, the shallow sinus bridged by a short, delicate, slightly concave plate, barely nicked at the margin to form about 8 very delicate squarish teeth; converging striations or lines corresponding in position to the slits continue back through the substance of the shell, the exact number of both slits and lines being often extremely difficult to determine, though the number appears to become considerably less in the more posterior valves. Eaves spongy and quite short (pl. 5, figs. 1–3).

Posterior valve with a rather depressed, yet conspicuous, mucro; posterior region flattened, its slope concave (pl. 5, fig. 4); side slopes convex; sutural plates and intermediate plate similar to those of the middle valves, except that there are only about half as many slits and lines as in the latter. The lines radiating from the mucro to the posterior slits are practically indistinguishable. The hinder margin is thickened and the central region shows a curious, much branched, triangular callus (pl. 5, fig. 2).

Anterior valve with 12, intermediate valves with 1–1, posterior valve with 11 slits.

Entire surface of shell closely and rather heavily granulose. Anterior valve otherwise smooth at the apex, but ornamented below by 33–40 low radial ribs having shallow, not sharply, incised grooves between; some ribs slightly bifurcating or otherwise rendered indistinct, but typically bearing a series of 5 or 6 separate sharply elevated pustules; the last series of pustules (4–8) on each side projecting like teeth from the valve margin. Intermediate valves with lateral areas sculptured like the anterior valve, the 6 or 7 low ribs usually bearing 3–8 pustules each, and the posterior series of 5–6 pustules projecting as dentations past the valve margin; central areas ornamented by some 22 (valve 7) to 26 (valve 4) nodulose ribs, for the most part slightly curved toward the jugum, connected by a series of much fainter and more irregular crossbars, the entire complex becoming reduced to a scarcely regular reticulum over the jugal tract. Posterior valve with central and posterior areas clearly marked, their sculpture closely similar to that of the intermediate valves; posterior area with some 18–24 pustulose radiating ribs, from which the pustules seem very often to be rubbed away (pl. 4, fig. 7).

Girdle wide, averaging about one-fourth the width of the median valves. Dorsal scales translucent, scarcely imbricating, strongly convex, the convexity directed obliquely outward and forward (except in the posterior region), and arranged with a fair degree of definiteness in oblique lines; variable in size, the largest occurring a short distance from the shell, the smallest at the margin; all distinctly ribbed-striate on the upper convexity, the number of striae being generally about 7 to 10 on the larger scales (pl. 4, figs. 5–6). Marginal scales minute, transparent, delicate, spiniform, finely striate, but a few smooth, needle-like spines now and then appearing among them. Ventral scales similar to the marginal, but elongate rectangular, and ranked in closely placed transverse series (pl. 3, fig. 6).

Color of shell in alcohol a warm orange brown, heavily mottled, and variegated with both darker and lighter tints. Girdle with alternate bands of orange brown and tan. Ventral surface a light pinkish tan. Interior of shell grayish pink with lavender clouding.

The radula has strong bidentate major laterals (pl. 3, fig. 7), but its further details have not yet been successfully worked out.

Ctenidia about 28 on each side, extending to a point nearly opposite the middle of the third valve.

Length of entire animal (type-specimen) 21, of shell 19 mm.; width of same 12.25, of shell 7.5 mm.; maximum width of girdle, 2.5 mm.

Type.—Cat. No. 215630, U.S.N.M. [S. S. B. 112].

Type-locality.—Station 4808,[1] 47 fathoms; bottom of sand, shells, and coarse gravel; off Cape Tsiuka, Japan; July 16, 1906 (three specimens).

Remarks.—This very attractive species seems chiefly characterized by the ruddy tones of its prettily maculated color scheme, the very weakly dentate sinus, the bidentate major laterals of the radula, and the small, little crowded, strongly ribbed girdle scales. The sculpturing of the central areas considerably resembles that of the following species, but here the longitudinal riblets are narrower, rougher, and have interspaces distinctly wider than the ribs, differences which are not shown well in the figures. A brief comparison

[1] The station number appearing on the original specimen label is 4708, but this seems clearly erroneous.

with such of the described forms as seem nearest allied is given in the course of our discussion of the next species.

ISCHNOCHITON (LEPIDOZONA) INTERFOSSA, new species.

Plate 3, figs. 8–9; plate 5, figs. 5–8; plate 6, figs. 1–4.

Description.—Animal small, elevated, rather elongate, the sides often nearly straight; maximum diameter about three-fifths the length, or of shell alone less than half the length.

Anterior valve rounded, conical, its slope very slightly convex. Interior smooth, marked by delicate lines radiating toward and in correspondence with the marginal slits; teeth slightly roughened at the edges, their outer surfaces faintly striate (pl. 5, figs. 5–6).

Median valves elevated, beaked, rather sharply carinate, their slopes very slightly convex. Sutural laminae broad; inner margins of same rather abrupt, anterior margins rounded and sloping off more gradually toward the sides; connected across the sinus by a short, delicate, weakly denticulate, concave plate, the minute slits separating the denticles continuing back into the shell as distinct incised lines, the number of these being uniformly 8. Eaves spongy and quite short (pl. 5, figs. 5–7).

Posterior valve with conspicuous mucro situated a little in front of the middle; posterior slope nearly straight (pl. 5, fig. 8). Sutural laminae and intermediate lamina similar to those of the preceding valves, except that there are 9 or 10 of the incised lines. Similar lines radiate from the region of the mucro to the posterior slits. There is a low, semicircular, rounded callus near the margin above the slightly roughened insertion teeth (pl. 5, fig. 6).

Anterior valve with 11, intermediate valves with 1–1, posterior valve with 10 slits.

Entire surface of shell very finely granulose. Anterior valve with immediate apex smooth; elsewhere with from 24–34 low, rounded, radial ribs, separated by shallow but rather sharply cut grooves; the ribs rarely showing a tendency to bifurcation, and typically ornamented with a series of some 6–8 separate, sharply elevated, round pustules, the posterior series on each side containing fewer pustules (4–6) a little larger than the others and projecting like denticles past the margin of the valve. Intermediate valves with lateral areas sculptured like the anterior valve, the 3–4 low ribs intergrooved as above, and bearing 2–3 pustules each, a series of 4–5 larger pustules occurring along the valve margin; central areas ornamented by some 20 (valve 7) to 24 (valve 4) straight or slightly curved, faintly nodulose, longitudinal riblets on each side, these riblets connected by slightly smaller and less regular transverse crossbars in such a manner that in some lights the surface appears reticulate, in others as though cut into lines of small square pits which become more irregular where the ribs curve over the jugal tract. Posterior valve with posterior and central areas very sharply delimited by a nearly straight line, the sculpture corresponding to that of the intermediate valves; posterior area with about 20–24 radiating pustulose ribs (pl. 6, fig. 2).

Girdle wide, averaging about a quarter the width of the median valves. Dorsal scales translucent, strongly convex, loosely imbricating, their convexities as a rule, except in the posterior region, directed obliquely outward and forward (pl. 6, fig. 4); variable in size, but largest near the shell, becoming exceedingly small at the outer margin, while a few scales larger than their immediate neighbors and of a more opaque whitish color occur scattered with no apparent regularity among the others. Mounted in balsam some of the smaller scales show a faint striation, but the larger appear almost perfectly smooth. Marginal armature comprising quite numerous, very minute, finely striate, conical, transparent spines, with a few scattered needle-like spines among them. Ventral scales minute, rectangular, rod-like, very closely ranked in transverse series (pl. 3, fig. 8).

Color of shell in alcohol a light grayish tan, faintly mottled with cloudings of a ruddier tone. Girdle pale above, with indistinct sutural bands of a darker shade. Entire ventral surface of animal and girdle a light pinkish tan. Interior of shell creamy, shading to warm tones of pink and salmon in the deeper regions.

Radula with strong, unicuspid major laterals, winged minor laterals, and well developed, fan-shaped rhachidian teeth (pl. 3, fig. 9).

Ctenidia about 28 on each side, extending forward to the second valve.

Length of entire animal (type-specimen) 21, of shell, 18.5 mm.; width of same 12.5, of shell 8 mm.; maximum width of girdle, 2.5 mm.

Type.—Cat. No. 215631, U.S.N.M. [S. S. B. 115].

Type-locality.—Station 4808,[1] 47 fathoms; bottom of sand, shells, and coarse gravel; off Cape Tsiuka, Japan; July 16, 1906 (three specimens).

Remarks.—*I. interfossa* is a very neat appearing little species and apparently a typical *Lepidozona.* Though much resembling the preceding species in form and sculpture, the color alone is sufficient for preliminary separation of the specimens, while a more minute examination reveals numerous differences. The special features are the large, smooth, whitish dorsal scales of the girdle; sharply angled jugum; beaked valves; sharply-cut grooves between the ribs of the anterior valve and lateral areas; the number of these ribs; and the very regular, basket-like sculpturing of the central areas, the longitudinal riblets being distinctly wider than the intervening spaces.

Of allied species *I. cultratus* Carpenter, according to Pilsbry's description, differs from both *I. amabilis* and *I. interfossa* in having

[1] These specimens were originally in the same vial as those of *I. amabilis*, so that here also the station number on the label requires correction.

but 4 ribs (separated by rather acute interstices, as in *interfossa*) on the lateral areas, 13 on the anterior valve, and but 16 narrow riblets on the central areas, the latter connected by irregular wrinkles rather than transverse bars. The anterior valve has only 8 slits, and the convex, *nondentate* sinus of the remaining valves is also distinctive if correctly observed. The dorsal girdle scales are said to be weakly striate.

I. craticulatus (Gould) differs from both the *Albatross* species in the far more numerous riblets of the lateral areas ("8–10"), and of the anterior valve ("about 50"), the minute latticing of the central areas, and the fact that the teeth of the head valve are said to be "distinctly notched or nicked at the edges and deeply, coarsely grooved outside." The girdle scales are described as striate.

I. coreanicus (Adams and Reeve) is insufficiently known and hence not liable to comparison with the above species in any certain fashion at the present time, though Pilsbry[1] has suggested a possible identity with *I. craticulatus.*

The only other *Lepidozona* which I can find to have been recorded from this region is *I. mertensii* (Middendorff), a much more coarsely sculptured species, with which none of the *Albatross* forms are likely to be confounded.

ISCHNOCHITON (LEPIDOZONA) PILSBRYANUS, new species.

Plate 6, figs. 5–9; plate 7.

Description.—Animal small, elevated, the sides only slightly convex; maximum transverse diameter a little less than half the length, or of shell alone about three-sevenths the length.

Anterior valve rounded, conical, its slope straight in front, becoming slightly convex on the sides (pl. 7, fig. 1). Interior smooth, marked with a series of about 13 delicate radiating lines corresponding to the marginal slits; teeth beveled, slightly rugose at the edges and obscurely and irregularly striate outside (pl. 7, fig. 2).

Median valves elevated, not beaked, high arched, sharply angled at the jugum, the side slopes nearly straight or very slightly convex. Sutural laminae short and broad; connected across the sinus by a delicate, scarcely projecting, very weakly dentate plate, the outline of the latter varying from strongly convex in the second valve to slightly concave in the more central valves, and showing apparently but about 8 slits, though there are some 10–12 of the incised lines which ordinarily correspond. Eaves short, relatively solid (pl. 7, figs. 1–4).

Posterior valve with mucro nearly median; posterior slope strongly concave; sutural laminae as described above, the minute slits and lines each about 8 in number; similar lines radiate from the mucro

[1] Man. Conch., vol. 15, p. 85.

region to the posterior slits, the concavity of the mucro forming the base of a low V-shaped callus extending forward; insertion teeth irregularly roughened at margin (pl. 7, figs 2, 5).

Anterior valve of paratype with 13 slits; intermediate valves with 2–2, 1–1, 1–1, 1–2, 2–2, 2–2 slits; posterior valve with 13 slits.

Entire surface of shell rather closely, heavily granulose. Anterior valve ornamented with many narrow radiating ribs, their total number about 55 at the margin, but becoming fewer and finally almost obsolete toward the apex, said ribs for the most part broken into a close set series of perhaps 20 low, distinct, rounded pustules, the latter often somewhat worn, and the posterior series larger and fewer (about 12) but so nearly obsolete as barely to dentate the margin; interspaces shallow and ungrooved. Intermediate valves with lateral areas slightly elevated and sculptured as above, the pustulose ribs 5–7 in number, and with a series of some 7–10 larger, but more obsolete, pustules bordering the posterior margin; central areas with 20 (valve 7) to 26 (valve 4) pustulose riblets on each side, usually a little narrower than their interspaces, the pustules small but distinct and coinciding with the lines of growth so as to appear grouped in squares, though usually the transverse connecting ridges are very faint if present at all; both ribs and pustules obsolete over the jugal tract. Posterior valve with posterior and central areas sharply delimited, the mucro forming an obtuse angle in their boundary; sculpture as above, the posterior area with 30–35 radiating pustulose ribs similar to those of the lateral areas (pl. 6, fig. 7).

Girdle wide, averaging about one-fourth the width of the median valves. Dorsal scales translucent, rather small, crowded, closely imbricate (pl. 6, fig. 8), their convex surfaces very finely ribbed-striate, the numerous (12–18) riblets being so delicate that the scales appear smooth under low magnifications (pl. 6, fig 9; pl. 7, fig. 6). Marginal scales small, partly needle-like, partly robust spiniform, the latter finely striate (pl. 7, fig. 6).

Color of shell in alcohol a light tan with scattered dark red-brown spots on the central areas and more numerously along the jugum, where they blend to form conspicuous triangular maculations. Girdle tan above, but darker and duller in tone than the groundwork of the shell and very indistinctly mottled with brown. Ventral surface of animal and girdle a light tan. Interior of shell a pale flesh color, some of the valves showing a narrow brownish ray on each side of the jugum.

The radula has strongly bicuspid major laterals, minutely winged minor laterals, and fan-shaped rhachidian teeth (pl. 7, fig. 7).

Ctenidia about 30 on each side, extending forward to the second valve.

Length of entire animal (type-specimen) 24, of shell 22 mm.; width of same 13, of shell 9 mm.; maximum width of girdle, 2.7 mm.

Type.—Cat. No. 215632, U.S.N.M. [S. S. B. 118].

Type-locality.—Station 4810; 195 fathoms; bottom of fine gray sand; bottom temperature 44.7° F.; off Cape Sirakami, Japan; July 16, 1906 (two specimens).

Remarks.—This handsome species is well characterized, the only one apparently requiring comparison with it being the *I. craticulatus* of Gould, but the latter is a more heavily granulose species and should be, according to the figures given by Pilsbry in his Manual, quite easy to distinguish. The special features of *I. pilsbryanus* seem to be in brief as follows:

1, the pale, tawny coloration.

2, the sharply arched, elevated shell.

3, the sculpture of numerous finely granulose riblets prevailing nearly all over the shell, and the arrangement of the pustules in squares without interlatticing on the central areas.

4, the reduplication of teeth and slits in many of the intermediate valves.

5, the numerous insertion slits (13) in each of the terminal valves.

6, the crowded, closely imbricating, very finely ribbed-striate dorsal scales.

The dedication of this species to Dr. Henry A. Pilsbry will require no apology to students of the group.

Family MOPALIIDAE.

Genus PLACIPHORELLA Carpenter, 1878.

PLACIPHORELLA STIMPSONI (Gould, 1859).

Plate 8, figs. 1–2; plate 9.

1859. *Chiton (Molpalia) stimpsoni* Gould, Proc. Bost. Soc. Nat. Hist., vol. 7, p. 161.

1860. *Chiton (Molpalia) stimpsoni* Gould, Otia Conch., p. 118, [fide Dall].

1886. *Placiphorella stimpsoni* Dall (part), Proc. U. S. Nat. Mus., vol. 9, p. 210.

1892. *Placiphorella stimpsonii* Pilsbry, Man. Conch. (1), vol. 14, p. 307, pl. 62, figs. 84–87.

Material.—The *Albatross* expedition took two specimens of this species between tides at Hakodate, Japan [S. S. B. 93].

Remarks.—I can add little to the excellent description given of the apparently somewhat variable shell characters by Pilsbry, but the preservation of the specimens in alcohol renders possible a few additional observations on the girdle. There is a series of large bristles near the middle of the girdle, one opposite each suture, and five or six continuing around the head valve. Other series of large bristles adorn the anterior lobe, more especially near the margin, in addition to a number of smaller and less definitely arranged bristles and tufts of spines. The figure of one of the large bristles by Carpenter, which appears in the Manual (vol. 14, pl. 62, fig. 86) is very misleading, and I can only surmise that he must have mistaken the white or light-colored bands of spines, revealed by these specimens under a sufficiently high magnification, for spineless areas. When perfect the light and dark brown bands in alternation are a conspicuous feature of the bristles. An attempt is made to convey some idea of this in the accompanying drawing (pl. 9, fig. 4). Here it also appears that the spinose armature of all the larger bristles is exceedingly heavy, the spines being crowded upon one another in a fashion not conspicuously different from that observable in *P. velata* Carpenter. These two species are indeed exceedingly close and resemble one another much more nearly than either patterns the various Alaska-Bering Sea forms, with which they have at times been confounded.

In addition to those mentioned by Pilsbry, the following differences from California specimens of *P. velata* may be noted:

1, the shorter, wider valves.

2, the flatter outline.

3, the conspicuously marbled slate and buff coloration.

Outline drawings of the valves (pl. 9, figs. 1–3) and the typically Mopalioid radula (pl. 9, figs. 7–8) aie here given, the latter for the first time.

The ctenidia number about 26 on each side.

PLACIPHORELLA BOREALIS Pilsbry, 1892.

Plate 8, figs. 3–5; plate 10.

1886. *Placiphorella stimpsoni* DALL (part), Proc. U. S. Nat. Mus., vol. 9, p. 210.
1892. *Placiphorella borealis* PILSBRY, Man. Conch. (1), vol. 14, p. 309, pl. 66, figs. 14–17.

Material.—Station 4803; 228 fathoms; bottom of black sand and gravel; bottom temperature 35.4° F.; off Cape Rollin, Simushir Island, Kuril Group; June 24, 1906 (seven specimens) [S. S. B. 94]. Four specimens are entered as Cat. No. 215633, U.S.N.M.

Remarks.—The shell of this species is the subject of a careful and detailed description by Pilsbry, but as the girdle characters have hitherto remained unknown it seems worth while to describe them in some detail. The dorsal surface of the entire girdle is covered with very minute pointed spinelets, rather heavily distributed. Among these one occasionally finds scattered spines or groups of spines slightly larger in size, a condition more evident near the margin than elsewhere. In addition occur the usual armored bristles characteristic of the genus, the most conspicuous being a fairly regular series bordering the entire anterior lobe a short distance within the margin, but inside of these only a few scattered bristles are evident, and taken as a whole the girdle is remarkably free of them. Most of them are quite broken away in my material, but a series of the stumps or "pores" can be made out running clear around the girdle, most of them corresponding to the sutures in position, though there are at least 6 or 7 behind the tail valve, and 2 in the same series on either side of the head valve. The extreme margin of the anterior lobe is decorated with a single series of short, very spinose bristles, between and beneath which occur a row of spines springing directly from the substance of the girdle itself (pl. 8, fig. 5). Toward the front of the lobe the spinose bristles are quite close together, but, although continued around the entire lobe, they become progressively smaller and more infrequent toward the sides and rear. The anterior margin frequently, if not always, exhibits a microscopic crenulation corresponding roughly to the bristles so that from certain aspects the latter appear as though borne upon small lobes. The contrast between the two types of bristles (i. e., marginal and dorsal) is very marked. The marginal bristles (pl. 10, fig. 6) have a bushy appearance, due to the very numerous spines, which, though not actually curved, often appear so because of the angle at which they project from the more or less twisted core. The dorsal bristles (pl. 10, fig. 4) are very narrow, trim, and slender, but larger, their long straight spinelets being much less crowded and closely applied to the core of the bristle for practically their entire length. Their arrangement is throughout very neat and regular. A cross section shows only about 8 spines to the tier on this type of bristle. The bristles do not appear to be banded, but are nearly uniform in color.

The radula (pl. 10, fig. 9) is of the same type as that of *P. stimpsoni* and *P. velata*, but the teeth show numerous differences in detail.

The ctenidia number 22–24 on each side.

The species has not been reported since its foundation by Pilsbry upon the valves of a single specimen obtained by Grebnitzki at Bering Island. The present record, therefore, constitutes a very appreciable extension of the known range. Despite his inadequate material, Pilsbry succeeded in acutely discriminating all the more important shell characters. *P. borealis* is, in fact, a very distinct species, and in the radiate sculpture of the anterior valve, complete sinus, and peculiar bristles, possesses features sufficient effectually to prevent confusion with any of the other described species, unless we consider the *Placophoropsis* group, the members of which are well separated by their subgeneric characters.

From *P. velata* and *P. stimpsoni* the more sparsely hairy girdle and much weaker armature of the bristles are striking differences.

Family CHITONIDAE.

Genus CHITON Linnaeus, 1758.

CHITON, species.

Plate 8, fig. 6.

A small specimen collected between tides at Aikawa, Rikuzen [S. S. B. 120], Cat. No. 215634, U.S.N.M., can not be identified with any of the described Japanese Chitonidae. It is quite likely new, and the accompaning illustration was prepared in the expectation of so treating it. Unfortunately the specimen seems at one time to have suffered immersion in formalin or some other decalcifying medium. At any rate, the valves proved so soft and subject to disintegration upon removal that their characters could not be made out with enough accuracy to justify naming the specimen. When the species is later rediscovered it may perhaps be recognized by the figure.

EXPLANATION OF PLATES.

PLATE 1.

FIG. 1. *Leptochiton diomedeae* Berry [95], dorsal aspect of first, third, and last valves of type specimen; × 8.

2. *Leptochiton diomedeae* Berry [95], entire animal in ventral aspect; × 3.
3. *Leptochiton diomedeae* Berry, dorsal view of portion of girdle of same specimen; drawn from a mount in balsam; × 28.
4. *Ischnochiton* (*Ischnoradsia*) *albrechti* Schrenck [83], dorsal view of portion of girdle; drawn from a mount in balsam; × 7½.
5. *Ischnochiton* (*Ischnoradsia*) *albrechti* Schrenck, a few scales from the same preparation as fig. 4 seen in greater magnification; × 27.
6. *Ischnochiton* (*Ischnoradsia*) *hakodadensis* Carpenter [85], dorsal view of portion of girdle of a specimen from Hakodate; drawn from a mount in balsam; × 10.
7. *Ischnochiton* (*Ischnoradsia*) *hakodadensis* Carpenter, a few scales from the same preparation as fig. 6 seen in greater magnification; × 27.

PLATE 2.

FIG. 1. *Leptochiton diomedeae* Berry [95], exterior view of first, third, and last valves of type; camera drawing; × 9.

2. Interior view of same, same scale.
3. Anterior view of third valve; same scale.
4. Isolated girdle scales from same specimen, the four larger from the dorsal, the four smaller from the ventral surface of the girdle; camera drawing from a mount in balsam; × 163.
5. Portion of girdle margin of same specimen, seen from above; camera outline from a mount in balsam; same scale as preceding.
6. Teeth from radula of same specimen; camera drawing from a mount in balsam; × 163.

Plate 3.

Fig. 1. *Ischnochiton* (*Ischnoradsia*) *albrechti* Schrenck [83], isolated girdle scales drawn by camera from a mount in balsam; the largest scale shows radial striae, the others transverse color bands; × 31.

2. Isolated radula teeth from same specimen; camera drawing from a mount in balsam; × 31.
3. *Ischnochiton* (*Ischnoradsia*) *hakodadensis* Carpenter [84], isolated girdle scales of a specimen from Mororan; camera drawing from a mount in balsam; × 31.
4. Isolated radula teeth from same specimen; camera drawing from a mount in balsam; × 66.
5. *Ischnochiton* (*Ischnoradsia*) *hakodadensis* Carpenter [85], isolated radula teeth of a specimen from Hakodate; camera drawing from a mount in balsam; × 66.
6. *Ischnochiton* (*Lepidozona*) *amabilis* Berry [113], isolated girdle scales of paratype; camera drawing from a mount in balsam; × 31.
7. Two major lateral teeth from radula of same specimen, camera drawing from a mount in balsam; × 66.
8. *Ischnochiton* (*Lepidozona*) *interfossa* Berry [114], isolated girdle scales of paratype; camera drawing from a mount in balsam; × 31.
9. Isolated teeth from radula of same specimen; camera drawing from a mount in balsam; × 66.

Plate 4.

Fig. 1. *Ischnochiton* (*Ischnoradsia*) *hakodadensis* Carpenter [85], dorsal aspect of a specimen from Hakodate; × $1\frac{1}{5}$.

2. Ventral aspect of same specimen; same scale.
3. Dorsal aspect of fourth valve of another specimen from the same lot; × 4.
4. *Ischnochiton* (*Lepidozona*) *amabilis* Berry [112], dorsal aspect of type; × 2.
5. Dorsal aspect of a portion of girdle of paratype [113]; camera drawing from a mount in balsam; × 11.
6. Portion of same preparation under greater magnification; × 50.
7. Dorsal aspect of first, fifth, and last valves of paratype [113]; × $6\frac{2}{3}$.

Plate 5.

Fig. 1. *Ischnochiton* (*Lepidozona*) *amabilis* Berry [113], exterior view of first, fifth, and last valves of paratype; camera drawing; × $6\frac{1}{2}$.

2. Interior view of same; same scale.
3. Anterior view of fifth valve; same scale.
4. Profile of last valve; same scale.
5. *Ischnochiton* (*Lepidozona*) *interfossa* Berry [114], exterior view of first, fifth, and last valves of paratype; camera drawing; × 6.
6. Interior view of same; same scale.
7. Anterior view of fifth valve; same scale.
8. Profile of last valve; same scale.

PLATE 6.

FIG. 1. *Ischnochiton (Lepidozona) interfossa* Berry [115], dorsal aspect of type; × 2.
2. *Ischnochiton (Lepidozona) interfossa* Berry [114], dorsal aspect of first, fifth, and last valves of paratype; × 6.
3. Dorsal aspect of portion of girdle of same specimen; drawn from a mount in balsam; × 12.
4. Portion of same preparation under greater magnification; × 43. On the immediate area selected for illustration the scales are less crowded than is typically the case.
5. *Ischnochiton (Lepidozona) pilsbryanus* Berry [118], dorsal aspect of type; × 1½.
6. Ventral aspect of same; same scale.
7. *Ischnochiton (Lepidozona) pilsbryanus* Berry [119], dorsal aspect of first, third, and last valves of paratype; × 4.8.
8. Dorsal aspect of portion of girdle of same specimen; drawn from a mount in balsam; × 9½.
9. Portion of same preparation under greater magnification; × 27. The scales are typically much more crowded than appears in the drawing.

PLATE 7.

FIG. 1. *Ischnochiton (Lepidozona) pilsbryanus* Berry [119], exterior view of first, third, and last valves of paratype; part camera drawing; × 7.
2. Interior view of same; same scale.
3. Anterior view of third valve; same scale.
4. Interior view of left side of second valve; same scale.
5. Lateral view of tail valve; same scale.
6. Isolated girdle scales from same specimen; camera drawing from a mount in balsam; × 25.
7. Isolated teeth from radula of same specimen; camera drawing from a mount in balsam; × 52.

PLATE 8.

FIG. 1. *Placiphorella stimpsoni* (Gould) [93], dorsal aspect of a specimen from Hakodate; slightly magnified.
2. Ventral aspect of same; same scale.
3. *Placiphorella borealis* Pilsbry [94], dorsal aspect of a specimen from 228 fathoms, off Simushir Island; same scale.
4. Ventral aspect of same; same scale.
5. Portion of margin of anterior lobe of girdle of another specimen from the same lot; viewed ventrally from a preparation in balsam; × 18.
6. *Chiton* species [120], dorsal aspect of a specimen from Aikawa; × 2.4.

PLATE 9.

FIG. 1. *Placiphorella stimpsoni* (Gould) [93], exterior view of first, fourth, and last valves; camera drawing; × 2½.
2. Interior view of same; same scale.
3. Posterior view of sixth valve; same scale.
4. Basal portion of large spinose bristle from anterior lobe of girdle of same specimen; camera outline from a mount in balsam; × 65.
5. Isolated spine from large bristle; camera drawing; × 65.
6. Portion of margin of girdle near front of anterior lobe of same specimen; camera drawing from a mount in balsam; × 65.
7. Isolated teeth from radula of same specimen; camera drawing from a mount in balsam; × 65.
8. Series of teeth from one side of radula of same specimen; same scale as fig. 7.

PLATE 10.

FIG. 1. *Placiphorella borealis* Pilsbry [94], exterior view of first, third, and last valves; camera drawing; × 2¼.

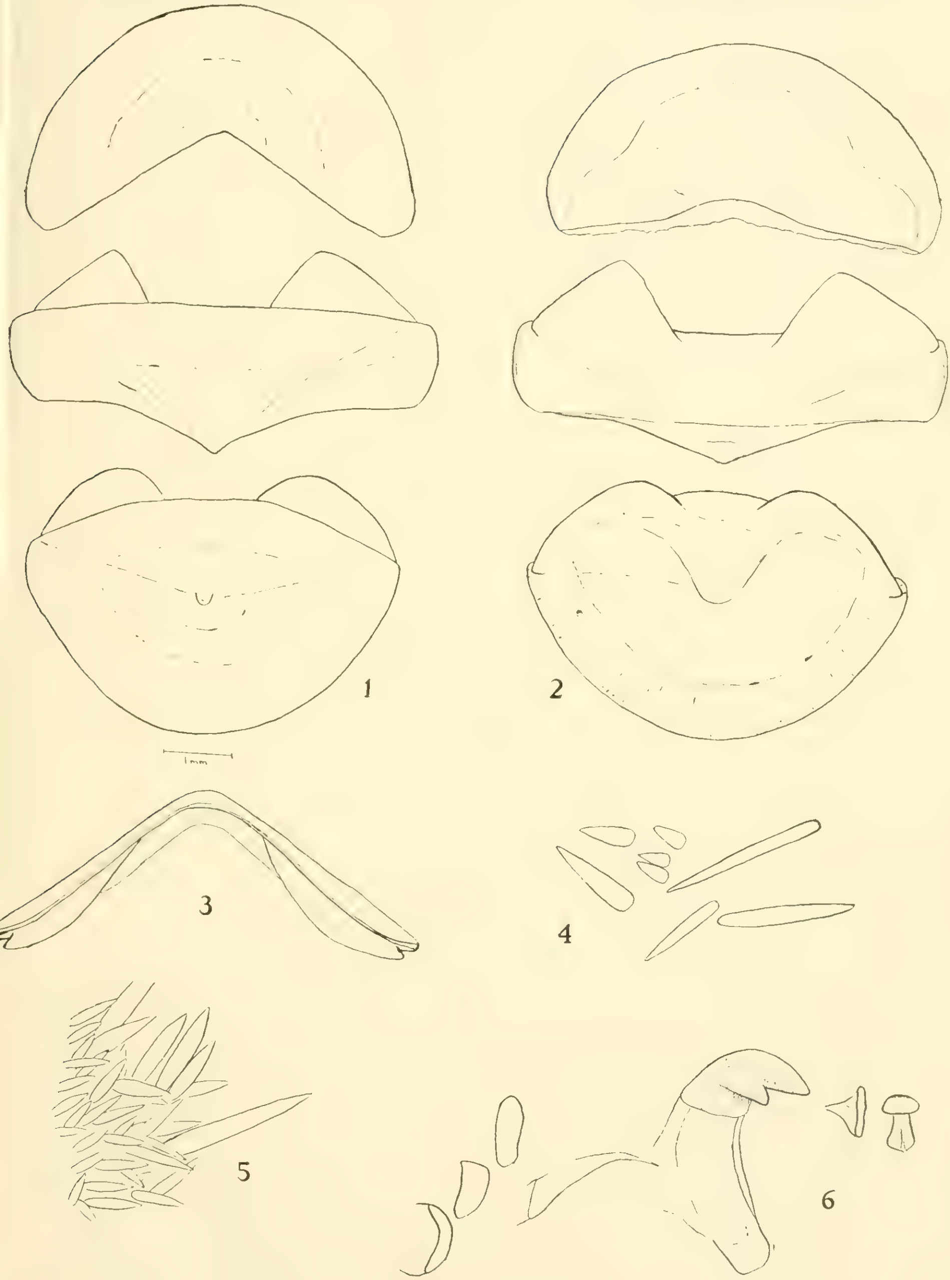
2. Interior view of same; same scale.
3. Posterior view of fifth valve; same scale.
4. Basal portion of large spinose bristle from anterior lobe of girdle of same specimen; camera outline from a mount in balsam; × 60. On most bristles the spines appear to be more closely placed than is indicated in the drawing.
5. Portion of ventral surface of anterior lobe of same specimen, showing patches of spinelets; camera drawing from a mount in balsam; × 60.
6. Basal portion of marginal spinose bristle from anterior lobe of girdle of same specimen; camera drawing from a mount in balsam; × 60.
7. Isolated spines from ventral surface of anterior lobe of same specimen; camera drawing from a mount in balsam; × 150.
8. Isolated girdle and bristle spines from same specimen; camera drawing from a mount in balsam; × 150.
9. Isolated teeth from radula of same specimen; camera drawing from a mount in balsam; × 60.

NOTE.—The drawings on Plates 1, 4, 6, and 8 are from the brush of Mr. E. Russel Lord-Wood.

The majority of the figures as originally prepared were intended for plates of a larger size than those used in these Proceedings. Then again the plates first made were destroyed by fire and the make-up of several of them subsequently rearranged. This resulted in changes in the degree of magnification of the figures at a time when most of the specimens were no longer available for checking. There is therefore an unavoidable source of possible error in the magnifications as given.

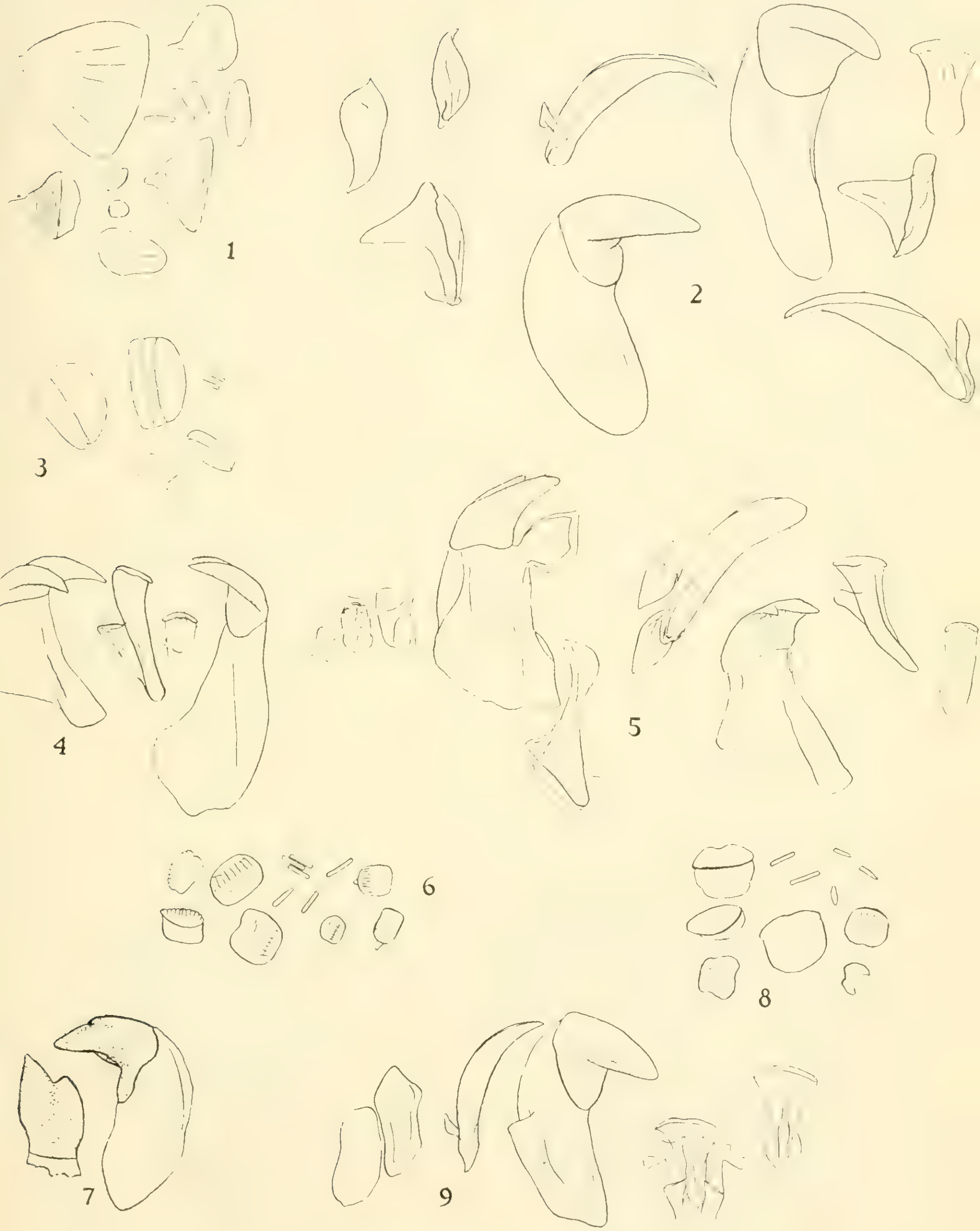
NORTHWEST PACIFIC CHITONS

FOR DESCRIPTION OF PLATE SEE PAGE 15



NORTHWEST PACIFIC CHITONS

FOR DESCRIPTION OF PLATE SEE PAGE 15



NORTHWEST PACIFIC CHITONS

FOR DESCRIPTION OF PLATE SEE PAGE 16

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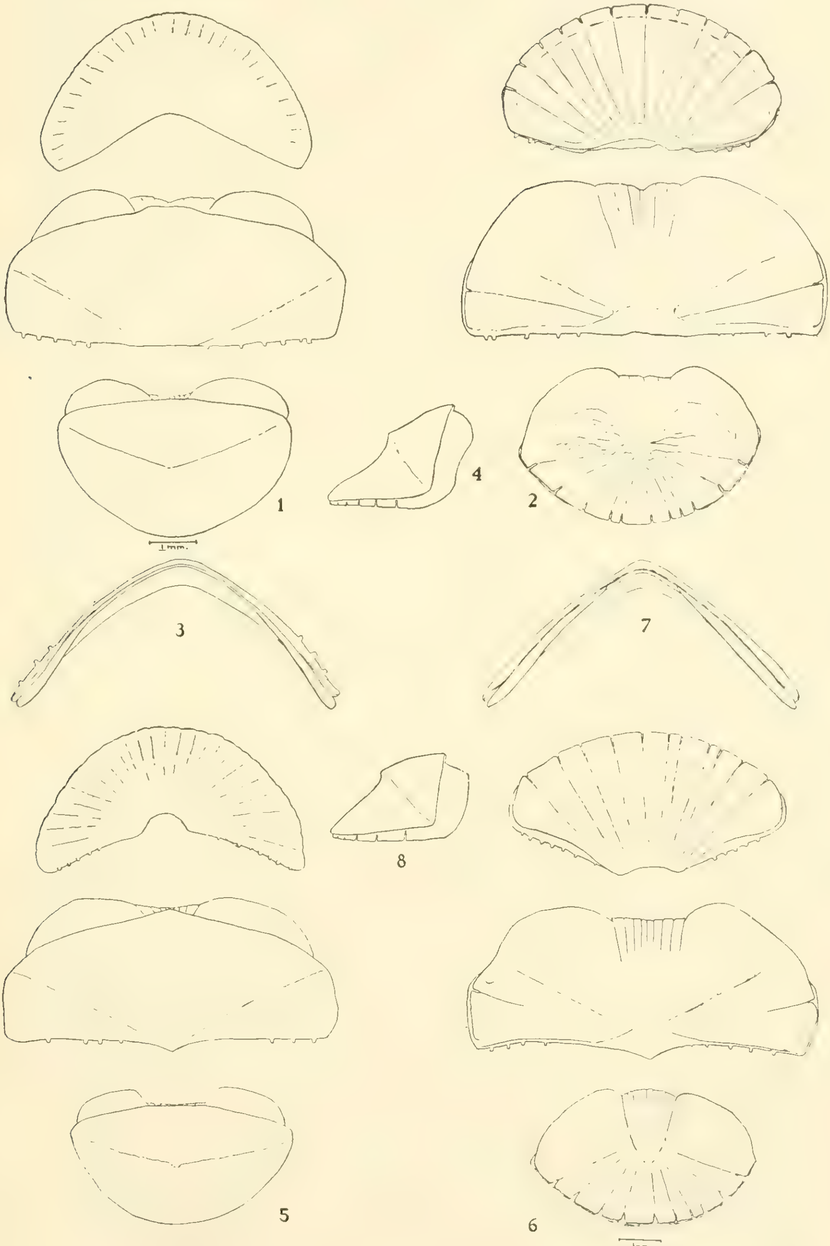

NORTHWEST PACIFIC CHITONS

FOR DESCRIPTION OF PLATE SEE PAGE 16

NORTHWEST PACIFIC CHITONS

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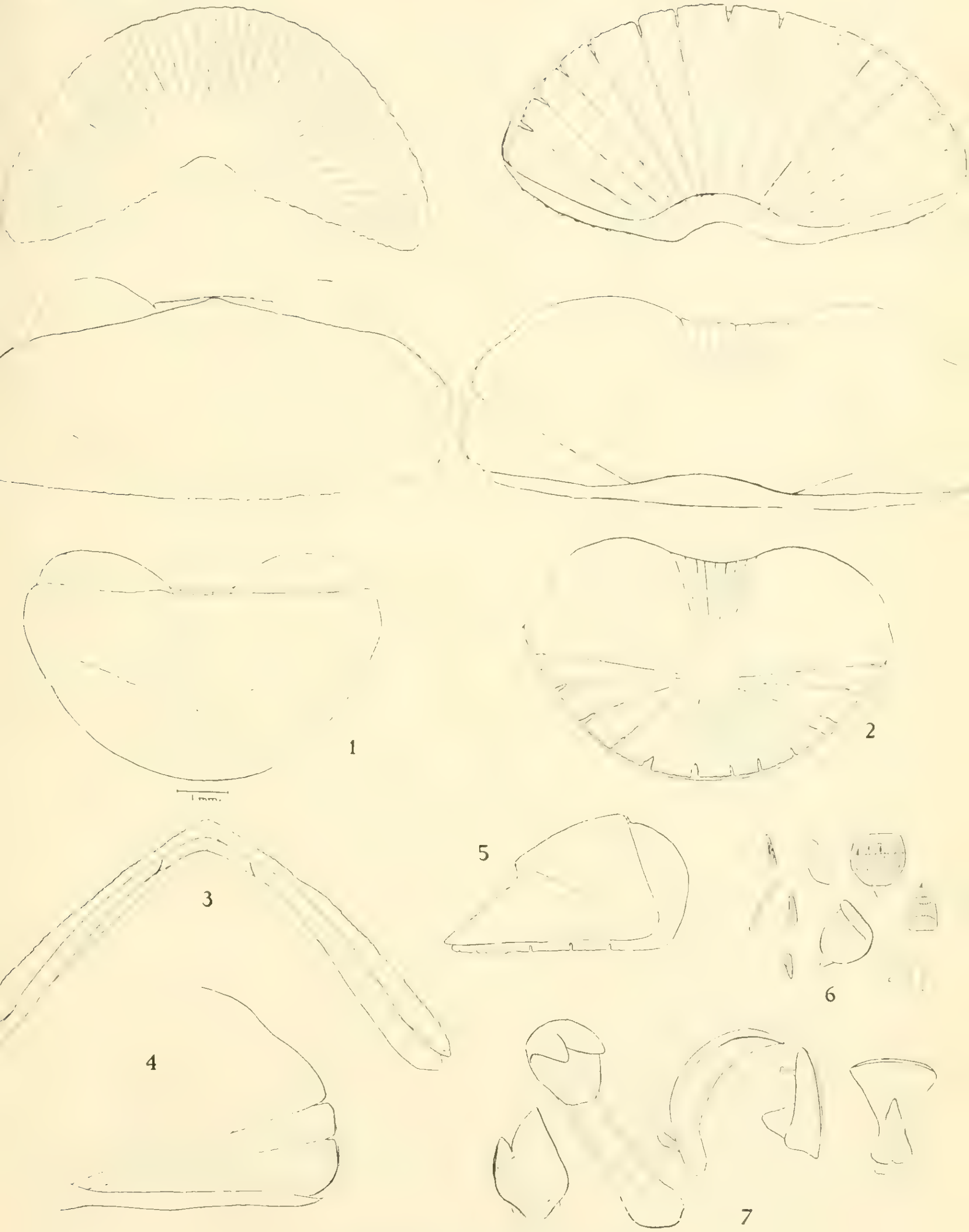

NORTHWEST PACIFIC CHITONS

FOR DESCRIPTION OF PLATE SEE PAGE 17

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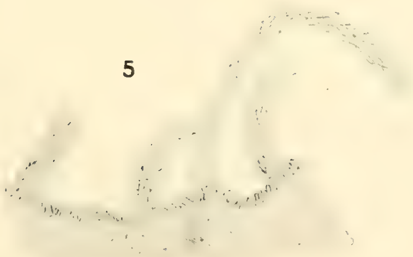

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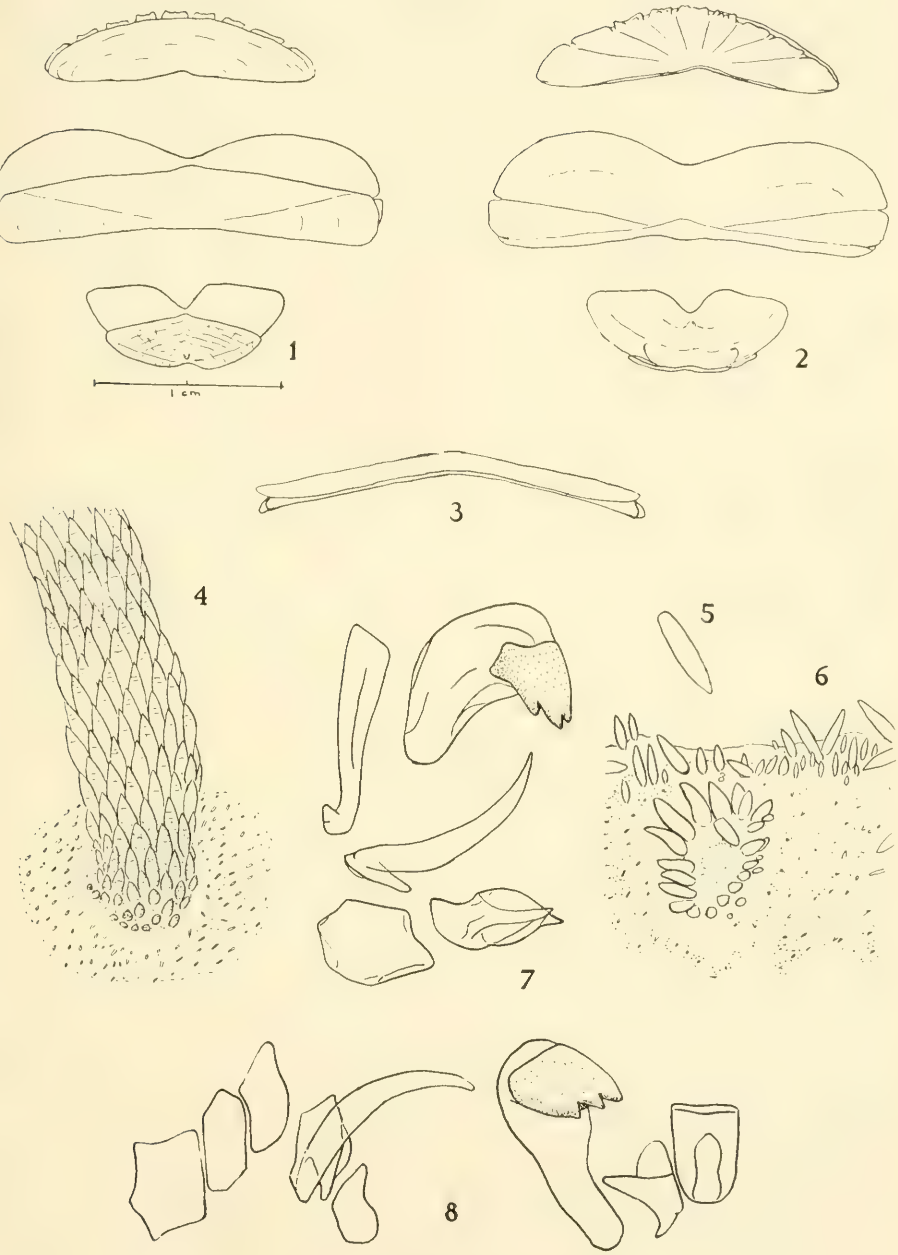
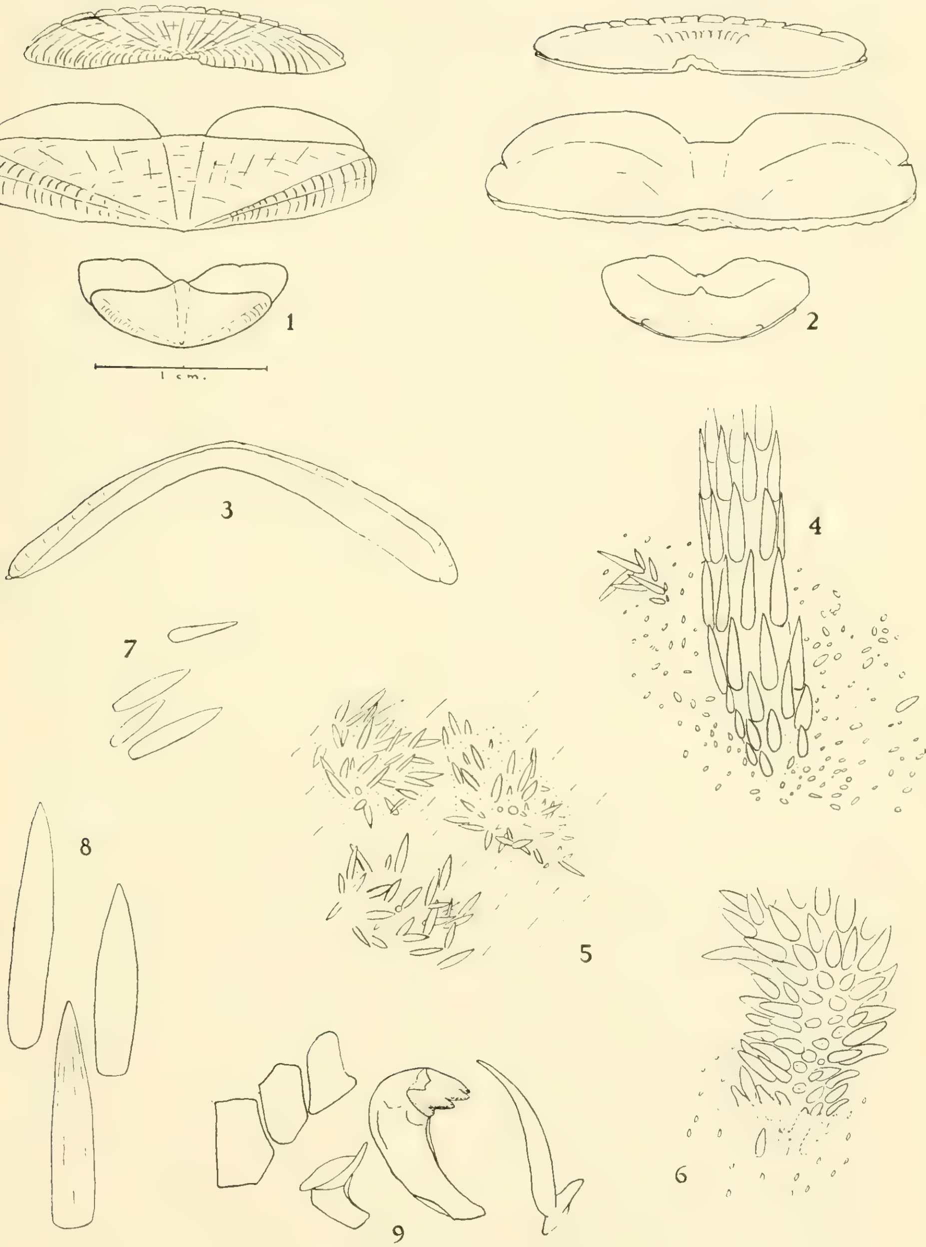
NORTHWEST PACIFIC CHITONS

FOR DESCRIPTION OF PLATE SEE PAGE 17



NORTHWEST PACIFIC CHITONS

FOR DESCRIPTION OF PLATE SEE PAGE 17



NORTHWEST PACIFIC CHITONS

FOR DESCRIPTION OF PLATE SEE PAGE

NOTES ON HAWAIIAN LIZARDS.

By John Otterbein Snyder,
Of Stanford University, California.

During the cruise of the United States Steamer *Albatross* in 1902 and on other occasions, the writer spent some time in observing the geckos and skinks on several islands of the Hawaiian group. Notes then made relating chiefly to their habits and distribution are here recorded. There is no occasion to attempt adding to the very complete descriptions of the species presented by Doctor Stejneger[1] in his paper on Hawaiian reptiles, but an observer might profitably employ himself in a study of their habits, life history, and local distribution. The geckos especially, which may be seen almost anywhere, are very peculiar, interesting, and engaging little animals. Considerable variation is found in their anatomical structure, color, and squamation; they live under a variety of conditions, and they may be easily kept in captivity.

In collecting the geckos a large pair of forceps proved useful, and a small shot-gun served to stop the more nimble and wary skinks. Specimens were dropped at once into a small quantity of 90 per cent alcohol which contained about 2 per cent formalin. They could then be carried in the jar all day without being affected by the hot, moist atmosphere. Later they were washed for a short time in water, pierced with the scalpel, and gradually hardened in alcohol.

The little white eggs of the geckos, not unlike those of humming-birds, never fail to attract attention. They are occasionally found after transportation to this country hidden in bunches of bananas or in the packing material of other tropical fruits. They are generally laid in any convenient place which is free from direct light, but they are not buried in the sand or moist earth like those of the skinks. The latter are elongate, pink when fresh, growing dark with the developing embryo. The shell is flexible and contains a relatively small amount of lime.

Gecko eggs are easily hatched if kept in glass-covered boxes away from direct light. As the eggs are more easily found in some places

[1] Proc. U. S. Nat. Mus., vol. 21, 1899, pp. 783-813. A brief paper by Richard C. McGregor deals with the lizards of Maui. (Proc. U. S. Nat. Mus., vol. 28, 1904, pp. 115-118.)

than the lizards themselves, ability to recognize those of the different species will aid in tracing their distribution. An interesting characteristic of the eggs of some forms is that when freshly laid the shells are soft, viscid, and flexible. They then adhere to each other, or to any foreign body which they happen to touch. They sometimes bear the appearance of having been forced with considerable pressure against some object the sides being greatly indented. On drying the shells become firm and hard, the surface retaining any impression that it may have received. The eggs of other species apparently have hard shells when laid, as they are not attached to objects, nor are their sides ever indented. Such eggs lie loose at the bottom of cavities in which they have been deposited. The period of incubation was not definitely determined. It seems short, however, as many eggs gathered July 6, some of which appeared to be quite fresh, were all hatched by August 14.

Doctor Stejneger's opinion that the lizards migrated to the islands with the ancestors of the Hawaiians is supported by observations of the habits of the geckos at least. Wherever large canoes were seen lying on the beach (a number of them were carefully examined), geckos were found concealed among the mats covering them. Eggs were found also in the canoes. It would be quite impossible at the present time to provision and launch a large canoe without including both adult geckos and their eggs.

The native name for the skink is "Moo," meaning lizard; for the gecko "Moo-kaula," a seer or magician-lizard. Some of the natives look upon the lizards with a degree of superstition, but they have no fear of them. They may be seen in the native huts and likewise in the best of houses. A number of them lived in the writer's stateroom for several months, finally arriving in San Francisco. They regularly appeared in the evening, running about the room in search of food. The climate here was apparently too cold, for they became torpid and refused to eat. They may be regarded as beneficial animals, as they destroy large numbers of insects.

Family GEKKONIDAE.

LEPIDODACTYLUS LUGUBRIS (Bibron).

Many more specimens of this species were seen than of all the others. Near Honolulu 102 examples of *L. lugubris* were noted in about two hours, while only five of other species were seen. At another time 144 specimens of *L. lugubris* were collected with only one each of the other species. The collector's catch should not be regarded as an index of the relative abundance of a species, and in this particular case it appears that the gregarious habit of the form was largely the cause of its being caught in such numbers. Geckos of a more wary nature, and those which closely resemble the bark of trees both in the color and roughness of the skin, are apt to be overlooked. *Hemidactylus garnotii*, for example, is well protected in this way, and moreover it seems to be possessed of keen vision, is cautious of danger, and swift in flight, frequently gliding like a flash from among other geckos which remain undisturbed at the approach of danger.

Many individuals of *L. lugubris* were often found huddled together in a small crevice where they were not exposed to direct light. In such cases they might be carefully removed with the forceps, until the number was considerably reduced, when those remaining would suddenly take fright and scatter in every direction. It was not only common to find them thus assembled in favorite crannies, but they were also frequently gathered in communities. For instance, every available crack in a particular part of an old board fence was occupied, while other sections of the same fence offering accommodations which to the observer appeared equally suitable sheltered very few individuals. Moreover, when the crevices of such a community were completely depopulated, it was found that after a short time they were recolonized. One such case will serve to illustrate. One hundred and forty individuals were taken from a portion of a fence. Each crevice was carefully examined and the lizards removed, very few escaping. After a lapse of 21 days the same place was again visited and 110 specimens found. These were all adults. Other experiments proved that the same individuals did not always retire to the same place on consecutive days, and it was also seen that members of different species often pass the day together in the same little den. In one instance eggs of three forms, with embryos in about the same stage of development, were found in one place together with adult individuals of two species.

Geckos are easily caught with long forceps, the instrument being useful in extracting them from the depths of cracks. When an individual found itself pursued with the forceps it either precipitately left its retreat or darted down to the innermost corner, where it remained perfectly motionless. If further troubled it usually moved the tail forth and back, often thrashing it with some violence. In one instance an excited individual slowly backed outward from the depths of its retreat, actually presenting the wriggling tail in the direction of danger. When seized the tail parted from the body, upon which the gecko instantly crouched down and remained motionless as if expecting the accepted offering to appease the enemy. Opportunity to repeat the observation was offered, and it became quite evident that individuals of the species when driven into close quarters instinctively offer a part of their bodies that they may escape with their lives. The tails reproduce quickly, and the individual is thus soon prepared for another encounter. Nothing was learned of the enemies of the geckos.

When caught the gecko sometimes utters a faint squeak, and in running about at night it occasionally makes a shrill, cricket-like sound, not audible to all ears. Two individuals at times approach one another and touch noses with a sharp chirp. This may be observed in the house after lamplight, when the geckos scamper about over the walls and curtains.

The eggs of *L. lugubris* are pyriform in shape. The shells are white, hard, and thick, and so firm that they may be dropped from the hand to the ground without always breaking. They measure from 6.2 to 6.8 by 8.8 to 9.2 millimeters. When laid the shell is soft and viscid, but it soon hardens and adheres to whatever it touches. The shells while soft usually become indented and variously modified in form by objects with which they come in close contact. They are found sticking against vertical surfaces or cemented together in clusters, often tightly wedged in narrow cracks. They may be seen in cracks of trees, boards, and posts, under loose bark, in clumps of leaves, under rocks, behind picture frames and books, or in any place that offers partial or entire concealment. Usually two to eight eggs are in a crevice, although one cavity was seen which contained 22 eggs of *L. lugubris*, together with several of *H. garnotii*, all with embryos in various stages of development.

In about two hours after hatching the young shed a thin, papery epidermis, which peels off in scraps, leaving the fresh skin bright and delicately marked with the grays, browns, and yellows of the adults. The young are very active, and when scarcely a day old pursue flies and mosquitoes with avidity. If touched with a bristle or straw they suddenly jump, then run a short distance, wriggling their tails violently, or quickly escape and conceal themselves. They are less nocturnal than the adults and may often be seen running about when the latter are hidden away. When 10 hours' old they measure 31 to 38 millimeters in length.

In life the color varies considerably in shade, and it appears that the lighter and darker ones possess a color in keeping with their surroundings. Geckos found among the dead leaves of the banana plant were very light, with a delicate brownish, yellowish, or pink tint, unlike those of the fences or tree trunks which were dark, in some cases quite dusky. It was seen with surprise, however, that the young on emerging from eggs which had been kept for a time on white cotton exhibited about the same degree of color variation as that of the adults. Opportunity to complete a few simple experiments suggested by the above did not occur.

No differences were observed on comparing specimens from Hawaii with numerous examples from Samoa.

Collected at Honolulu; Aiea, Oahu; Waimea, Kauai.

HEMIDACTYLUS GARNOTII Duméril and Bibron.

This is the largest and most brightly colored of the Hawaiian geckos. The upper parts present a fine mosaic of grays, browns, and blacks, with prominent white spots which are arranged in somewhat irregular rows. The under parts are bright lemon yellow, the throat barely tinted, the color more intense on chest and belly, the tail inclining to orange or even salmon red; ventral parts of legs yellow.

Individuals of the species appear to be solitary in habit, at least not gregarious like *L. lugubris*. One passes the day concealed in some crevice, from which it may be seen peering out, or it may be lying flat on the shady side of a limb conveniently near an opening in the bark. On an observer's approach it darts within, not always concealing itself. If not further disturbed it soon turns about and cautiously looks out. If a capture is attempted it either disappears within its retreat or instantly springs out and makes for another crevice, or scrambles nimbly up the tree on the side opposite the enemy. If closely pursued it may suddenly drop to the ground, where it lies sprawled out and perfectly motionless. When driven into a corner it turns about, opens its mouth, and thrusts out its tongue, which is moved along the lips in a characteristic way. It will bite one's finger, holding on tenaciously, although not able to produce the slightest wound.

The eggs are white, almost spherical, measuring 9 to 10 by 10 to 11 millimeters in diameter. The shells are smooth and firm, apparently neither soft nor sticky when laid. They are deposited loosely in crevices, often among eggs of *L. lugubris*. Four or five may occasionally be found in the same place.

The newly hatched young vary considerably in size, specimens about 10 hours old measuring 39.5 to 56 millimeters in length, the slender tail adding much to the elongate form. They are very active, snapping up small insects and occasionally springing upon flies almost too large for them to manage. When pursued with one's finger or a pencil they rush about in a panic, thrashing their tails from side to side. An egg, accidentally dropped and broken, freed a young gecko, which immediately disappeared to new cover, leaving the tail wriggling among the pieces of shell. The young are able to utter a scarcely audible squeak. On hatching, the skin is moist, but it soon dries and becomes silvery in color. Small areas of the epidermis loosen, puff out from the body, and eventually tear and break away, so that in from one to two hours the new skin appears bright and shining. The dorsal surface lacks the white spots of the adult; the under parts are light yellow or orange, deepening on the tail to orange or salmon red.

Honolulu; Aiea, Oahu; Puako Bay, Hawaii; Lahina and Wailuku River, Maui; Waimea, Kauai. Eggs of the species were found on Laysan Island.

PEROPUS MUTILATUS (Wiegmann).

The skin of this species is so thin and tender that a specimen may scarcely be caught without mutilating it. The struggles of the animal in one's fingers result in tearing great rents in the skin, and it is difficult to retain one between the tips of the forceps. The wounds thus made bleed but very little, and it appears that the fragile skin, like the easily broken tail, aids the animal at times in escaping from an enemy.

In life the under parts are more or less tinted with yellow, very bright in some examples, almost absent in others. The color is more intense on the hind legs and belly.

Eggs of the species, easily distinguished from the others, were secured and successfully hatched. Specimens of both the eggs and young were lost in transportation, and no description remains.

Honolulu; Waimea, Kauai; Puako Bay, Hawaii.

HEMIPHYLLODACTYLUS LEUCOSTICTUS Stejneger.

In life the whole body is slightly tinted with pink. The under parts from the throat posteriorly, including the legs, are pale yellow. In the younger specimens the tail is pale orange beneath. Where the tail has been reproduced, the yellow color stops short, the lately acquired part being dark beneath. The throat is spotted with dusky.

Eggs measuring 5.7 to 6.6 millimeters, smaller than those of other species, found under a bit of loose bark, proved on hatching to belong to this species. They were slightly indented and firmly cemented together. The young, just hatched, measured 29 millimeters in length; snout to tail, 15.5. They soon shed the epidermis, exhibiting the colors of the adult. They are precocious like the young of other forms.

Honolulu; Waimea, Kauai.

Family SCINCIDAE.

LEIOLOPISMA NOCTUA (Lesson).

One specimen was seen at Honolulu.

EMOIA CYANURA (Lesson).

Specimens collected by the writer exhibit two types of coloration [1] one with a well-defined, narrow, light band extending from the posterior edge of the rostral plate to at least the middle of the body; the other without a distinct median band, which if at all developed never extends on the head.

[1] Stejneger (Proc. U. S. Nat. Mus., vol. 21, 1899, p. 808) discusses the color variation of this species, and Werner (Zool. Jahrb. Syst., vol. 14, p. 384) describes some dark-colored examples from Molokai as *Lygosoma cyanurum schauinslandi*. The figure in Zoology of the Voyage of the *Coquille* (pl. 4, fig. 2) is of interest in this connection.

Examples from Waimea, Kauai, belong to the first type. In some of these a median band which covers the adjoining halves of two rows of scales is sharply outlined to the base of the tail, while in others it grows indistinct and blends with the lateral bands near the middle of the body. The lateral bands vary, as does the median one, occasionally fusing with the latter not far behind the shoulders, but always remaining distinct on the head and neck. There is no light band on the side, extending between the front and hind legs. In life the light bands are brassy, and many scales on the sides have a metallic sheen. The tail is not blue, but becomes so on immersion in alcohol.

The second type is represented by specimens from Hanalei Valley, Kauai, and from Wailuku Valley, Maui. In one individual three light bands are present. The median one, which covers two rows of scales, is well separated from the others, and extends from the occiput to near the base of the tail. Lateral bands extend from the eye to the same point posteriorly. In others the bands are more or less completely fused, forming a broad, light-colored area. All agree in being much darker, both on the dorsal and ventral surfaces, than those of the first type, the brassy bands being much duller and contrasting less strongly with the darker portions. In these also the bands have a metallic sheen in life and the tails are not blue.

An examination of this material seems to show that the color variation is not due to age or sex. It is worth mentioning that those of the first type were found in a relatively dry region where lantana and prickley pears flourish, while the others were taken at a high altitude from the moist ground beneath masses of ferns, in dense thickets of tropical vegetation.

Waimea and Hanalei Valley, Kauai; Wailuku River, Maui.

ABLEPHARUS POECILOPLEURUS (Wiegmann).

Unlike *Emoia cyanura*, this species appears to be confined to the dryer regions of low altitudes, and is not seen in the moist valleys of the mountains.

Of 10 adult specimens found on Laysan Island none possessed a perfect tail. They had suffered amputations at various times, one individual having a third growth. Lizards' tails are not mentioned in papers dealing with the food of birds, the probable enemies of Laysan skinks.

Puako Bay and Waimea, Hawaii; Laysan Island.

NUCULITES FROM THE SILURIAN FORMATIONS OF WASHINGTON COUNTY, MAINE.

By Henry Shaler Williams
Cornell University, Ithaca, New York.

CONTRIBUTIONS TO THE GEOLOGY OF MAINE.

In the year 1897 the writer began a study of the Paleozoic rocks and fossils of eastern and northeastern Maine.

As the work proceeded a series of publications have been issued, by several agencies, illustrating the new facts regarding the geology and paleontology as they have been elaborated.

As all of these papers are more or less intimately related to each other, it may be convenient for the reader to have before him a list of them, with date, place of publication, and general nature of contents.

I. Contributions to the Geology of Maine. Bulletin United States Geological Survey, No. 165, 1900, 8, 212 pp., 14 pls. and maps.

Part I. The Paleozoic faunas of Maine: a preliminary report upon the Paleozoic faunas already known and upon new faunas recently collected from Aroostook County, by Henry S. Williams.

Part II. Geology of the Aroostook volcanic area of Maine, including an account of the clastic rocks of Aroostook County, by Herbert E. Gregory.

Part III. List of Localities of Paleozoic, igneous and other crystalline rocks examined during the seasons of 1897 and 1898, by Henry S. Williams.

In this bulletin the following geological formations are named and defined and preliminary lists given of their fossils, by which their position in the geological time scale is determined:

9. Mapleton sandstone	Devonian.
8. Moose River sandstone	
7. Chapman sandstone	Silurian.
6. Square Lake limestone	
5. Ashland limestone	
4. Ashland shale	
3. Sheridan sandstone	
2. Graptolite shales	
1. Aroostook limestone	

No new species of fossils are described, but a couple of plates of figures of *Rhynchonella mainensis* Billings and other species from the Square Lake limestone, illustrating the variability expressed by representatives of this one genus in the restricted limits of this one limestone bed, are given and discussed.

II. The Silurian-Devonian boundary in North America, I, The Chapman Sandstone fauna. Amer. Journ. Sci., vol. 9, 1900, pp. 203–213.

III. The Silurian-Devonian boundary in North America. A discussion of the problems involved in determining geological boundary planes. Bull. Geol. Soc. Amer., vol. 11, 1900, pp. 333–346.

IV. Note on fossils collected by N. S. Shaler from the Cobscook Bay region of Washington County, Maine, incorporated in Smith and White's paper on The Geology of the Perry Basin in Southeastern Maine. U. S. Geol. Survey, Professional Paper No. 35, 1905, pp. 21–27.

V. A new Brachiopod, *Rensselaeria mainensis*, from the Devonian of Maine. Proc. U. S. Nat. Mus., vol. 32, pp. 267–269.

In this paper the new species, *Rensselaeria mainensis*, is described and figured. The types are from the Chapman sandstone of Aroostook County, Maine. The types are deposited in the United States National Museum.

VI. On the revision of the Mollusk genus Pterinea Goldfuss. Proc. U. S. Nat. Mus., vol. 34, pp. 83–90, published April 17, 1908.

In this paper the new genera *Tolmaia*, *Follmanella*, *Actinopterella*, and *Cornellites* are defined. This revision was incident to the classification and description of the Pterinoid fossils of the Chapman sandstone formation.

VII. Some new Mollusca from the Silurian formations of Washington County, Maine. Proc. U. S. Nat. Mus., vol. 42, No. 1908, pp. 381–398, with plates 49 and 50. Published July 3, 1912.

In this paper the new genus *Eurymyella* was defined and the species, *Eurymyella shaleri*, *E. shaleri*, var. *breva*, var. *longa*, and var. *minor*, and *Eurymyella angularis*, *E. simulans*, *E. plana*, *E. recta*, *E. convexa*, and *E. denbowensis*. The new genus *Cliopteria* and species *C. bicostata* and *C. unicosta*, *Pterinea laxata*, and the new species *Streptotrochus ione*, *S. regularis*, *S. carinatus*, and *S. sulcatus* were described and figured.

VIII. Correlation of the Paleozoic Fauna of the Eastport Quadrangle, Maine. Bull. Geol. Soc. Amer., vol. 23, 1912, pp. 349–356.

In this paper the formations of the Eastport quadrangle are subdivided into six (unnamed) divisions based on the faunal characteristics of the sediments.

IX. New Species of Silurian Fossils from the Edmunds and Pembroke formations of Washington County, Maine. Proc. U. S. Nat. Mus., vol. 45, July, 1913, pp. 319–352, with plates 29–31.

In this paper are described the species *Whitfieldella edmundsi, Chonetes edmundsi, Chonetes cobscooki, Brachyprion shaleri*, the new genus *Palaeopecten*, and species *P. cobscooki, P. danbyi* (McCoy) (*sensu stricto* Williams), *P. transversalis, Pterinea* (*?Tolmaia*) *trescotti, Tolmaia campestris, Dalmanella lunata* Sowerby was recognized and figured. *Chonetes bastini, Camarotoechia leightoni, Lingula scobina, Lingula minima*, var. *americana, Actinopteria bella, A. fornicata, A. dispar, Grammysia pembrokensis, Leiopteria rubra, Modiolopsis leightoni, M. leightoni*, var. *quadrata*, and *Nuculites corrugata* were described and figured and the species *Grammysia triangulata* (Salter) and *Platyschisma helicites* (Sowerby) were recognized and figured.

X. Correlation problems suggested by a study of the Eastport Quadrangle, Maine. Bull. Geol. Soc. Amer., vol. 24, 1913, pp. 377–398.

This paper announces the names adopted for the six divisions of the rocks of the Eastport quadrangle, and gives a tentative correlation of the formations with the divisions of the Silurian-Devonian formations of New York State and England.

XI. Eastport Folio Maine. U. S. Geological Survey, Folio No. 192, 1914, By Edwin S. Bastin and Henry S. Williams. Eight plates, 16 to 23, contain 148 figures illustrating the faunas of the Quoddy, Dennys, Edmunds, Pembroke, and Eastport formations, and in the text lists of the faunas are given and their correlation values discussed.

XII. New Spirifers from the Silurian Formations of Washington County, Maine.

Spirifer trescotti.

Slirifer cobscooki.

Spirifer edmundsi.

Spirifer lubecensis.

ON THE GENUS NUCULITES CONRAD, 1841.

The original definition of the genus *Nuculites* Conrad, 1841, is as follows:

"*Genus Nuculites. Equivalved; hinge with cardinal teeth as in Nucula, but apparently uninterrupted beneath the apex; an anterior rib like that of Solecurtus, but narrower, extends from the apex, either direct or slightly oblique, toward the base, never passing much beyond the middle of the valve.*" [1]

TYPE-SPECIES OF THE GENUS.

Nine species of "*Nuculites*" were defined by Conrad in the same paper with the definition of the genus (p. 50).

Of these, the first, *N. lamellosa*, was not figured, and the specimen appears to have been lost, as no further reference to it appears in the literature.

[1] Geol. Surv. New York, 5th Ann. Rept., 1841, p. 49.

The second species, *Nuculites emarginata*, was transferred by Hall to his new genus *Palaeoneilo*, the shells of which "*differ from Nuculites in having no anterior clavicular ridge.*" [1]

The third species, *N. triqueter*, the fourth, *N. oblongata*, and the seventh, *N. cuneiformis*, all from the Hamilton group, Devonian, of New York State, have been recognized as typical representatives of Conrad's genus *Nuculites*.[2]

FIGURES OF THE TYPE-SPECIES.

In the generally distributed edition of the 5th Annual Report of the Geological Survey of New York, published in 1841, containing Conrad's definition of the genus *Nuculites*, no figures were published.

The original plate, prepared by Conrad to illustrate the species described in that report, was reproduced in the fifteenth annual report of the regents of the University of New York on the state of the Cabinet of Natural History with the following explanation:

The plate is plate 2 opposite page 194, described as "*Copied from the original lithographic plate of T. A. Conrad, Esq.*" On page 193 it is stated that "*this is a copy of the lithographic plate—which was published with his* (Conrad's) *report in 1841 and circulated with some but not with all the copies.*"

In a footnote to page 192 is the additional remark: "*I* (James Hall) *inferred that only a small number of copies of the plate were published with the report, but it may have been more extensively distributed than I supposed, for I have found five copies among my own volumes.*"

In the explanation of this plate, figure 7 is cited as "*Nuculites cuneiformis;* Conrad, Annual Report, 1841, p. 50;" and figure 8 as "*Nuculites oblongatus*, Conrad, Annual Report, 1841, p. 50." Both of the figures show the anterior clavicle, and the figures of *N. oblongatus* shows the continuous series of crenulations on the hinge line.

Hall, 1885, recognized *Nuculites oblongatus* Conrad and *Nuculites cuneiformis* Conrad, as the types of the genus *Nuculites* Conrad, 1841,[3] and emended the definition with full illustration of the two species (see pl. 47).

The emended generic definition is as follows: "*Nuculites, Conrad* (Geol. Surv. N. Y.; Ann. Rep., p. 49, 1841) *Types, Nuculites oblongatus, Conrad, and Nuculites cuneiformis, Conrad.*

"*Shell equivalve, inequilateral, transverse. Anterior end rounded. Posterior sometimes obliquely truncate and pointed. Beaks anterior. Cardinal line arcuate. Post umbonal slope rounded or angular. Surface marked only by concentric striae in all the known species. Hinge furnished with a row of transverse narrow teeth beginning at the anterior*

[1] Prelim. Notice Lamellibranchiata, pt. 2, 1870, p. 8.

[2] Idem., p. 4. Pal. New York, vol. 5, pt. 1, Lamellibranchiata, pt. 2, pp. 26, 324, 325, and 326, 1885.

[3] Pal. New York, vol. 5, pt. 1, Lamellibranchiata, pt. 1, p. 26, 1885.

muscular scar and extending without interruption posteriorly as far as the posterior scars. Ligament external, contained in a narrow groove along the margin of the hinge. Anterior muscular scar deeply impressed, separated from the cavity of the shell by a vertical or slightly oblique clavicle or partition, extending about two-thirds the distance from the beak toward the base.

Posterior scar elongate, situated just below the termination of the hinge crenulations. Just anterior to the posterior adductor are one or two small retractor impressions. The cavity of the umbo also usually shows three or four impressions of umbonal muscles. Pallial line simple.

This genus differs very distinctly from Nucula in the anterior clavicle and absence of cartilage pit.

Examples: *Nuculites oblongatus*, plate xlvii, figures 1–12. *Nuculites triqueter*, plate xlvii, figures 17–28.[1]

NEW SPECIES FROM WASHINGTON COUNTY, MAINE.

The following species of *Nuculites* have been recognized from the faunules of the uppermost beds of the Edmunds formation (locality numbers 5.33.8 B, and 1443 D 7) and from the Leighton shale member of the Pembroke formation (locality numbers 1.43.9 A, 1.45.6 A, 1.55.1 A, 5.34.7 A^2, 5.44.2 A, 5.3.2 A, 5.3.8 F, E and M^1, 5.4.7 B, 5.25.4 B, 5.24.6 B).

EDMUNDS FORMATION.

Nuculites corrugatus, page 32, plate 11, figures 10, 18.
N. subplanus, page 34, plate 11, figure 17; plate 12, figure 8.
N. trescotti, page 35, plate 12, figure 1.
N. lentus, page 46, plate 12, figures 6, 13.

PEMBROKE FORMATION, LEIGHTON MEMBER.

Nuculites corrugatus, page 32, plate 11, figure 12.
N. amycus, page 43, plate 11, figure 5.
N. battus, page 43, plate 11, figures 11, 13.
N. galeus, page 44, plate 11, figures 1, 14, 19; plate 12, figure 2.
N. thyestes, page 41, plate 11, figure 8.
N. atreus, page 40, plate 12, figure 3.
N. chrysippus, page 39, plate 12, figure 5.
N. speciosus, page 38, plate 12, figures 9, 18, 19.
N. pelops, page 44, plate 11, figures 3, 7, 19.
N. eurylochus, page 45, plate 11, figure 4.
N. pholus, page 32, plate 11, figure 6.
N. ladon, page 33, plate 11, figure 15.
N. lichas, page 34, plate 11, figure 20.
N. nessus, page 33, plate 11, figure 21.

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[1] Pal. New York, vol. 5, part 1, Lamellibranchiata, 2, pp. xxvi, xxvii.

N. robustus, page 36, plate 11, figure 9; plate 12, figures 4, 7, 10, 12, 14, 15.

N. abnormis, page 39, plate 11, figure 16.

N. crassus, page 37, plate 12, figures 16, 17.

DESCRIPTIONS OF SPECIES.

NUCULITES CORRUGATUS Williams.

Plate 11, figs. 10, 12, 18.

1913. *Nuculites corrugatus* WILLIAMS, Proc. U. S. Nat. Mus., vol. 45, p. 347, pl. 31, figs. 11 and 14.

In the original publication of this species two specimens were selected for illustration, both of which are more or less distorted. Considerable variation in form was recognized. Since then all the representatives of the genus, from the Eastport Quadrangle, have been critically studied with the result that the normal form of the species can now be more accurately determined. This normal form is fairly well represented by the new figures given in this paper (pl. 11, figs. 10, 12, and 18).

The average length of 18 specimens from the Leighton Cove locality is 23½ mm. The average height in proportion to length is 53/100.

The specimens from the Crowe Neck locality are smaller, rarely exceeding the average length of the Leighton Cove specimens. Their relative height is approximately the same.

Other forms, associated with this species in the typical locality, are represented by figures 6, 15, 20, and 21. These are described beyond under separate specific names.

Formation and locality.—Pembroke formation, in the Leighton gray shale member at the head of Leighton Cove, Pembroke Township (loc. 5.3.8 F) for the cotypes Cat. No. 58976 U.S.N.M. and the specimen figured on plate 11, figure 12.

Edmunds formation, gray shales, shore of the little cove in northeast part of Crowe Neck opening into northeast end of Straight Bay Trescott Township (loc. 5.33.8 B) for the specimens figured as figure 10 and 18 on plate 11, Cat. No. 62869 U.S.N.M.

This last locality is believed to be at the dividing line between the Edmunds and Pembroke formation. In the folio it is mapped as Edmunds.

Remarks.—Specimens of this species have been found in other outcrops of the Pembroke shales, at the head of Leighton Cove in lower beds of the same section (namely, loc. No. 5.3.8 m and 5.3.8 E also on the outside of Leighton Point (at loc. No. 5 : 4.7 B).

NUCULITES PHOLUS, new species.

Plate 11, fig. 6.

This is a small species, which in general form resembles *N. corrugatus*, but it is less than half the size; the beak is further back and both the front and back ends are more prolonged and narrowed. The clavicle is distinct, dips forward and reaches half way across the shell. The hinge is crenulate. The posterior end is depressed without distinct umbonal ridge but with obscure traces of corrugations.

Dimensions, 14 by $6\frac{1}{2}$ mm. = 46%.

Formation and locality.—Pembroke formation. Thin gray shales at the head of Leighton Cove (loc. 5.3.8. F).

Remarks.—The type-specimen of this species comes from the same faunule with typical *Nuculites corrugatus* (loc. No. 5.3.8 F).

The same species has been recognized in the faunules of other localities of the Pembroke, namely, Oak Hill (loc. No. 1.43.9 A) species No. 2087 A and C and 2089; a mile or so southeast of Oak Hill (loc. No. 1.55.1 A) species No. 1849; northeast of Leighton Point, in the shales continuing Kelley Point outcrops to the southeast (loc. No. 5.4.7 A) species No. 2124, 2125, and 2126.

Type-specimen.—Cat. No. 62870, U.S.N.M.

The following three species come from the same shales in which typical *Nuculites corrugatus* is found (loc. No. 5.3.8 F). Morphologically, they are specifically distinct from that species. Their present form is evidently secondary, not original. They have been figured and given separate names in order to discuss the problems they offer the paleontologist for solution.

NUCULITES LADON, new species.

Plate 11, fig. 15.

Nuculites ladon resembles in its present outline *N. battus*, represented in the figure immediately above it on plate 11. It differs in the narrowing of both front and back ends, associated with an arching of the center of the shell, which removes it from a subquadrate to an oval shape.

It is so near to *N. battus*, however, that taken alone one would naturally consider it a variety of that species. It is probable that it is a distorted specimen of *N. corrugatus*. There are no traces on the umbonal slopes of the corrugations characteristic of the latter species.

Formation and locality.—Pembroke formation, gray shale at head of Leighton Cove, (loc. No. 5.3.8 F), Leighton Neck, Pembroke.

Remarks.—The same form has been found in the Pembroke shales outside Leighton Point (loc. No. 5.4.7 B).

Type-specimen.—Cat. No. 62871 U.S.N.M.

NUCULITES NESSUS, new species.

Plate 11, fig. 21.

The second species, *Nuculites nessus*, is more like *N. corrugatus* in its general surface characters, but is a short, high form, with broadly rounded ends, a beak nearly central, high, overarching the hinge, and a slender, long clavicle. Hinge short and arching. The corrugations are present on the umbonal slopes and the slight broad depression across the center is like *N. corrugatus.*

Formation and locality.—Same as *N. ladon.*

Remarks.—A specimen presenting this form has been seen in the shales of the Edmunds formation at northern end of Straight Bay (loc. No. 1443 D 7).

Type-specimen.—Cat. No. 62872, U.S.N.M.

NUCULITES LICHAS, new species.

Plate 11, fig. 20.

The third species, *Nuculites lichas,* is still closer in general form to *N. corrugatus,* but the front is higher, more broadly rounded, the back low and not projecting above the hinge, the posterior end is probably like that of *N. corrugatus* but low and flattened. Several wrinkle-like lines radiate backward from behind the beak, which in the specimen are nearly as prominent as the long, slender backward trending clavicle.

Formation and locality.—Same as *N. ladon.*

Remarks.—It would be misleading to speak of these three forms as varieties, in the biological sense, of *N. corrugatus.* There is no reason to suppose that the shells of the species *N. corrugatus* varied in these ways in life. Nor is it any more correct to call them varieties of *N. battus* to which in their present state they have close resemblance.

Strictly speaking, they are metamorphic species, real for the paleontologist, but mythical, as are their names, for the zoologist.

Type-specimen.—Cat. No. 62873, U.S.N.M.

NUCULITES SUBPLANUS, new species.

Plate 11, fig. 17; plate 12, fig. 8, magnified.

Shell thin, transversely elliptical, compressed, somewhat narrowed behind, basal margin regularly and gently rounded with a slight undefined constriction near the posterior end. Beak low and broad, rising but little above the hinge line, terminating a little in front of center. General surface depressed-convex, umbonal ridge low, undefined, and with a slightly depressed furrow in front of it. Surface crossed by fine concentric lines, the posterior umbonal ridge and slope crossed by fine radiating lines. Clavicle short but distinct, hinge with crenulate teeth.

The dimensions of the type-specimen are 20 by 12 mm., making the height 60 per cent of the length, which is within the limit already set for specimens of *N. corrugatus.*

Formation and locality.—Edmunds formations: Gray shales, shore of the little cove in northeast part of Crowe Neck, opening into north end of Straight Bay, Trescott Township (loc. No. 5.33.8 B).

This outcrop is believed to represent the uppermost beds of the Edmunds.

Remarks.—The discovery that specimens, from the Crowe Neck locality, Edmunds formation, in other respects having the characters of *N. corrugatus*, are crossed upon the umbonal ridge and slope by distinct fine radiating lines suggests intimate genetic relationship between the two species.

From a morphologic point of view *N. subplanus* and *N. corrugatus* are two distinct species. The fact that the radiating lines on the posterior end of the shell occur only in this Crowe Neck locality, suggests that they are a matter of preservation rather than of specific distinction.

From a taxonomic point of view, if the radiating lines be given specific value, then *N. subplanus* becomes the type of the Crowe Neck forms and the more elongate forms which in other respects agree with the typical *N. corrugatus* of the Leighton Cove locality become varieties of *N. subplanus* distinguished from *N. corrugatus* by the radiating lines.

With this interpretation the Leighton Cove (Pembroke) species *N. corrugatus* becomes the later representative of the Edmunds, Crowe Neck, species *N. subplanus* from which it differs by absence of the radiating lines on the posterior end of the shell.

Type-specimen.—Cat. No. 62874, U.S.N.M.

NUCULITES TRESCOTTI, new species.

Plate 12, fig. 1.

Shell obliquely ovate; front end short, narrowly rounded; posterior end large, subcuneate, produced both downward and backward. Beak prominent, arching over the hinge and terminating near the front. Valves convex, most so over the central portion. Umbonal ridge prominent, subangular, below and anterior to which is a well-defined depressed furrow extending from posterior side of beak obliquely across to the post-inferior margin. Basal margin broadly rounded from the front to the umbonal furrow, where it turns upward to form a distinct reentrant sinus. Hinge short, with crenulate teeth (evident behind the beak); the posterior margin, from the end of the hinge to top of the umbonal ridge, long and nearly straight. The cardinal slope abrupt and slightly concave. Surface crossed by sharp, fine concentric lines. The clavicle is approximately vertical to the hinge line, well defined, but slender, and in some specimens distinctly curved as in *Nuculites triqueter* Conrad.

The long axis, from the center of the front margin to extremity of the postumbonal ridge, cuts the shell into two approximately equal portions; the arched basal margin protruding below to balance the umbonal extension forward. The height is slightly (one to two-tenths) greater than one-half the length.

The figured specimen (pl. 12, fig. 1) is the largest specimen seen. A smaller specimen (M 1773), presenting more fully the specific characteristics, has a length of 11 millimeters and is regarded as cotypical with the former.

Formation and locality.—Edmunds formation, northeastern part of Crowe Neck (loc. 5.33.8 B), Trescott Township, Washington County, Maine, gray shales near the top of the Edmunds formation.

Remarks.—This species recalls *Nucula coarctata* Phillips=*Cucullella coarctata* McCoy, from Fresh water, East, Pembrokeshire, England; especially Phillip's figure 47, plate 26, from which our species differs in its greater proportionate length. McCoy, in redefining the species, mentions the proportion of height to length as 65/100 which is approximately that of *N. trescotti.*

Type-specimen.—Cat. No. 62875, U.S.N.M.

NUCULITES ROBUSTUS, new species.

Plate 11, fig. 9; plate 12, figs. 4, 7, 10, 12, 14, 15.

1839 cf. *Cucullaca antiqua* SOWERBY, Murchison Sil. System, p. 602, pls. 3, 11 and 12*a*.

1855 cf. *Cucullella antiqua* (MCCOY) British Pal. Fossils, p. 284.

A small, thick-shelled species, much resembling *Cucullaea antiqua* Sowerby, but having a more prominent overarching beak, stronger clavicle and more transversely elongate form.

Externally, the shell is transversely ovate, rather convex, beak prominent overarching, posterior end produced, basal margin broadly rounded, a shallow furrow below the inconspicuous umbonal ridge, front margin rounded (pl. 11, fig. 9).

Interior molds show prominent beak, arching over the hinge margins, terminating about ¼ length back from front margin. Clavicle strong, straight, reaching beyond middle of shell; the anterior muscular scar to within the space set off by the clavicle. Behind the beak the interior of the shell is strengthened by a broad rib bounding the posterior muscular scar on its front side. The cardinal edge is strongly developed and has a continuous series of crenulate teeth from near the front end of the hinge to a point beyond the front side of the posterior muscular scar.

In front the teeth incline inward toward the beak, and are slightly longer than those behind the beak, which also incline inward toward the beak. Those immediately under the beak are smaller than at either end.

Of 16 specimens measured, the average length is a little over 12 mm., the smallest 6½, the largest 18 mm. The average height 51/100, the length, varying from 42 to 69 per cent.

The figures of *Cucullaea antiqua* given by Sowerby are $8\frac{1}{2}$ and 14 mm. long, with height about 70 per cent and 64 per cent of length.

McCoy gives the proportion 65/100 for height to length, thus showing, mathematically, the more slender form of our species.

Formation and locality.—Pembroke formation, gray shales on east side of Young's Point, Denbow Neck, Lubec (loc. No. 5.25.4 B).

Type-specimen.—Cat. No. 62876, U.S.N.M.

NUCULITES CRASSUS, new species.

Plate 12, figs. 16 and 17.

The definition of this species is founded upon two molds of the interior of left valves and a fragment of the exterior.

Shell large, long, elongate-ovate, anterior and posterior ends about equally narrowly rounded. A deep, broad posterior furrow on the exterior runs from the hinge to the basal margin separating off the strong umbonal ridge from the body of the shell. In the mold of interior the shell seems to have been thickened for a width of several millimeters in front of the posterior adductor, which is deeply impressed. The clavicle is strong and expanding at the inner surface of the shell; and extends more than halfway across the shell. The basal margin is broadly, evenly rounded up to the edge of the posterior furrow, which ends in a sinus. The surface curves down abruptly at both the anterior and posterior ends. The crenulations are strong both sides the beak. The beak arches over the hinge.

The exterior surface is marked by fine concentric lines.

Dimensions, 37 by $15\frac{1}{2}$ mm. ($41\frac{1}{2}$ per cent); 30 by 13 (43 per cent).

The teeth behind the beak distinctly express the "V-shaped form" which Verrill and Bush considered to be a characteristic of modern genera of this group of shells.[1]

Formation and locality.—Pembroke formation, gray splintery shales on east side of Denbow Point, north side of a little cove on north side of Young's Point. Lubec (loc. No. 5.24.6. B).

Remarks.—This is a large, thick shell, having about the proportions of *N. robustus* but twice as large. Our specimens are larger than the largest reported specimen of *Nuculites oblongatus* Conrad, and proportionally the shell is longer and narrower. The height of two specimens of *N. crassus* is 41 per cent and 43 per cent of the length. The corresponding proportion of *N. oblongatus* is 57 per cent.

It agrees with *N. robustus* in the strong reinforcement of the inner surface of the shell between the umbonal cavity and the posterior muscular scar, the narrowing of the posterior end, and the flattening of the umbonal and central cavity of the shell shown in the interior molds. In these features, the resemblance to *Cucullaea antiqua* Sowerby is closer than to the Devonian *N. oblongatus* Conrad.

Type-specimen.—Cat. No. 62877 U.S.N.M.

[1] Amer. Jour. Sci., vol. 3, 1897, p. 58.

NUCULITES SPECIOSUS, new species.

Plate 12, figs. 9, 18, 19.

Shell thin, large, elongate, subcylindrical,[1] length nearly three times the height. Hinge line long, crenulate. Posterior end cuneate. Front rounded, clavicle in type-specimen strong but thin and inclining forward; in a second specimen (M 1809) inclining backward. Beak low, in the mold of interior scarcely projecting beyond hinge, terminating about one-fourth of length back of front margin. Posterior end prominently corrugated, apparently in part due to puckering of the shell by pressure.

The dimensions of the largest specimen are: Length 43, and height 15 mm. (pl. 12, fig. 19); another specimen from the same locality (M. 1807) measures 40 by 14 mm. Two other specimens from same locality, probably the same species, measure 33 by 13 mm., and 32 by 13 mm. (M. 1806, see pl. 12, fig. 9, and M. 2081).

Another specimen, from another outcrop of probably the same horizon (M. 1809, see pl. 12, fig. 18) has an estimated length 42, estimated height 14 mm.

In size and general form it resembles *N. crassus*, but differs from that species in its thin shell, inconspicuous beak, slender clavicle and absence of trace of muscular impressions.

In these latter characters, it approaches *N. corrugatus;* but it is longer, thicker, not so flat, and the extremities, both anterior and posterior, are lengthened and more attenuate than in *N. corrugatus*.

These differences from *N. corrugatus* may, in part, be accounted for by the slaty deformation of the rock in which they are contained. The rock containing the types of *N. corrugatus* is a similar shale, but does not show the splintery structure of the shale holding *N. speciosus*, and it is to be noted that all of the specimens referred to *N. speciosus* have their long axis in line with the long axis of the splinters.

The only specimen associated with them, lying crosswise to the direction of slaty elongation, is abnormally short (see *N. abnormis*, pl. 11, fig. 16).

Formation and locality.—Pembroke formation, gray shale on the west side of Coffin Neck, opposite Gooseberry Island, Lubec Township (loc. No. 5.44.2 A). These beds rest immediately upon some light greenish shales holding an unmistakable Edmunds fauna.

Remarks.—This species has been found in other outcrops of the shales near the border between the Edmunds and Pembroke formations, at the northern end of Coffin Neck (loc. No. 5.34.7 A²), and in the collection made by N. S. Shaler in Straights Bay, precise locality not known (loc. No. 1443 D 7), probably the same as locality No. 5.33.8 B.

Type-specimen.—Cat. Nos. 62878, 62880, U.S.N.M.

[1] A specimen (M 2013) from the collection made by N. S. Shaler (loc. 1443 D 7), probably the same locality as our 5.33.8 B, presents apparently the characters of this species undistorted—the subcylindrical form of the types is supposed to have been produced by pressure (see M 1805, *N. abnormis*).

NUCULITES ABNORMIS, new species.

Plate 11, fig. 16.

Shell rhomboid-ovate, flattened, resembling in outline a Devonian *Cypricardella,* but with the clavicle and crenulate teeth of *Nuculites.* The antero-posterior diameter is 28 mm. and height (estimated) 20, or at least 70 per cent of length. Beak situated about one-third of length back of front margin. The umbonal ridge, as in *Cypricardella,* with central body of the shell depressed convex, the postumbonal slope is concave and falls off abruptly from the umbonal ridge. The hinge behind the beak is marked with the characteristic crenulate teeth of *Nuculites* and the clavicle is distinct and slants forward.

This specimen was found in the same shales with *Nuculites speciosus,* from which it differs very greatly in form; nevertheless it is quite possible that the difference in form is due to metamorphic distortion after fossilization.

Formation and locality.—Pembroke formation, gray shales on west side of Coffin Neck, opposite Gooseberry Island, Lubec (loc. No. 5.44.2 A). These shales lie immediately above some light greenish shales containing an Edmunds fauna.

Type-specimen.—Cat. No. 62881, U.S.N.M.

NUCULITES CHRYSIPPUS, new species.

Plate 12, fig. 5.

The name *Nuculites chrysippus* is given to an elongate, cuneate form similar to that of *N. cuneiformis* Conrad. Most of the terms used in describing that species apply equally well to this one.

Shell of medium size, elongate-ovate, cuneiform, widest in front and pointed behind; length (22 mm.) twice the height (11 mm.), thus differing from *N. cuneiformis,* the length of which is greater than the height. Basal margin gently curving in the anterior part, becoming nearly straight behind. Posterior extremity narrow, but less so and less elongate than in *N. cuneiformis* and obliquely truncate behind. This truncation of the margin lies between the two faintly expressed umbonal ridges which radiate from the beaks. At the base, they are 3½ mm. apart, the space between them is flat and marked by two intermediate faint corrugations as in *N. corrugatus.* The cardinal line is nearly straight. Anterior end sloping rapidly in a straight line from the beaks and abruptly rounded below. The beak is at the extreme front (if the axis of the shell be made parallel to the hinge line). If the margin of the base be made the transverse axis of the shell, the beak stands near the front, which is broadly rounded to the center of the base and the shell is very oblique and the umbonal slope is greatly elongate and bounded by two faint diverging ridges. In front of the more anterior of these ridges, there is a broad shallow furrow extending from the middle of the shell to the basal margin, The post-cardinal slope is abrupt as is also that at the front end of the shell. The surface is marked by fine concentric stria and stronger lines of growth about two millimeters apart. The clavicle is slender, runs about half way to the base, and is directed backward at about 40 degrees from the hinge line.

Formation and locality.—Pembroke formation, splintery gray shales, in the southern part of West Pembroke, on west side Pennamaquam River (loc. No. 1.45.6 A).

Type-specimen.—Cat. No. 62882, U.S.N.M.

NUCULITES ATREUS, new species.

Plate 12, fig. 3.

The name, *Nuculites atreus*, is given to a transversely elliptical shell, the beak of which is situated almost central (about 1 mm. in front of the center). The valves moderately convex, beak low, protruding slightly beyond the hinge margin. The two ends are sub-equal, the anterior evenly rounded, the posterior obliquely truncated, forming a blunt angle with the base line. The umbonal ridge is only slightly angular, scarcely separating the body lope from the post-umbonal slope. The hinge line is slightly arching, corresponding to the gentle curvature of the basal margin, making the form nearly equilateral. The clavicle is thin and reaches less than half way to the basal margin, and inclines forward about 35° from a transverse line running through the middle of the shell. There are distinct crenulations on the hinge. The surface markings are as upon *N. chrysippus*.

The surface of this shell is evenly rounded from front to the umbonal angle, which is only slightly and broadly undulate. There are no indications of furrows or ridges radiating from the beak, and the only break in this even curvature of the margin is the posterior truncation spanning the end of the slope between the umbonal ridge and the end of the hinge line.

The shell presents some resemblance in outer form to *Palaeoneilo plana* Hall, and may be distinguished from Hall's figure (24 of plate 48) by the more central position of its beak, the broader curvature of the anterior end, and the wider and truncate termination of the posterior end. In addition to the crenulate teeth of *Palaeoneilo*, this species has the clavicle of *Nuculites*. Dimensions: antero-posterior diameter 18 mm., height from beak to basal margin, 7 mm. (= 39 per cent). The beak is 8½ mm. from front and 9½ mm. from posterior extremity.

Formation and locality.—Pembroke formation, splintery gray shales in the southern part of West Pembroke on west side of Pennamaquam River (loc. No. 1.45.6 A).

Type-specimen.—Cat. No. 62883, U.S.N.M.

NUCULITES THYESTES, new species.

Plate 11, fig. 8.

Nuculites thyestes has a broadly ovate form; the length is about one-third greater than the height, valves depressed-convex, beak low, and (when viewed in such a position that the line connecting the middle of the anterior with the middle of the posterior end is horizontal), the beak is decidedly posterior to the center. From this point of view, the anterior end is evenly curved and is very broad, and the posterior end is short and not more than half the height of the front. The hinge is not in evidence, but the posterior slope indicates the position of the beak, and there is a gradually broadening furrow separating two very low umbonal ridges. The clavicle is short, reaching about one-third the distance to the margin and slants forward. The surface markings are the same as for *N. chrysippus* and *N. atreus*. Dimensions, greatest diameter 21½ mm. (which is on the line connecting the center of posterior end with center of anterior end); height 17 mm. (79 per cent).

Formation and locality.—Pembroke formation, splintery gray shales in the southern part of West Pembroke, on west side of Pennamquam River (loc. No 1.45.6 A).

Type-specimen.—Cat. No. 62884, U.S.N.M.

REMARKS ON N. CHRYSIPPUS, N. ATREUS, AND N. THYESTES.

These three quite dissimilar shells, found in a small outcrop of the splintery Pembroke shales in West Pembroke village, offer some particularly interesting facts for the paleontologist.

They are represented by figure 8 on plate 11, and figures 3 and 5 on plate 12.

At first glance they appear to represent three distinct genera neither of which is *Nuculites*. On closer inspection, however, a slender clavicle is discovered on each specimen and on one of them the characteristic crenulations are seen, so that upon comparing them with fuller collections of *Nuculites* from other outcrops of the Pembroke shales, it is clear that each of them is a distorted specimen of some species of *Nuculites*.

The three forms are so decidedly different that, from a morphologic point of view, they must be regarded as distinct species. In order to discuss them, I have given them names:

M 1787 = *Nuculites chrysippus* (pl. 12, fig. 5).

M 1788 = *N. atreus* (pl. 12, fig. 3).

M 1789 = *N. thyestes* (pl. 11, fig. 8).

Although neither of the forms has any near resemblance to *N. corrugatus*, nor has there been found in this locality any specimen that can be referred morphologically to that species, a study of the collections leads very strongly to the belief that they are but distorted representatives of the same zoological species I have called *N. corrugatus*.

But on this hypothesis it would not be correct to refer to these species as varieties of *N. corrugatus* for there is no evidence to show that the zoological species *N. corrugatus* expressed anything like these divergences in form.

Further, they are not imaginary species, for the characters they express as fossils are as positive and real and exact as those expressed by any other fossils.

Nevertheless, taken separately, as figured and morphologically described, there is nothing to indicate that they are not as "good" species as any others described in this paper.

They are, however, evidently distorted as is demonstrated by the ollowing diagrams, which show the realtionship of the present form

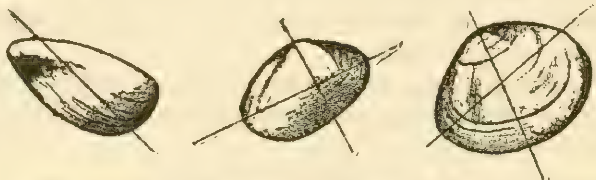


FIG. 1.—AXES OF DEFORMATION IN VARIETIES OF NUCULITES.

of each to the axis of general deformation of the splintery shales in which they lie.

The outline is here drawn as near as possible as it lay on the splintery shale, the long axis of which is here placed horizontal and the chief compression of which has been in a vertical direction.

The line C–D is, for each specimen, approximately its long transverse axis and A–B its vertical axis running through the tip of the beak, on the supposition that they were originally normal shaped specimens of *Nuculites*.

Taking these three specimens to be actually three distorted individuals of the same species, a study of the effects of the pressure and movement of the rock upon the original form is instructive.

In the first figure (*N. chrysippus*) the squeezing has changed the relations of the lines A–B to C–D from 90° for each arc to 145° for the arcs A–D and B–C and 45° for the arcs D–B and A–C, thus relatively shortening the height of the front and the back and lengthening the hinge margin behind the beak and the front half of the base; redistributing each of the elements of the circumference without markedly disturbing the general shape of the contour. The beak is shifted forward to the extreme front and the clavicle is turned strongly backward.

In the second figure (*N. atreus*) the squeezing has not greatly affected the angular position of the parts, as shown by the nearly normal relation of the axes A–B to C–D (90°); but has apparently thrust the front half of the shell upward and forward, elongating the part in front of the beak, while the posterior basal part has been forced upward toward the beak, thus shortening the posterior end.

In the third figure (*N. thyestes*) the arcs A–C and D–B have been reduced about 20°, with corresponding increase of the arcs A–D and C–B. But the effect of this squeezing has been very different from the first case, because of the different position of the beak, which was evidently more stable, the other parts of the shell moving about it. The result has been a great flattening out of the front half of the shell, a shortening and pushing forward of the posterior part, arching of the hinge margin, and thrusting of the beak into a nearly central position, leaving the clavicle in a normal relation to the beak.

NUCULITES AMYCUS, new species.

Plate 11, fig. 5.

Shell narrow, elongate, with a high, angular umbonal ridge. The beak low, terminating at about one-quarter distance back from front to posterior extremity. The umbonal ridge forms the most elevated part of the surface in the middle where it is sharply angular and flattens out both toward the beak and toward the postero-basal angle. On the posterior slope there is a slightly raised secondary parallel ridge. Anterior to the umbonal ridge, the surface slopes off gradually toward the front. The clavicle, inclines slightly backward, and extends scarcely halfway to the base.

Dimensions.—Antero-posterior diameter 13½ mm.; height, 7 mm. (52 per cent). There is a faint linear depression in the specimen (which is a mold of the interior) proceeding from behind the tip of the beak, crowning the umbonal ridge near its cardinal end, and terminating on the basal margin at a point about 3 mm. in front of the posterior extremity. This depression appears to have been a raised line on the interior of the shell about one-half the strength of the clavicle. It is possible that it is the expression of a crack of the shell, as its direction is parallel to the axis of elongation of the rock in which it lies.

Formation and locality.—Pembroke formation, gray splintery shales in the vicinity of Oak Hill, northwestern Pembroke (loc. No. 1.43.9 A).

Type-specimen.—Cat. No. 62885, U.S.N.M.

NUCULITES BATTUS, new species.

Plate 11, figs. 11 and 13.

Shell thin, subquadrate, flattened, height more than half the antero-posterior diameter. Both anterior and posterior ends broadly rounded, clavicle slender, nearly erect, and reaching halfway to base. Beak low, terminating slightly anterior to the middle.

Dimensions.—M 1802, 18½ by 12 mm. (65 per cent), M 1803, 18 by 13 mm. (72 per cent).

Formation and locality.—Pembroke formation, gray splintery shales outcropping near Oak Hill, northwestern Pembroke (loc. No. 1.43.9 A).

Type-specimen.—Cat. No. 62886, U.S.N.M.

NUCULITES GALEUS, new species.

Plate 11, figs. 1, 14, 19c; plate 12, fig. 2.

Shell elongate-oval, the posterior end narrow and subangular, the anterior somewhat narrowed and evenly rounded.

The beak terminates at about the anterior third. The body of the shell is subcylindrical, swollen in the middle and tapers down toward both ends. The umbonal ridge is near the cardinal margin, its outer slope abrupt and rounded off toward its outer end. The umbonal furrow is faintly expressed and its termination forms a slight sinus at the margin. The clavicle is slender, reaches halfway across the shell and slants obliquely forward from the beak. The concentric growth-lines are distinct, the finer concentric lines also are in evidence.

Dimensions.—Transverse length 29 mm., height at beak 12 mm. (41 per cent). Tip of beak 11 mm. from front end; the lower end of clavicle, 6½ mm. from front end.

Formation and locality.—Pembroke formation, splintery gray shales on south side of Pennamaquam River at Kelly Point and westward, Pembroke Township (loc. No. 5.3.2 A).

Remarks.—Several specimens (one figured) from this same locality have the same general form. Specimens from the Oak Hill (loc. No. 1.43.9 A) outcrop of probably the same shales, have the same form. One of them is given on plate 12, figure 2. Another specimen from the Kelley Point shales (loc. No. 5.3.2 A) is figured (pl. 11, fig. 1) and is referred to this species. Their affinities with both *N. corrugatus* and *N. speciosus* are apparent.

Type-specimen.—Cat. Nos. 62887, 62888, U.S.N.M.

NUCULITES PELOPS, new species.

Plate 11, figs. 3, 7, 19*a*.

Shell erect, obliquely ovate, height greater than the transverse diameter; beak narrow overarching the hinge. Shell moderately convex; posterior surface gently sloping off to the hinge and posterior margin; the anterior slope more abrupt than the posterior. The posterior margin forms a blunt angle with the hinge margin and falls off toward the base in a nearly straight line to the middle, then gently curves around the postero-basal angle into the basal margin. The front margin is gently arched, running into the basal margin in a broad regular curved line. The anterior side is shorter than the posterior and their margins are subparallel. The hinge is arched and shorter than the transverse diameter of the shell. The clavicle is slender and short, extending about one-third distance to the base. The hinge is crenulate. The surface is marked by fine concentric lines; and, in this specimen, is marked by several small pustulous elevations, which are seen to be produced by Ostracods lying inside the shell and pressed into the shell during fossilization, thus showing the thin structure of the shell.

Another specimen from the same locality is M 1790 A (pl. 11, fig. 3).

Dimensions of 1791: length 15 mm.; height 17 mm. (113 per cent).

No. 1790, transverse diameter, 14, estimated height 19 mm. (135 per cent).

The type-specimen shows faint indication of an umbonal furrow, and in the umbonal region it is bounded by a slight indication of an umbonal ridge.

The second specimen shows some faint indication of wrinkling of the surface in the direction of the long axis of deformation of the shales in which it lies.

Both specimens lie with the transverse axis of the shell, at near right angles to the axis of elongation of the shales, thus clearly indicating the metamorphic nature of their specific characters.

Formation and locality.—Pembroke formation, gray, splintery shales, Kelley Point, south shore of Pannamaquam River (loc. No. 5.3.2 A).

Type-specimen.—Cat. No. 62889, U.S.N.M.

NUCULITES EURYLOCHUS, new species.

Plate 11, fig. 4.

Shell of medium size, subcircular, length and height about equal, margins regularly rounded. Valves moderately convex below, becoming gibbous a little above middle. Beaks a little anterior to the middle, small, rising but little above hinge line. Posterior slope a little longer than the anterior slope and marked by a curved depression fading out toward the hinge and toward the base. The clavicle distinct, erect and distinctly in front of the beak, reaching nearly half way across the shell. Test thin. Surface marked by fine concentric strias and at irregular distances stronger growth lines. The crenulations of the hinge are not actually seen, but their presence is inferred from the fact that the specimens of *N. galeus* on the same slab (1790 A) show the crenulations and the two agree in other characters of the shell except form.

This species, like *N. galeus*, is regarded as a metamorphic species (namely, the acquired are more prominent than the original characteristics). Except for the presence of a distinct clavicle, this species might, on morphologic grounds, be classed with *Paracyclas*. Another specimen (M 1799) represents the same form.

Formation and locality.—Pembroke formation, gray, splintery shales, Kelley Point, south shore of Pennamaquam River (loc. 5.3.2 A).

Type-specimen.—Cat. No. 62890, U.S.N.M.

REMARKS UPON THE SPECIES N. GALEUS, N. PELOPS, AND N. EURYLOCHUS.

On plate 11 a figure is given (fig. 19) of a slab of the splintery shale from the Kelly Point locality (loc. No. 5.3.2 A) showing examples of these three species as they, at present, lie upon the surface of the shale.

At the top of the plate separate figures are given of each species oriented as is customarily done in preparing plates to illustrate fossil species. The straight lines drawn across the faces of the separate figures represent the long axis of the splintery slab upon which they lie, thus indicating roughly the direction in which the specimens have been distorted.

On the same plate, figure 7, is a more perfect specimen from the same shales of the species *N. pelops*, and its orientation in relation to the long axis of the splintery shales is the same as the specimen figured above it (fig. 3) seen on this particular slab (fig. 19).

This presentation of the facts will make it clearly evident that the morphologic characters upon which the specific descriptions are (and must be) based have been greatly affected by distortion incident to movement of the containing rock after the shells were embedded.

Paleontologists are familiar with this fact, but may not be aware of the great difficulty there is in determining from the literature, or from the actual specimens in museums, whether distortion has or has not taken place.

NUCULITES LENTUS, new species.

Plate 12, figs. 6 and 13.

1860 cf. *Clidophorus elongatus* Hall, Canadian Nat. and E., vol. 5, p. 150. Also Dawson, T. W., Acadian Geology, ed. 4, 1891, p. 601, fig. 206.

This species agrees in so many particulars with the definition given to *Clidophorus elongatus* Hall from the Silurian at Arisaig, Nova Scotia, that the definition will be given entire and note made of points of divergence from that definition.

Hall's definition is as follows: *Clidophorus elongatus*, Hall, figure 206.[1] Shell subelliptical, length about twice the height, beak much nearer to the anterior end, which is narrowly rounded; umbones rounded, prominent; a defined gradually widening depression extends from the umbo to the posterior basal margin, causing a straightening or slight sinuosity in the edge of the shell; a defined ridge along the

[1] The quotation is made from Dawson's Acadian Geology, 4th edition, p. 601.

posterior slope between the sinus and the cardinal margin. Surface very finely striated. A slender clavicle extends from the anterior cardinal margin a little more than halfway to the base, and curving slightly forward.

Arisaig, coll. J. W. D.

In the first place, *Nuculites lentus* has crenulate hinge teeth. The genus *Clidophorus* was, in its original definition, distinguished from *Nuculites* by the absence of crenulation upon the hinge. The application of the generic name *Clidophorus* to the species *C. elongatus* thus distinguishes the two species.

In our figure 6 (pl. 12) the two valves of the same shell are together, and comparison with Hall's figure shows that the right valve is narrower while the left valve is broader than his figure. The difference between the two valves is, however, clearly a matter of distortion. Figure 13 shows a specimen which differs from *C. elongatus* in the broader, less extended, posterior end; both of our figured specimens show the preumbonal furrow to be less strongly marked than in *C. elongatus,* and the beak is also broader and less conspicuous. The clavicle of *N. lentus* is apparently more slender and straighter than that of *C. elongatus.* The specific definition of the latter, however, is in all its particulars broad enough to include such specimens as *N. lentus* and not specific enough to exclude them.

Formation and locality.—Edmunds formation, gray shales on shore of small cove in northeast part of Crowe Neck forming the northern extremity of Straight Bay, Trescott Township, near the dividing line between the Edmunds and Pembroke formations, classified as Edmunds in the Eastport folio (loc. No. 5.33.8 A).

Type-specimens.—Cat. No. 62891 U.S.N.M.

ON THE INTERPRETATION OF FOSSILS.

In selecting *Nuculites corrugatus* for description, and in writing the description of the species, the chief purpose was to present to the reader the characteristic fossils of the several formations which were being mapped in the Eastport Folio.

It was a species met with in several of the outcrops of the Leighton member of the Pembroke formation and in one exposure of the Edmunds formation, which latter, by its fauna as well as position, was interpreted to be at the top of the Edmunds formation.

Specimens from the typical locality were found to express considerable variation in form. Two specimens (one transversely elongate and the other much shorter and higher in form) were selected to express this variability. In this description, therefore, several of the characters regarded as of specific value were described as varying in presence or absence or in strength of expression of the characters.

In this method of species-description I was following rules very commonly adopted by expert paleontologists.

In the present paper, the description of the representatives of the genus *Nuculites*, as expressed in the Silurian formations of Washington County, was made the chief purpose of the investigation. In this study the object in view has not been paleontological but zoological (or rather conchological), namely, the determination of the proper zoological categories to which the several specimens under investigation belong.

The first point to determine was the meaning of the generic category *Nuculites* and the validity of its name.

Having decided this point, all specimens from the whole collection, which belonged within this category were examined and their morphologic characters closely studied. They were classified, labelled and named strictly on the basis of their morphology. The reason for being strict in the application of this rule was the realization that there are several quite diverse causes both for difference and for likeness of morphologic characters, neglecting which must necessarily lead to a misinterpretation of the significance of the fossils.

Some of these diverse causes may be mentioned as self-evident:

1. The shells of the same zoological species may differ by reason of a natural variability in development of the shell in normal growth.

2. Morphologic differences may arise in addition to natural or inherent variability by reason of differences in food or in conditions of environment. Such a cause is likely to show itself on comparing specimens of the same species from distinct localities.

3. Differences may arise in fossil species from difference in the kind of sediment in which they are imbedded, due to chemical or purely physical causes incident to the solidifying of the rock.

4. Differences in fossil shells may be caused by movements of the rock magma after fossilization. Such changes may be considerable and of unknown amount and without leaving any indication upon the shell itself of such metamorphism.

5. Another cause may find its expression in the literature and figures by which knowledge of fossils is recorded and communicated. The author may associate as characteristics of the species characters observed on separate specimens which he imagines were originally the same species. This results in producing a composite idea of the species, the composition being made up in the author's mind, the reasons for which may or may not be manifest to the reader of the literature or the student of the fossil specimens.

From these considerations it becomes evident that the scientific record of carefully made observations may be affected by the relative importance the author (it may be quite unconsciously) assigns to one or other of these various causes of the morphologic differences he observes.

The fossils described in this paper offer such an admirable example of these diverse causes of difference that it has seemed to the author worth while to supplement the purly descriptive part of the paper by a discussion of the more obscure problems of interpretation of fossils, particularly of those from the Paleozoic rocks.

I use the word interpretation purposly, because when the paleontologist gives a zoological name to a Paleozoic fossil he is necessarily interpreting the morphologic form impressed upon the rock into the category of living organisms.

Interpretation is very much more and a different process than description. In description we are narrating what is visible to our eyes and what we see; in interpreting we are explaining what we conceive to be the meaning of the thing before our eyes and thus are imagining what is supposed to be symbolized by the thing seen. Fossils are, like the cuneiform inscriptions on Babylonian cylinders, symbols, and their correct interpretation involves a hypothesis as to the cause or causes for the particular form they assume. In both cases it is of prime importance to determine with precision the exact form of the symbol, but in the interpretation, the complexity and difficulties are far greater for the fossils than for the cylinders. The general hypothesis that the fossils were produced by living organisms may be adopted with the same confidence we have that the cuneiform inscriptions were written by men.

It is a simple matter also to compare a fossil shell with the shell of a living organism and to interpret the various characters, such as beak, hinge, clavicle, muscular impressions, etc. The real difficulty comes when we attempt to give generic and specific names, and to assign taxonomic values to the characters observed. These difficulties are increased when we find, as is above stated, that the characters themselves have been modified after their original formation. Not only are there these difficulties in reaching a correct interpretation of fossils, but the evils resulting from misinterpretation are great and far-reaching.

They become misleading in the field of zoology and evolution, as well as in the field of stratigraphy and formational correlation. These misinterpretations of fossils are not to be corrected by accumulation of statistics, but only by a more careful attention to the processes of thinking and the conceptions formed in interpreting the facts observed.

It involves the training of the imagination as well as the training of the powers of observation.

THE NUCULITES FROM THE LEIGHTON COVE SHALES.

(Loc. No. 5.3.8 F.)

In order to give mathematical expression to the divergence of form of specimens associated in a single faunule, I have measured all the specimens (perfect enough for record) from the Leighton Cove locality, Pembroke (loc. No. 5.3.8. F), giving in the following table the length, height, and percentage of height to length, and the specific definition under which they fall.

No.	Name.	Length.	Height.	Per cent.
		mm.	*mm.*	
M 1215 A	*N. corrugatus*	25	13	52
(Fig. 11)	do	26½	16½	62+
(Fig. 14)	do	33	14	42½
M 1215 B	do	26	11	42+
C	(?)	26	12	46
D	*N. corrugatus*	24	10	42
G	do	28	14	57
F	do	21	13½	65
I	do	2	13	65
K	do	24	12	50
N	do	18	10	55½
T	do	23	12	52+
O	do	22	13	59
R	do	19	10	52+
S	do	28	14	50
V	do	22	13	59
W	do	21	11½	55
Y	do	15½	8½	55
E	cf. *N. corrugatus*	26	10	33½
M 1767 L	*N. pholus*	14	7	50
M 1815	*N. nessus*	19	14	74
M 1817	*N. ladon*	17	12	70+
M 1816	*N. lichas*	19	11½	60+

It will be seen from the table that 18 specimens were definitely referred to the species *N. corrugatus*. The average length of these (omitting fractions) is 23 mm. and the average height 53 per cent of the length. The extremes of length are 33 and 15, and 12 of the 18 specimens vary but 3 mm. from the mean. The extremes of height are 42 per cent and 65 per cent, and 9 of them (namely, one-half) vary only 4 per cent from the mean, 53 per cent.

Another specimen is more slender than these (height 38 per cent,) but comes within the average length, 26 mm.

The other four specimens have a specifically different shape and have been given separate names.

The shales in which these specimens are imbedded are fine-grained fissile shales, showing no particular deformation since solidification. The specimens do not appear to have been elongated or shortened in any particular relationship to the angle of their position on the shales. Their general surface characters, also, are not so diverse as to furnish basis for good specific distinction.

It is, therefore, quite consistent with common usage to consider all of them zoologically as belonging to a single species and to regard those named *N. pholus*, *N. nessus*, *N. ladon*, and *N. lichas* as subspecies or varieties of *N. corrugatus*.

This interpretation will work no particular harm for purely paleontologic purposes, except in making the characters of this species indefinite and elastic; but, from what follows, it will be seen that it would be misleading to assume that the variability found to be a fact in the fossils represents actual variability of the species in producing its shell, from a zoological point of view.

It will be seen, also, that the calling of *N. ladon*, or any of the last four named forms, a variety of *N. corrugatus* or a distinct species is a matter of interpretation not of facts observed. For instance, in case 18 of the 23 specimens from this one faunule were of the form of *N. ladon* and only one of them was like *N. corrugatus*, common usage would lead the paleontologist to decide that *N. corrugatus* is a variety of *N. ladon*. And in case we had in evidence only a single specimen of *N. corrugatus* and *N. ladon*, there would be no question of their specific distinctness.

THE NUCULITES FROM THE SPLINTERY SHALES OF KELLEY POINT.

In the same Leighton member of the Pembroke formation, but above the Leighton Cove shales, there is a series of gray splintery shales outcropping along the northeastern side of the Leighton peninsula on the western shore of Pennamaquam River, extending from outside Leighton Point (at loc. 5.4.7 B) to West Pembroke and beyond. *Nuculites* have been found in these splintery shales from several localities (loc. No. 5.4.7 B, Kelley Point (5.3.2 A), West Pembroke (1.45.6 A) and Oak Hill (1.43.9 A)).

The following species come from these localities:

No.	Name.	Locality.	Length.	Height.	Per cent.
			mm.	*mm.*	
M 2922	*Nuculites corrugatus*	5.4.7 B	28	12	43
2124	*N. pholus*	5.4.7 B	17	8	47
2125	do	5.4.7 B	10	5	50
2126	do	5.4.7 B	10	5	50
2127	*N. ladon*	5.4.7 B	12	8	66+
1790 A	*N. pelops*	5.3.2 A	18	14	77½
1791 A	do	5.3.2 A	15½	17	109
B	do	5.3.2 A	15½	16	103
1790 B	*N. eurylochus*	5.3.2 A	14	13	93
1792	do	5.3.2 A	13½	11½	85
1798	do	5.3.2 A	12½	12	96
1799	do	5.3.2 A	15	15	100
1790 C	*N. galeus*	5.3.2 A	21	9	43
1793	do	5.3.2 A	29	12	41½
1794	do	5.3.2 A	24	12	50
1795	do	5.3.2 A	24	9	37½
1797	do	5.3.2 A	26	10	38½
1796	*N.* cf. *lentus*	5.3.2 A	21	9½	45
1787	*N. chrysippus*	1.45.6 A	22	11	50
1788	*N. atreus*	1.45.6 A	18½	11	59
1789	*N. thyestes*	1.45.6 A	22	17	72
1800	*N. galleus*	1.43.9 A	27	10	37
1801	*N. amycus*	1.43.9 A	12	6	50
1802	*N. battus*	1.43.9 A	18½	12	65
1803	do	1.43.9 A	18	13	72
2087 A	*N.* cf. *pholus*	1.43.9 A	19	15	79
2087 C	do	1.43.9 A	18	9	50
2087 D	*N. galeus*	1.43.9 A	26	11	42
2088	do	1.43.9 A	25½	10	39
2089	*N. pholus*	1.43.9 A	15	7½	50

The great diversity of form presented by the *Nuculites* from these splintery shales is evident from the fact that the attempt to classify and describe the 31 specimens has resulted in assigning them to 12 distinct species.

An average of less than three specimens are found sufficiently alike, morphologically, to be classed under the same definition. Also this diversity of form is shown by the distribution in the faunules. In the faunule 5.4.7 B, five specimens are distributed in three species.

Faunule 1.45.6 A with only three specimens has three species.

In faunule 1.43.9 A the 13 specimens fall into 7 species.

In order to obtain a mathematical expression of this diversity of form, we may take the relation of height to length expressed in percentages. Taking all the 31 specimens from these splintery shales, sufficiently perfect to give the percentage, the height averages 60 per cent of the length, and the extremes range from 37 to 109 per cent.

The averages for the specimens of each faunule are 51 per cent, 70 per cent, 60 per cent, and 52 per cent.

The form of the several species as expressed by the percentage of the height to the length is as follows:

N. galeus, 41 per cent; *N. amycus*, 44 per cent; *N.* cf. *lentus*, 45 per cent; *N.* cf. *corrugatus*, 43 per cent (the average for the type is 53 per cent); *N. pholus*, 50 per cent; *N. chrysippus*, 50 per cent; *N. atreus*, 59 per cent; *N.* cf. *ladon*, 66 per cent; *N. battus*, 68 per cent; *N. thyestes*, 72 per cent; *N. eurylochus*, 93 per cent; *N. pelops*, 96 per cent.

The greatest number of specimens falling under one specific definition is 8 for species *N. galeus*, the height ratio of which is 41 per cent, with range from 37 to 50 per cent. And the total number of the specimens coming within this range of form is 18 or over half of the total number of specimens in the list.

From this analysis, it is evident that, whatever may have been the original form of the specimens here under consideration, it was a narrower, more elongate form than *N. corrugatus*, the average height of which, in its typical locality (loc. No. 5.3.8 F), is 53 per cent of the length.

METAMORPHIC SPECIES.

Without going into further details, the evidence is sufficient to show that the species of the splintery shales, all of them, have an entirely different status from ordinary zoological species.

Independent of the question whether they are well or poorly described, or as to their taxonomic rank, the causes of their present form are evidently secondary and not (wholly) attributable to the organisms supposed to have produced the shell.

It is quite evident, also, that these secondary causes have more or less obliterated the original characters. Nevertheless, the characters they now exhibit are as clear and distinct as if they were original characters, and in description and illustration must be treated as any other fossils.

In the present case I have taken pains to bring together the morphological characters with the evidences of metamorphism exhibited by the shales in which they lie so as to demonstrate the real cause of the specific form.

The evidence of metamorphism is mostly obliterated, when the specimens have been detached and trimmed for the museum, and is entirely absent in the ordinary figures by which the fossil species are illustrated.

In order to distinguish such species from those fossil species which preserve their original characters, I propose to call them METAMORPHIC SPECIES, using the word metamorphic in the sense proposed in the Rules of Nomenclature and Classification adopted by the United States Geological Survey in 1903. In these Rules the following definition is given: "*Metamorphic including altered rocks of either sedimentary or igneous origin in which the acquired are more prominent than he original characteristics.*"

The species of the splintery shales of Kelley Point are metamorphic species in this sense that the acquired are more prominent than the original characteristics. With this definition in mind the paleontologist will be able to remove a large number of fossil species from zoological nomenclature, and place them in a category by themselves for the special use of the geologist.

In the present paper I have assigned names selected from classical mythology to those species which seem to me to come under this definition of metamorphic species. They are of importance to the paleontologist in defining the fossil contents of formations and the characteristic expression of the faunas of particular localities. But they have no legitimate place in zoological nomenclature as species or varieties, although their generic characters may be cited whenever these characters have not been obliterated by the metamorphic processes.

EXPLANATION OF PLATES.

PLATE 11.

The figures on this plate are all natural size.

The arrangement of the figures is designed to illustrate the effects of distortion by which the original form of the shells has been obscured or entirely obliterated.

Figure 19 is an elongated slab of the splintery shale from locality 5.3.2. A showing the specimens, illustrated in figures 1, 2, 3, and 4, as they lie upon the surface of the slab; the separate figures have been rearranged to correspond to the ordinary mode of representing such figures upon a plate.

The original orientation of these specimens is indicated by the lines, drawn across them, which represent the long axis of the slab on which they lie.

Nuculites galeus Williams.

Fig. 1. A right valve, the same as marked C on figure 19 (specimen number M 1790 C).

14. A left valve from the same locality, somewhat, larger than figure 1, but presenting the same elements of form (M 1793).

19c. The same specimen as figure 1, shown in its original position on the slab (M 1790).

Locality.—Slaty shale of the Leighton member of the Pembroke formation, on the south shore of Pennamaquam River at Kelley Point. Pembroke Township (loc. No. 5.3.2 A).

Nuculites, species indet

Fig. 2. A nearly circular specimen, the outlines of which are too imperfect for exact delineation, figured in order to illustrate the extreme shortening of the shell. The same as figure 19 *d* (M 1790).

Locality.—Same as figure 1.

Nuculites pelops Williams.

Fig. 3. An imperfect specimen of a left valve, the same as figure 19 *a*, of the form better expressed by figure 7 which is made the type of the species.

19*a*. The same specimen as figure 3 shown in its original position (M 1790 A).

7. A left valve showing the full form. By the line drawn across its face (showing its original position in relation to the axis of deformation of the shale in which it lay) the agreement in form with figure 3 is explained.

Locality.—Same as figure 1 (loc. No. 5.3.2 A).

Nuculites eurylochus Williams.

Fig. 4. A left valve which might easily be mistaken for a *Paracyclas*. The different position of the cross lines in figures 6 and 4 demonstrates how the deforming force was exerted nearly at right angles upon the two specimens, thus accounting, in part, for the present diversity of form (M 1790 B).

Locality.—Same as figure 1 (loc. No. 5.3.2 A).

Nuculites amycus Williams.

Fig. 5. A left valve, probably narrower than normal, the umbonal ridge appears to be accentuated by pressure (M 1801).

Locality.—Slaty shales of Pembroke formation, near Oak Hill, northwestern Pembroke (loc. No. 1.43.9 A).

Nuculites pholus Williams.

Fig. 6. A small right valve, presenting some of the characters of *N. corrugatus*. Its narrower form and more central position of the beak may be the results of distortion (M 176).

Locality.—Pembroke shales at the head of Leighton Cove, Pembroke Township (loc. No. 5.3.8 F).

Nuculites thyestes Williams.

Fig. 8. A right valve in which the front half of the shell is evidently flattened and produced in the direction of the antero-basal angle, and the posterior part is shortened (M 1789).

Locality.—Slaty shales of the Pembroke formation from the southern part of West Pembroke (loc. No. 1.45.6 A).

Nuculites robustus Williams.

Fig. 9. A figure of the exterior surface; produced directly from the mold of the exterior of the same specimen, mold of the interior of which is represented by figures 12 of plate 12. This effect is produecd by reversing the figure on the plate from the position in which it was photographed, making it to appear convex instead of concave as is the original specimen (M 1786).

Locality.—Gray Pembroke shales from the east side of Young's Point near the end of Denbow Neck, Lubec (loc. No. 5.25.4 B).

Nuculites corrugatus Williams.

Fig. 10. A slightly elongated left valve, presenting otherwise the typical characters of the species (M 1764 A).

Locality.—Shales from the upper beds of the Edmunds formation, in the cove at the north end of Straight Bay, northeast corner of Crowe Neck, Trescott (loc. No. 5.33.8 B).

12. An undistorted specimen of a left valve, showing the normal shape of this species from the original locality. This specimen expresses the mean form of which the two figures originally published are extremes (M 1215 A).

Locality.—Pembroke shales at the head of Leighton Cove, Pembroke township (loc. No. 5.3.8 F).

18. A left valve somewhat crushed at the umbo, the clavicle forced outward toward the front margin (M 1764 B).

Locality.—Edmunds formation same as figure 10 (loc. No. 5.33.8 B).

Nuculites battus Williams.

Figs. 11 and 13. Two specimens of left valves. The quadrate form is probably produced by flattening of the very thin shells. The pustulose elevations of the surface are seen, in the original, to be impressions of ostracods pressed through the shell from inside (M 1803 and 1802).

Locality.—Slaty Pembroke shales from vicinity of Oak Hill, Western Pembroke Township (loc. No. 1.43.9 A).

Nuculites ladon Williams.

Fig. 15. A right valve, somewhat resembling *N. battus*, but a more gibbous form (M 1317).

Locality.—Same locality as figure 12 (loc. No. 5.3.8 F).

Nuculites abnormis Williams.

Fig. 16. An imperfect mold of interior of a left valve, showing a very high, flattened form. This specimen is probably distorted by pressure. The specimens of *N. speciosus* of plate 12 (M 1805) came from the same locality.

Locality.—Gray slaty shales at the base of the Pembroke formation on west side of Coffin Neck, opposite Goosberry Island, Lubec (loc. No. t.44.2 A).

Nuculites subplanus Williams.

Fig. 17. A compressed, oval left valve, entirely differing from *N. corrugatus* in form (compare with figs. 10 and 18 from the same locality) but resembling it in the possession in this locality of fine radiating lines on the posterior umbonal ridge and slope (see pl. 12, fig. 8) (M 1765 A).

Locality.—Edmunds formation. Crowe Neck locality same as figure 10 (loc. No. 5.33.8 B).

Nuculites lichas Williams.

Fig. 20. A right valve. In its present form this has little in common with *N. corrugatus.* It is quite easy to imagine, however, the specific characters of this shell to have been produced by distortion of a specimen originally like figure 12, with which it is associated (M 1816).

Locality.—Same as figure 12 (5.3.8 F).

Nuculites nessus Williams.

Fig. 21. A right valve of a thin shelled species, the puckering of the surface of which is quite evidently secondary. The lower half of the shell appears as if it had been thrust backward in relation to the upper half. The impressed grooves behind the beak are nearly as strong as the clavicle, but, as morphologic characters, are equally prominent (M 1815).

Locality.—Same as figure 12 (loc. No. 5.3.8 F).

PLATE 12.

All natural size, except figure 7, magnified 2 diameters; figure 8, magnified; and 11 and 14 magnified several diameters.

Nuculites trescotti Williams.

Fig. 1. A left valve, exhibiting the general characteristics of form, but larger than the average size of the specimen from the same locality (M 1766). Another specimen (M 1773) (not here figured) is cotypical with it and better represents the average characters of the species.

Locality.—Edmunds shales in the cove at the northern end of Straight Bay on Crowe Neck, Trescott (5.33.8 B).

Nuculites galeus Williams.

Fig. 2. Slightly elongate right valve referred to this species. Compare with figure 14 of plate 11 (M 1800).

Locality.—Pembroke shales in vicinity of Oak Hill, western part of Pembroke Township (loc. No. 1.43.9 A).

Nuculites atreus Williams.

Fig. 3. A right valve, having a shorter and more gibbous form than *N. subplanus* and differing also in surface characters (M 1788).

Locality.—Pembroke shales, southern part of west Pembroke village, west side of Pennamaquam River (loc. No. 1.45.6 A).

Nuculites robustus Williams.

Fig. 4. A small slab with three internal molds, showing the high prominent beak, strong clavicle and the strong reinforcement of the inside surface separating the umbonal cavity from the impression of the posterior muscular scar (M 1776).

Locality.—Pembroke shales on east side of Youngs Point near the end of Denbow Neck, Lubec (loc. No. 5.25.4 B).

7. A right valve, magnified two diameters (the same specimen represented on upper side of figure 4). In making this figure, the specimen has been turned upward so as to show under the beak the hinge margin with the crenulations (M 1776).

Locality.—Same as figure 4 (loc. No. 5.25.4 B).

10. Another specimen of the right valve (M 1777). The form is more elongate than figure 4.

Locality.—Same as figure 4 (loc. No. 5.25.4 B.)

12. An internal cast of a left valve (M 1786 D). In this specimen the strong clavicle is in evidence, but the internal ridge separating the umbonal cavity from the posterior muscular scar is wanting. The figure showing the external surface of this species (pl. 11, fig. 9) was made from the impression of the exterior of this same specimen, and the drawing of the hinge teeth enlarged represented by figure 14 is also made from this specimen.

Locality.—Same as figure 4 (loc. No. 5.25.4 B).

14. An enlarged drawing of the hinge border and its teeth made from the internal mold (fig. 12) on a scale to compare with the hinge of *Tindaria* reproduced in the figure 1 immediately above it.

Locality.—Same as figure 4 (loc. No. 5.25.4 B).

15. An umbonal view of a left valve associated with the other specimens of this species. Introduced to show the effect of changing the point of view in preparing illustrations (M 1781).

Locality.—Same as figure 4 (loc. No. 5.25.4 B).

Nuculites chrysippus Williams.

Fig. 5. A specimen of the right valve, oriented on the plate as seems consistent with the development of the lines of growth. If it were turned on its center about 20 degrees to the right, its characteristic form would be obscured. (M 1787).

Locality.—Pembroke splintery shales in the southern part of West Pembroke on west side of Pennamaquam River (loc. No. 1.45.6 A).

Nuculites lentus Williams.

Fig. 6. The two valves of a single specimen as originally attached at the hinge line. The much narrower and elongate form of the right valve than the left is readily explained by the different relation of the two valves to the compressing force which affected the whole rock in which the shell was imbedded (M 1769).

Locality.—Edmunds shale at north end of Straight Bay near east end of Crowe Neck, Trescott (loc. No. 5.33.8 B).

13. A detached right valve of apparently normal size and shape (M 1768).

Locality.—Same as fig. 6 (loc. No. 5.33.8 B).

Nuculites subplanus Williams.

Fig. 8. A magnified portion of the surface of the posterior end of the specimen figured on plate 11, figure 17, showing the radiating lines crowning the finer, more closely set concentric lines (M 1765 B).

Locality.—Edmunds shale formation, at north end of Straight Bay, Crowe Neck, Trescott (loc. No. 5.33.8 B).

Nuculites speciosus Williams.

Fig. 9. A right valve, of smaller size. The front is rather shorter than in the other examples of this species, showing, however, the normal characters of the posteroir end (M 1806).

Locality.—Pembroke shales on the west side of Coffin Neck, opposite Gooseberry Island, immediately underlain by shale carrying an Edmunds fauna (loc. No. 5.44.2 A).

18. A right valve, the basal margin of which is curved inward narrowing the front part of the shell (M 1809).

Locality.—Pembroke shale at north end of Coffin Neck, Lubec (loc. No. 5.34.7 A^2).

19. A right valve, imperfectly showing the surface characters of the posterior end, but in outline expressing approximately the normal shape (M 1804).

Locality.—Same as figure 9 (5.44.2 A).

Tindaria callistiformis Verrill and Bush.

Fig. 11. Hinge of a right valve (mag. 8 diam.) front view, introduced here for comparison of crenulate dentition with that of *Nuculites robustus*, figure 14. Copied from figure 21 on page 61 of Verrill and Bush article in Amer. Journ. Sci., ser. 4, vol. 3, 1897.

Locality.—Recent off Atlantic coast of North America.

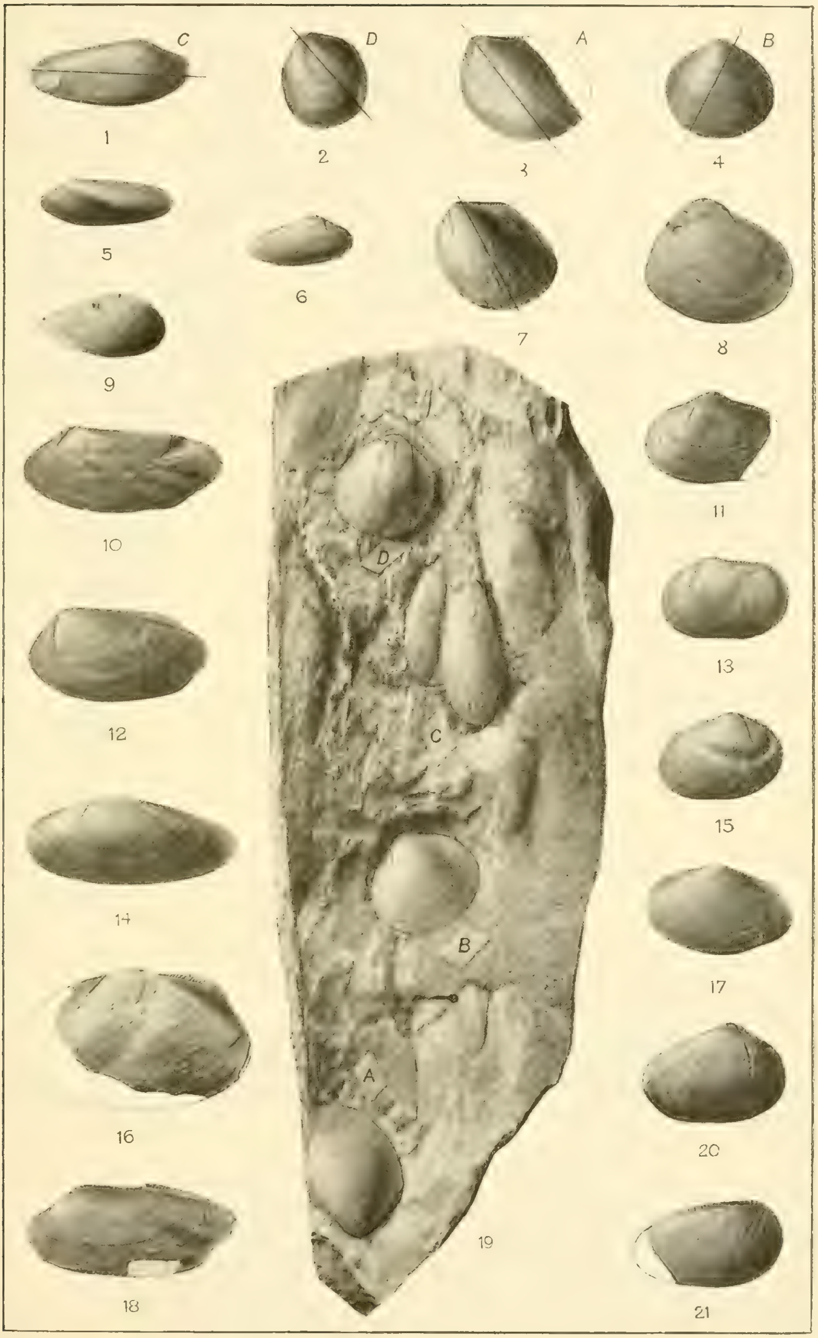
Nuculites crassus Willlams.

Fig. 16. Mold of interior of a left valve, showing the strong clavicle and posterior muscular scar (M 1761 A).

Locality.—Pembroke shales, in cove between Youngs Point and extremity of Denbow Neck, Lubec (loc. No. 5.24.6 B).

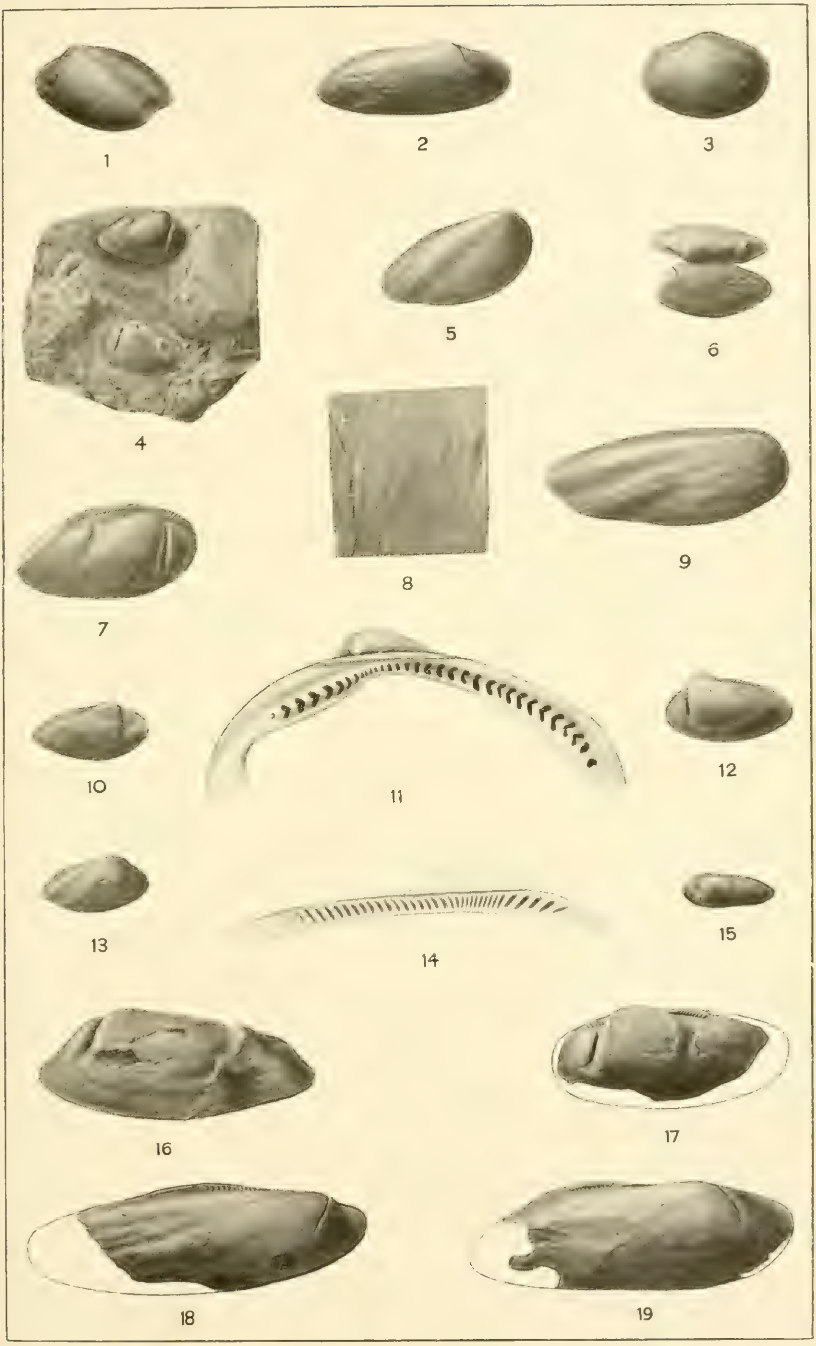
17. Another mold of interior of a left valve, showlng the crenulate hinge both sides the beak, the strong clavicle and muscular scars (M 1761 B).

Locality.—Same as figure 16 (loc. No. 5.24.6 B).



NUCULITES FROM THE SILURIAN FORMATIONS OF MAINE

FOR EXPLANATION OF PLATE SEE PAGES 53–56



NUCULITES FROM THE SILURIAN FORMATIONS OF MAINE

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ALTITUDINAL DISTRIBUTION OF ENTOMOSTRACA IN COLORADO.

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INTRODUCTION.

During the summers of 1908, 1912, and 1913 I made collections of plankton Crustacea from 124 lakes and ponds in Colorado, at elevations from 4,100 to 12,188 feet. I have also received material from Prof. Max M. Ellis and Mr. L. C. Bragg. These collections have yielded 55 species of Entomostraca, which form the basis of this report. I have also made use of all other available records of species previously reported from the State, giving a total of 71 species (Phyllopoda, 16; Cladocera, 34; Copepoda, 21).[1]

The following list includes the localities where fairly complete collections have been made in the State.

	Feet.
On the plains:	
La Junta (Dodds), 11 lakes at about	4,100
Boulder (Dodds), 7 lakes at about	5,300
Greeley (Beardsley), several lakes at about	4,600
In the mountains:	
Tolland region (Dodds), 106 lakes	8,100–12,188
Twin Lakes region (Juday), several at about	9,200
Pikes Peak region (Ward), 5 lakes at about	11,000

Besides these, there are a number of localities from which one or two species have been reported—scattered records in mountains and plains by various men, including some records by early naturalists, chiefly with the Hayden survey.

The interest of this study lies in the fact that here, within a relatively small area, we find a wide range of environmental conditions, physiographic and climatic, with a corresponding diversity of animal and plant life. The eastern two-fifths of the State of Colorado is included within the area of the Great Plains, with a climate, except for its arid nature, essentially like that of the Mississippi Valley generally, while the remainder includes the highest area of the Rocky Mountain region, parts of which have a climate almost arctic.

[1] For list of these lakes, their elevations, and the species collected in each, see Table 8, printed as a folio at the end of the text.

It will be seen from the above that while collections have been made from widely scattered representative localities in the eastern half of the State, the greater part of my own collections are from an area with the city of Boulder as its center, including 7 lakes on the plains east of this city and 106 in the mountain region to the west. This mountain area I will refer to as the Tolland region after the town of Tolland, where, during most of my study, I made my headquarters, at the summer mountain laboratory of the University of Colo-

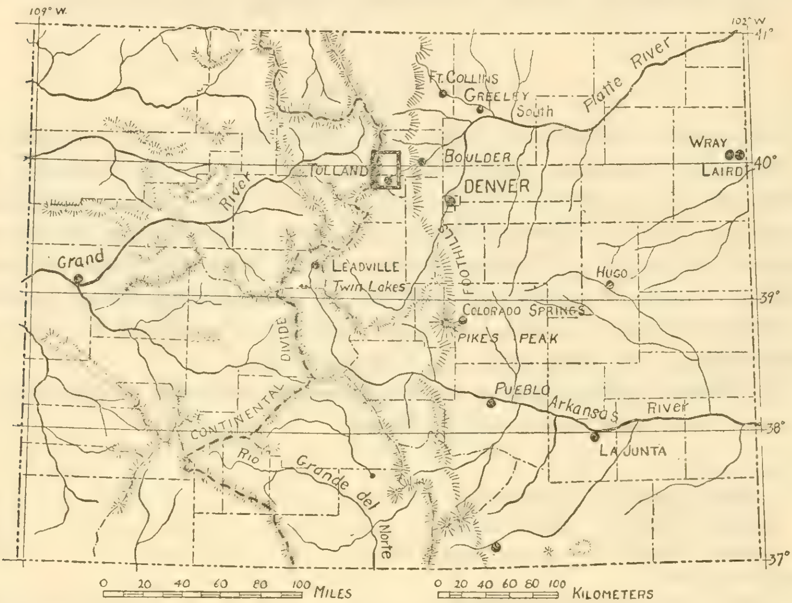

FIG. 1.—MAP OF COLORADO SHOWING LOCALITIES WHERE ENTOMOSTRACA HAVE BEEN COLLECTED. THE BLACK RECTANGLE INCLOSES THE TOLLAND REGION, THE AREA SHOWN IN DETAIL IN FIG. 2.

rado. The lakes of the Tolland and Boulder regions afford especially favorable conditions for the study of altitudinal distribution, because here, within a distance of less than 30 miles, is passed through the whole range of climatic conditions, from temperate to subarctic. To the east of Boulder extend the plains with elevations up to 5,400 feet, while to the west, clearly visible, 20 miles away, Arapahoe Peak with its glacier, rising to 13,506 feet, marks the Continental Divide.

The climatological data presented in the following paragraphs, while in general true for any part of the State, apply particularly to this area.

CLIMATE.

The data regarding climate presented in this paper are, for the most part, from the annual summaries of the Weather Bureau for the Colorado section, though use is also made of data collected by Francis

Ramaley and other members of the biological staff of the University of Colorado, all interpreted in the light of eight years' residence at

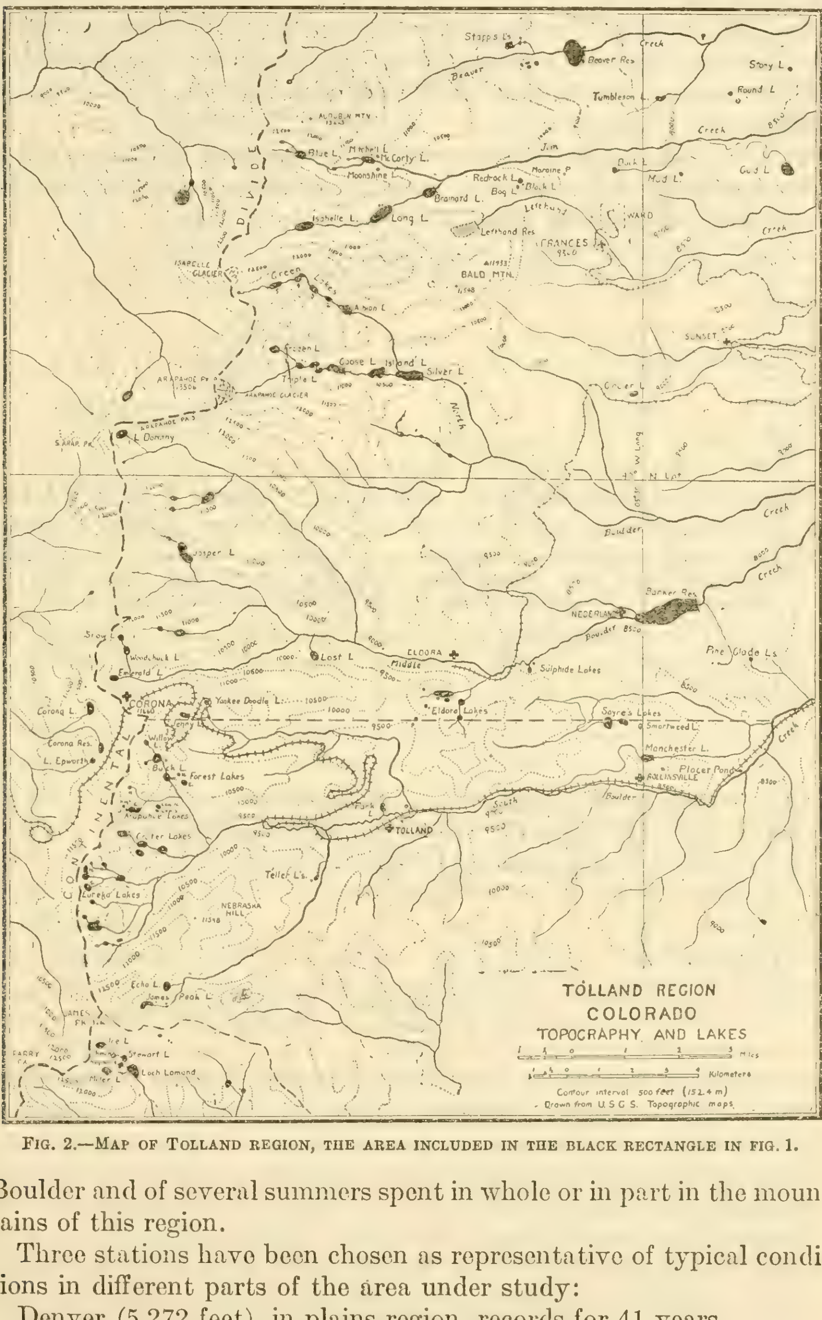

FIG. 2.—MAP OF TOLLAND REGION, THE AREA INCLUDED IN THE BLACK RECTANGLE IN FIG. 1.

Boulder and of several summers spent in whole or in part in the mountains of this region.

Three stations have been chosen as representative of typical conditions in different parts of the area under study:

Denver (5,272 feet), in plains region, records for 41 years.

Frances (9,300 feet), mountains, records for 8 years.

Corona (11,660 feet), high mountains, records for 6 years.

Reference to the maps (figs. 1 and 2) will show that the two mountain stations lie within the Tolland region and that Denver on the plains is also so located as to be of direct use when compared with the other two stations. In discussing climate, special attention has been given to *precipitation* and *temperature*, because these two factors of climate seem to be those most directly of interest in relation to the fauna under study.

Precipitation.—The usual increase of precipitation with elevation is well marked in this region and seems to continue to the highest elevations, as is shown in Table 1.

TABLE 1.—*Annual precipitation.*

Stations.	Total precipitation.	Snowfall.
	Inches.	
Denver	14.02	62.3 inches (5+ feet).
Frances	24.16	180 inches (15 feet).
Corona	43.69	390.6 inches (32+ feet).

The plains are decidedly an arid region. Denver is fairly typical of the entire eastern plains of the State, but there are places where

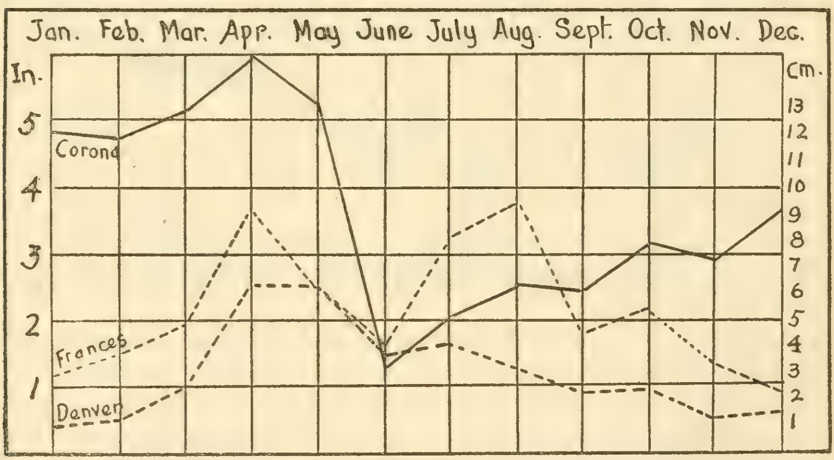

FIG. 3.—MEAN PRECIPITATION BY MONTHS.

the rainfall is only 11 or 12 inches. The arid climate of the plains seems, as will be pointed out later, to play the chief part in determining the nature of their entomostracan fauna. The greater precipitation of the mountain region is probably of little importance directly, but has its chief significance in the fact that a large proportion of it comes in the form of snow. Reference to figure 3 shows that at Corona the greater part of the precipitation comes in those months when it is entirely in the form of snow (all months but June, July, and August). At the higher lakes, great banks of snow accumulate on the slopes above, or extend out over the lakes on the ice, and have a great deal to do with keeping the temperature of the lakes low throughout the summer.

Temperature.—Temperature is probably the climatic factor which in this region plays the largest part in determining the distribution of animal life, and it is the factor which within our area is subject to the greatest variation. On the plains we have the conditions which are prevalent throughout temperate latitudes, while in the higher parts of the mountains there is a close approach to arctic conditions. For purposes of comparison between different parts of the area under study, I have made use again of the three stations—Denver, Frances, and Corona—the elevations and temperatures of which are shown in Table 2.

TABLE 2.—*Mean annual temperature.*

Stations.	Elevation.		Mean annual temperature.	
	Above sea.	Above Denver.	As observed.	Below Denver.
	Feet.	*Feet.*	°*F.*	°*F.*
Denver	5,275	....	49.8	....
Frances	9,300	4,028	41.0	8.8
Corona	11,660	6,385	26.0	23.8

The conditions recorded at Denver are representative of the plains in general, and those at Corona of the highest lakes studied in this region, so that the difference between these two stations expresses the divergence between the two extremes of lakes. It is seen that the mean annual difference between these two stations is 23.8° F., which, allowing 1.35° F. as equivalent to 1° of latitude, corresponds to 17.2° latitude. Thus, though Corona is distant from Denver but 40 miles, it has an annual mean which might be expected 1, 200 miles to the north. It is this steep temperature gradient that gives interest to studies in this region.

As a matter of fact, the isotherm corresponding to the temperature of Corona does actually pass through these far northern regions as may be seen by reference to map (fig. 4), while that of Frances, though less extreme, also passes well to the north, at one place touching the Arctic Circle. In this map it is to be noted that the isotherms are drawn as reduced to sea level, so that the effect of elevation is already felt at Denver, where the actual temperature is probably 15° F. below the corresponding sea-level temperature shown on the map. An isotherm map, not reduced to sea level, would show all lines bending far southward over the Rocky Mountain system, as a result of which the isotherm of 26° F. would actually pass through Corona, while at Denver, only 40 miles to the east, would be that of 50° F.

The mean distribution of temperature throughout the year at these three stations is shown in figure 5.

Though the annual mean gives a ready basis for comparison, and furnishes an index of general climatic conditions, it is probably not of itself as effective in determining distribution of aquatic animals as

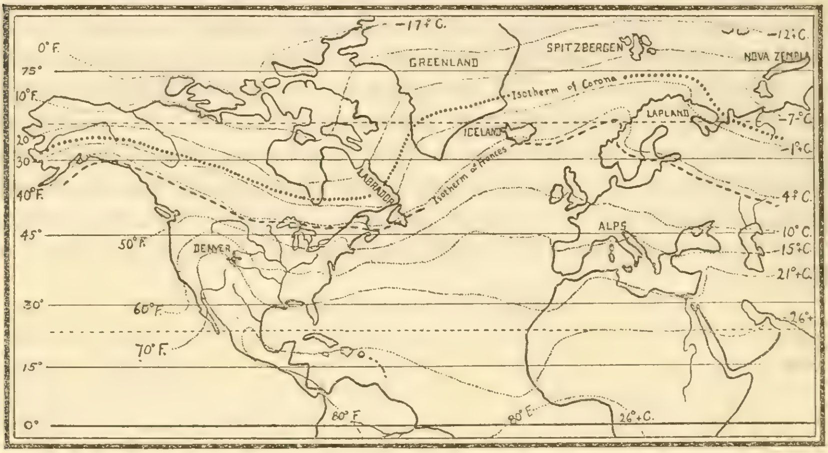

FIG. 4.—ISOTHERM MAP OF THE WORLD, WITH THE ISOTHERMS OF CORONA AND FRANCES DRAWN IN.

other peculiarities of temperature, such as maximum and minimum temperature at certain seasons. Figure 6, a graphic representation of mean monthly minima for the three stations, shows that at

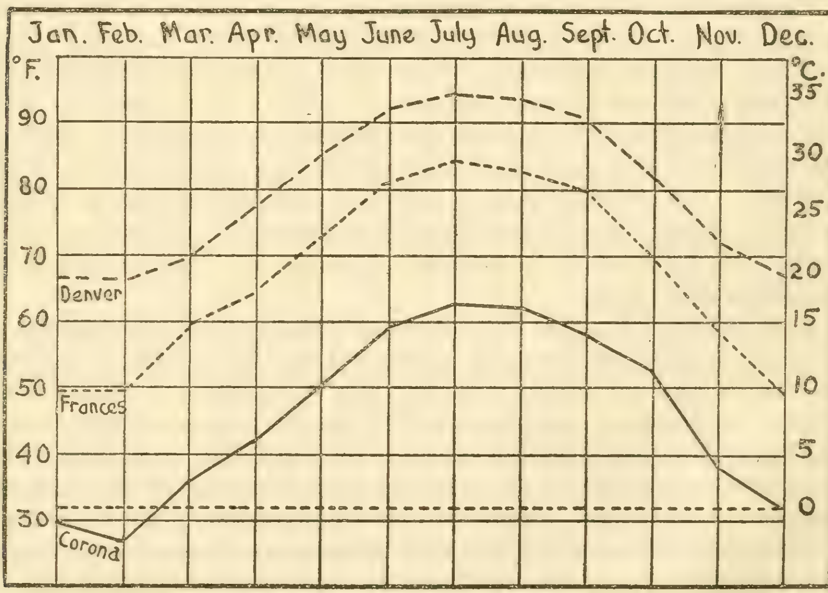

FIG. 5.—MEAN TEMPERATURE BY MONTHS.

Corona there are six months in the year during which zero F. is commonly reached, and that further, during all months, freezing temperatures may be expected. As a matter of observation, frosts are not uncommon during the entire summer in the higher parts of this region.

Figure 7, showing mean monthly maxima, indicates in another way the difference between these three stations. It is seen that at Corona

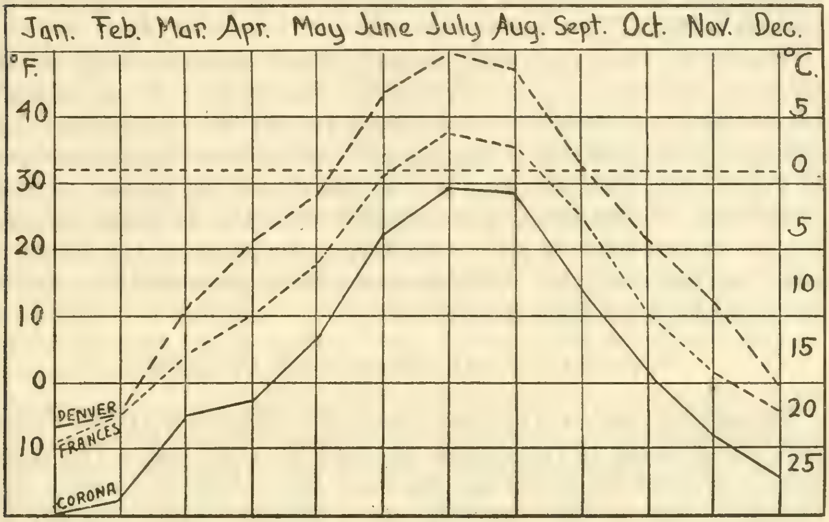

FIG. 6.—MEAN MONTHLY MINIMUM TEMPERATURES.

there are three months—December, January, and February—during which the temperature remains constantly below freezing, while at

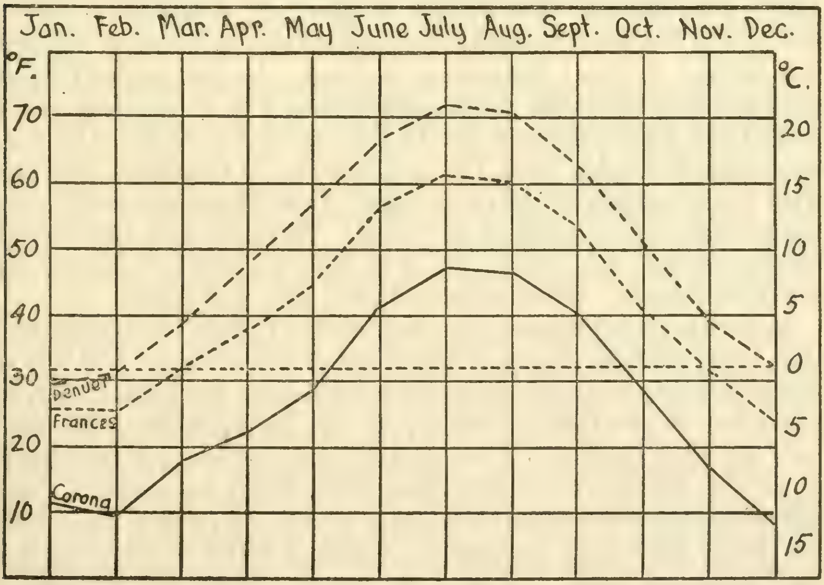

FIG. 7.—MEAN MONTHLY MAXIMUM TEMPERATURES.

Denver during the same months it commonly reaches 65° F., a higher figure than the average maximum at Corona during the summer months. These studies of maxima and minima show more clearly than does the annual or monthly mean the rigorous nature of the climate and short duration of the summer season in the region of the highest lakes.

The above data regarding climate do not touch directly on the medium inhabited by the Crustacea—the water. To an aquatic animal climate means water temperature, not air temperature, and the data just given are of importance only because the temperature of the water is determined by that of the air and by general climatic conditions. Nevertheless it is desirable that data be given concerning the temperature of the water during the summer, the length of time free from ice, etc. Such records will be presented as a part of the account of the lakes themselves.

TOPOGRAPHY AND DESCRIPTION OF LAKES.

The eastern portion of Colorado lies in the region of the Great Plains, with an elevation of from 4,000 to 5,000 or 6,000 feet. The plains have a gradual slope toward the east, the valleys are broad, and the hills gently rolling. In this region natural bodies of water are few and small, being limited almost entirely to transient pools and ponds which are dry for a considerable part of the year. In addition to these natural ponds there are many pools, ponds, and reservoirs which owe their existence to irrigation and are filled periodically from ditches. The largest of these are reservoirs a mile or two in the largest dimension, containing water throughout the year, but subject to great fluctuation in level. Another quite frequent type includes the cattle ponds, depressions 2 to 4 feet deep and 50 to 100 feet across, scooped out to hold water for stock. The water is commonly muddy from the clay bottom, is frequently very foul with the droppings of the stock which water there, and seldom contains much plant growth of any kind. There are long periods with neither outflow nor inflow and they may be entirely dry for considerable periods. Some of these have a very rich fauna.

In drawing conclusions about distribution it must be borne in mind that these artificial bodies of water are of recent origin, and it is entirely probable that their development has been more rapid than the migration of plankton Crustacea, so that an equilibrium has probably not been reached. This condition may account for the absence of certain species from the plains which might be expected there. The climatic conditions of these lakes present no facts of great interest, being essentially like similar bodies of water in other parts of the Mississippi Valley. During the winter months, from the last of November till the close of February, they may be covered with ice, and the water temperature only a little above the freezing point. From May to September the temperature during the day commonly rises to 90° F. in small bodies of water and probably at times to 100° F. Upper figure, plate 13, illustrates a typical lake of the plains.

A description of the lakes in the mountain region is not so simple a matter, and, in view of the fact that the greatest interest of the present studies centers in the alpine fauna, must be given in greater detail.

At their western border the plains pass, for the most part, abruptly into the mountains, so that the first rank of foothills often rises within a distance of a mile or two from one to three thousand feet above the plains. In sharp contrast to the topography of the plains, the relief in the mountains is great and the streams run in narrow valleys a thousand or more feet in depth. The highest part of the mountains, the Continental Divide, crosses the State from north to south, in much of its course being from 11,000 to 13,000 feet in elevation, with peaks rising to 14,000 feet.

In the mountain region west of Boulder there are very many small lakes, from 106 of which I have made collections. Inasmuch as nearly all of these lakes are of glacial origin, some account of glaciation and glacial topography is necessary. Though no part of Colorado was covered by the continental glacier there were in the higher mountains at the same time very many glaciers, only a few remnants of which remain. In the Tolland region these extended downward from the Continental Divide to an elevation of 8,000 to 9,000 feet, reaching eastward in the valleys as tongues of ice a distance of 5 to 10 miles. On the western slope glaciation in this region was less extensive.

The cirques in which these glaciers had their origins, just below the divide, are now one of the conspicuous topographic features of the higher parts of the mountains. Each cirque, separated from those adjacent to it by high, narrow ridges extending outward from the divide, is shut in on three sides by steep rock walls a thousand feet or more in height. In nearly every cirque is a lake fed by water from the huge snow banks, some of them perennial, which accumulate on its walls in the winter.

These lakes in the cirques at the heads of streams are the highest bodies of water to be considered and present the most extreme alpine conditions. They lie just at or above the upper limits of timber, nearly all of them at elevations above 11,000 feet, the highest one studied being Ice Lake at 12,188 feet. I have designated these as alpine lakes, and those at lower elevations in the mountains will be spoken of as montane, the division, as will be explained later, being made on the basis of faunal as well as physical peculiarities. I have made collections from 24 alpine lakes.

None of these is more than one-fourth mile in length, and, while they are considered locally to be very deep, I suspect that few, if any of them, are over 50 feet, though as boats are not available it can not be determined certainly. One of them (Yankee Doodle Lake), reputed locally to be "bottomless," I found to measure about 25 feet. The rugged inclines surrounding these lakes are covered with large angular fragments of rock, and the bottoms of the lakes are largely of the same material and usually practically devoid of silt and entirely without vegetable mold. The water, derived from melting snow on the slopes above, is very clear, and in many lakes, when viewed from above, presents a brilliant green color.

A striking feature of these lakes is the great amount of snow which accumulates on the cirque walls above, in some of them extending well out over the ice cover of the lake. A lake so covered is long in becoming free from ice and the water remains at a low temperature all summer, so that climatic differences between alpine lakes are determined by the size and position of such snowbanks rather than by elevation.

At the beginning of June, even in warm seasons, all of these lakes are completely covered with ice, and in 1912, a season of heavy snowfall and delayed spring, the breaking up of the ice did not begin until early in July. In those where much snow extends over the ice the process is greatly delayed, as an extreme of which we have Ice Lake (12,188 feet), which on August 28, 1912, was still about half covered with ice and had a temperature of 40° F. (See lower fig., pl. 14.) It is probable that the ice did not entirely melt during the summer and that the temperature did not rise above 45°. I have made no observations of the time of freezing of these lakes in the autumn and have been unable to get definite information, but, judging by general weather conditions in this region, the temperature of the water must begin to decrease early in September and it is probable that by the end of the month they are frozen over. By records made at times of studying each lake it has been learned that, at the time of breaking up of the ice, the surface temperature is 35° to 37° F. and by the time the last floating pieces have melted it has reached about 44.° It then rises rapidly to about 52°, where it remains without much change as long as any considerable mass of snow persists on the cirque walls above to furnish cold water. In all alpine lakes except the few where there is insufficient snow to last well through the summer 52° F. is about the maximum temperature.

The striking conditions then, which characterize the alpine lakes are short season (two to three months free from ice) and the low temperature even during the warmest part of the year (a maximum of about 52° F.). (See fig. 8.)

Though it is not in all cases possible to assign a given lake definitely to one group or the other, yet, for the most part, the alpine lakes form a well-defined group, quite distinct from any of the kinds of lakes which must be included in the montane group.

The lakes which I have designated as montane are of two main types: (1) Rock-basin lakes on the upper courses of the streams, just below the cirques; (2) morainal lakes inclosed by the morainal ridges in the valleys and on the lower hillsides These lakes are similar to each other and different from the alpine lakes in that they are surrounded by forests (pine, fir, and spruce), and that there is an abundance of other vegetation growing about them and at the water's edge, as a result of which there may be much plant débris and considerable silt on the bottoms of the lakes. There may also be a considerable growth of algae and other aquatic plants. These features, together with the longer season and warmer temperatures,

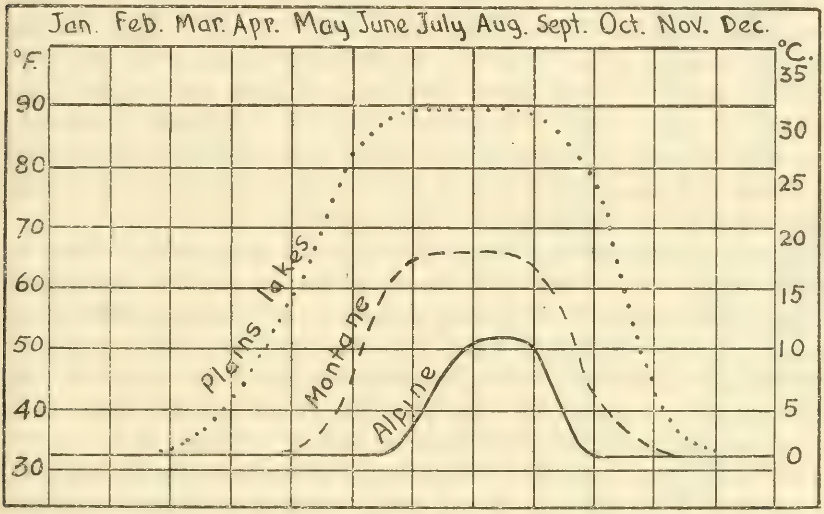

FIG. 8.—CURVES SHOWING THE APPROXIMATE DISTRIBUTION OF SURFACE TEMPERATURE THROUGHOUT THE YEAR IN THREE SORTS OF LAKES.

set them off distinctly from the lakes of the preceding group, and we shall see later that the fauna is also quite distinct.

The rock-basin lakes on the upper stream courses are about the same size, on the average, as the alpine lakes in the cirques above but probably have less depth. There may be one or more of these lakes on a stream, which between the lakes usually descends over a steep terrace often several hundred feet high. (See upper fig., pl. 14.) The temperature conditions here are somewhat less rigorous than in the alpine lakes. The cold water flowing out from the higher lakes becomes somewhat warmed, and temperatures from 55° to 60° F. are common, the latter figure about corresponding to 52° in the higher lakes. The time of breaking up of the ice in the spring is about a month earlier than in the higher lakes. Though most of the lakes of this type are above 10,500 feet, and there are none to correspond to them at lower elevations, it seems probable that, if lakes were present on the stream courses lower down, the difference in elevation would not give to the lakes a decided faunal peculiarity to differentiate them from those just described.

Morainal lakes, from about 40 of which I have made collections, are most abundant between 9,000 and 10,500 feet. These lakes, very numerous in some localities, are inclosed by a network of morainal ridges, usually timbered, varying from a few feet to about 100 feet in height. Most of them are small, many of them mere ponds, and few are more than a few feet deep. They represent all stages of filling with silt and obliteration by growing vegetation. At one extreme are those with clean gravel bottoms and at the other marshes, where the water is entirely hid by plant growth, or meadows and thickets where the process of filling has produced dry land. None of these lakes are on large streams and most of them receive only the surface water from the small basin bounded by the surrounding ridges. Many never have any outflow and others only at times of high water. They are chiefly of a stagnant character, in strong contrast to those on the direct course of the streams, and the water is frequently of a dark brown color, due to the decaying organic matter on the bottom. (See lower fig., pl. 13.)

Climatic conditions are much less rigorous than in the lakes at higher elevations. I have not observed the time of the melting of the ice in the spring, but inquiries among people living in this region place it at about the last of April, and freezing in the fall is probably in October or November. Water temperatures of 55° to 65° F. are common in June, July, and August, while in some of the lower ones 70° or exceptionally 80° have been recorded. (See fig. 8.)

It is to be noted that all of these lakes are included in the western or higher half of the area between the Continental Divide and the plains, and that in the eastern portion (the foothill area), to which glaciation did not extend, there are very few bodies of standing water of any sort. Accordingly data from elevations between 5,400 and 8,000 feet are wanting.

METHODS.

In the plains region no special difficulties are experienced in collecting, but in the mountains, especially in the higher and rougher portions, the work involved in getting from lake to lake is great. Many of them can be reached only on foot, and my practice was to make trips of two or three days, carrying food, blankets, and the necessary collecting materials. For such work I reduced the collecting outfit to a size which was carried in an Army haversack with special pockets sewed in for vials, etc.

A conical net of No. 10 bolting cloth was used. It was 16 inches long, with an opening of 5 inches, supported by a stout wire ring, to which a long cord was attached by three shorter ones. In the bottom of the net, instead of the screw cup of Dr. E. A. Birge, I employed a small copper funnel of about 40 cc. capacity, which may be stopped with a cork and easily discharged into any suitable vessel. The funnel was loaded with about 2 ounces of lead to give weight to throw the net out from shore and to cause it to sink below the surface of the water. Such a net may be thrown out 50 to 75 feet from shore, or, by means of a long cord, drawn across small lakes or arms of larger ones. In practice I commonly threw out from several places on the shore and made surface collections by drawing the net in promptly, or deeper ones by allowing it to sink to the desired depth before drawing it in (fig. 9).

FIG. 9.—DRAWING OF NET USED IN MAKING COLLECTIONS.

During three seasons of collecting by this method the question often presented itself whether there is a considerable chance that important species may be overlooked, rendering unreliable any conclusions based upon such material. Comparisons of collections made at different times and at different points on the shore at the same time lead me to believe that there is little danger that any but some of the most infrequent species are likely to be overlooked. One weak point in my collections is that they were all made in the summer, which, while securing the majority of species resident in the lake, fails to get those which may be winter residents only. It is probable that in some lakes in lower altitudes there exist species as winter forms that are part of the summer fauna in the higher ones. From some of these lakes only one collection was made, while from others material was secured at frequent intervals during one or two summers. It seems that in the higher lakes, where the summer season is short, one good collection at the proper time may be relied upon to contain all species; but in those at lower altitudes, where the season is longer, and seasonal succession is more marked, frequent collections are necessary.

THE FAUNA OF THE AREA STUDIED.

General nature and distribution.—A tabulated summary of the results of my collections, by groups of lakes, is given in Table 4, page 76. From this it will appear that they contain 55 species including: Phyllopoda, 10; Cladocera, 28; and Copepoda, 17. As noted in the introductory paragraph, when we add to these species those recorded by other students, we have a list of 71 known for the State. So far as possible I have considered all these records in drawing conclusions. Figure 10 includes the total list for the State, with a graphic expression of the known range of each. The solid black part of the line represents the range as it appears from my collections and the open part the extension of range from other Colorado records. The broken lines indicate probable extensions of range into elevations not covered by the present records and are based upon the facts of general distribution of each species. The downward extension of many species below the Colorado records means that these are common lowland forms in temperate latitudes and do not in Colorado find their lower limit, inasmuch as even the lowest portions of the State have considerable elevation.

It is at once evident from the above chart that the species in this list fall into three groups—(1) those confined to the plains; (2) those limited to the mountains; (3) those that are not so restricted, but are found at all elevations. The first two of these groups include the stenothermic species, those unable to live except within rather narrow extremes of temperature. The two stenothermic groups differ from each other in that while one of them is unable to withstand high temperatures, the other can not tolerate low. The third group includes the euthermic species—those not so limited by temperature conditions, but able to live about equally well within wide limits, such as those between mountains and plains or between arctic conditions and tropical. In comparing vertical and latitudinal distribution, the first of these groups represents the arctic, or far northern, fauna; the second the more southern forms; while the third is typical of the species which have a wide north and south range. A brief analysis will show to what extent this parallel holds and will also point out that the stenothermic groups are in various respects more narrowly limited than the euthermic.

In the group confined to the mountains there are 16 species, and 3 others, which, though they do extend to the plains, belong primarily in the higher area, making 19 in all. These 19 species fall into two groups: (1) Ten species with a wide range in arctic and subarctic regions (all but one in both old and new worlds), which here range southward along the higher parts of the Rocky Mountains, a true southward extension of a northern fauna; and (2) nine species (some with very narrow ranges), pretty strictly confined to the Rocky Mountain region of the United States, a purely mountain fauna having the characteristics of an arctic fauna but including different species.

The group confined to the plains has somewhat similar components. Of the 28 species assigned to this group (the position of 3 is somewhat doubtful) 5 are found also in the old world and 6 others have quite a wide range in the United States. The remaining 17 species have a rather restricted range on the plains of the western part of the United States, some few extending into Mexico and southern

Canada. The two stenothermic groups have the common characteristic, that each has a considerable proportion of species with a very restricted range.

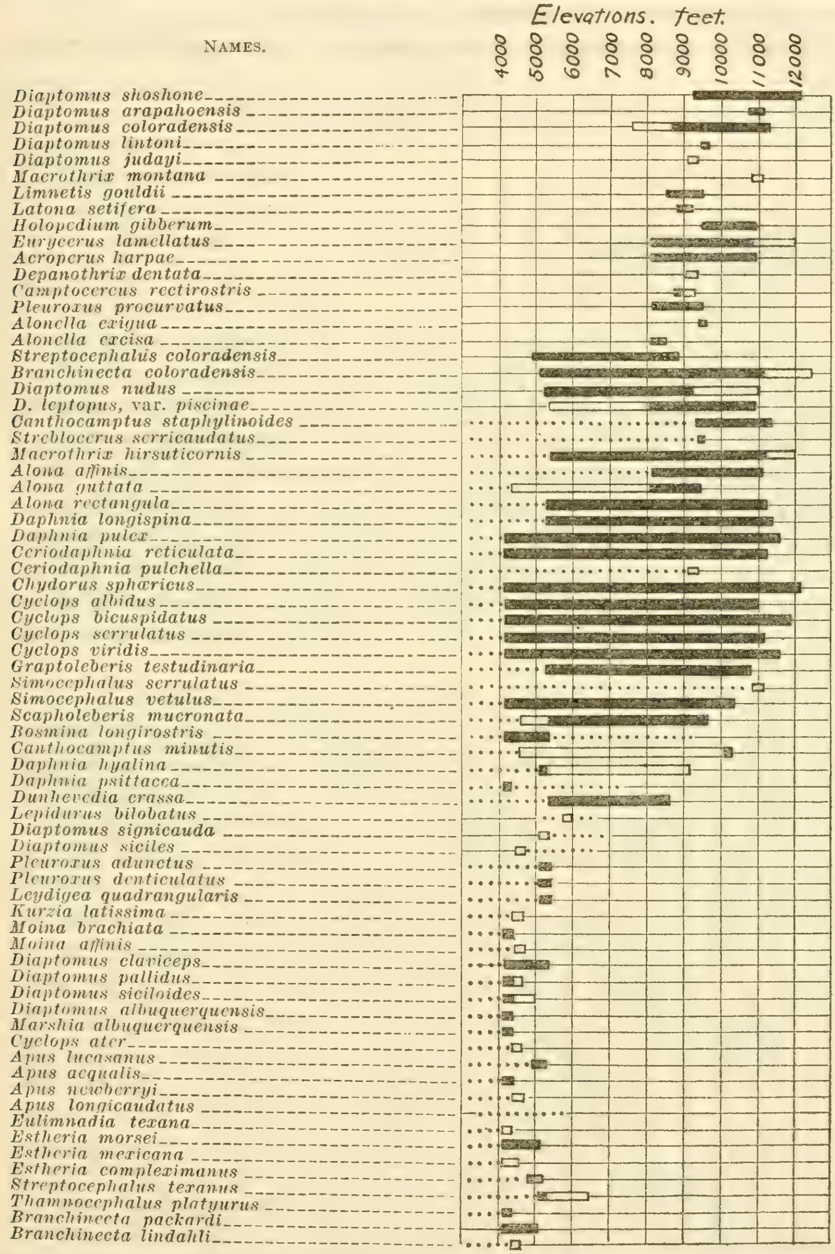

Fig. 10.—Graphic representation of altitudinal ranges of all species of Entomostraca known to occur in Colorado. Solid bars indicate the range as seen in the collections of the writer; open portions, extensions of range from other records; dotted portions, probable extensions of range into elevations not covered by Colorado records, especially into lower elevations than those found in the State.

In strong contrast is the third group, including 24 species which seem about equally at home in either mountains or plains. Of these there are 22 common to both old and new worlds, and only two have a range restricted to the western United States.

Table 3 summarizes the facts presented in the preceding paragraphs.

TABLE 3.—*Distribution of species by groups.*

	Mountains.	Plains.	Mountains and plains.
Number species in each group	19	28	24
Confined to western United States	9	17	2
Confined to North America	1	6	....
World-wide	9	5	22

In the above comparisons between the euthermic and stenothermic groups of species there have doubtless been some mistakes made in assigning certain species to a given group, but, even allowing for some error from this source, it is quite evident that the stenothermic forms found in this region have a much less extended range than the euthermic. Of course, inasmuch as stenothermic species are of necessity shut out from large areas by unsuitable temperatures, it is not to be expected that such species should have as wide ranges as do those forms not so limited, but such differences as those just pointed out can hardly find a complete explanation in this set of conditions.

In this connection it is of interest to compare the genera *Cyclops* and *Diaptomus*, each of which is world-wide, forming an important part of the fresh-water plankton Crustacea everywhere. *Cyclops* is characterized by having a relatively small number of species, most of which are euthermic in nature and have a wide geographical range, while *Diaptomus* includes a multiplicity of species, usually stenothermic and with very limited ranges. Of the five species of *Cyclops* found in Colorado, four are very common at all elevations and are also practically world-wide in distribution; while of the 13 species of *Diaptomus* about half belong strictly to the mountains, the other half to the plains, and not one of them has a range extending beyond North America, most of them being confined to a narrow area in western United States. Moreover in the entire genus there is not known a single species common to Eastern and Western Hemispheres. The apparent correlation between stenothermic habit and restricted range is striking, but to what extent it is of general application and whether there is any necessary relation between the two conditions must at present be left unanswered.

Zonation.—If we can recognize among plants or animals ranging through different climatic conditions a zonation, we have an instructive method of analysis of use in bringing out significant points in their distribution. Thus we recognize on the basis of latitude a very striking zonation of both animal and plant life and in a similar way a definite zonation on the basis of altitude. In the region of the Rocky Mountains from which my collections were made, Ramaley (1907) has defined and limited the plant zones on the basis of distribution of forest growths as follows:

Plains zone: Up to 5,800 feet. Grassland with trees and shrubs along water courses only.

Foothill zone: 5,800–8,000 feet. An open forest chiefly of rock pine (*Pinus scopulorum*).

Montane zone: 8,000–10,000 feet. Close forest of lodge-pole pine (*Pinus murrayana*).

Subalpine zone: 10,000–11,500 feet. Forests chiefly of Engelmann spruce (*Picea engelmanni*).

Alpine zone: Above 11,500 feet Above timber line, where conditions are so extreme that trees will not grow.

Such a zonation gives a definite datum to which other animals or plants may be referred. This expresses much more significantly their true position than to place them between such and such elevations, because on the basis of zonal position we at once have suggested the environmental conditions and associates.

A study of the plankton Crustacea in my collections, and comparison with the records of others, so far as they can be applied to this problem, indicate three pretty well defined zones, which I shall call alpine, montane, and plains zones, the first and the last corresponding in the main with Ramaley's zones of the same names, and the montane zone covering pretty much the same range as his three middle ones. Whether these shall prove to be of general application to other parts of the Rocky Mountains or not, they afford an instructive method of pointing out the significant features of distribution in the region under study.

Alpine zone.—This zone includes lakes, nearly all of which are above 11,000 feet. The bodies of water that I have assigned to this zone (43 in all) include the lakes that I have designated as "alpine" lakes (together with a very few of these on upper stream courses, though not at the head), 32 in number, and 11 shallow pools at the same general elevation, all of them at or above timber line. Their general characteristics have already been pointed out.

The fauna of these lakes, while less abundant in species and individuals than that of the lower lakes, is by no means meager and includes 17 species, some of which were found in certain lakes in considerable abundance. The fauna of this zone is characterized by (1) the greater abundance here of certain species than in other zones, and (2) the absence of a considerable number of species that are present in lower zones.

TABLE 4.—*Summary of the writer's collections by groups of lakes, giving number of records in each zone, the total number of localities, and the altitudinal range of each species.*

Names.	Plains zone.	Montane zone.		Alpine zone.		Total.	Altitudinal range (feet).
	22 lakes and ponds up to 5,400 feet.	49 stagnant lakes and ponds 8,100–10,950 feet.	14 flowing lakes 8,200–11,350 feet.	32 lakes 10,580–12,188 feet.	11 pools 10,500–11,900 feet.		
Branchinecta coloradensis Packard	1	1			5	7	5,100–11,200
B. packardi Pearse	2					2	4,100–5,100
Thamnocephalus platyurus Packard	1					1	4,100
Streptocephalus coloradensis Dodds	1	3				4	4,900–8,850
S. texanus Packard	2					2	5,100–5,300
Apus aequalis Packard	1					1	4,100
A. lucasanus Packard	2					2	4,900–5,300
Estheria compleximanus Packard	1					1	4,900
E. morsei Packard	2					2	4,100–5,100
Limnetis gouldii Baird		2				2	8,500–9,500
Latona setifera (O. F. M.)		1				1	8,850
Holopedium gibberum Zaddach		9	1	1		11	9,500–10,950
Daphnia hyalina Leydig	1	(*)				1	5,200
D. longispina O. F. M	1	39	8			48	5,250–11,350
D. psittacea Baird	6					6	4,100
D. pulex De Geer	3	14	4	20	7	48	4,100–11,650
Scapholeberis mucronata (O. F. M.)	1	12	1			14	5,400–9,650
Simocephalus vetulus (O. F. M.)	3	22	1			26	4,100–10,350
Ceriodaphnia reticulata Jurine	3	17		1	1	22	4,100–11,185
Moina brachiata (Jurine)	7					7	4,100
Bosmina longirostris (O. F. M.)	3					3	4,100–5,400
Streblocerus serricaudatus (Fischer)		1				1	9,500
Macrothrix hirsuticornis Norman and Brady	1	5	3	2		11	5,400–11,250
Eurycerus lamellatus (O. F. M.)		8	2			10	8,100–10,850
Camptocercus rectirostris Schoedler		2				2	8,880
Acroperus harpae Baird		11			1	12	8,100–10,950
Graptoleberis testudinaria (Fischer)	3	4				7	5,200–10,800
Leydigea quadrangularis (Fischer)	1					1	5,200
Alona rectangula Sars	3	10	2	7		22	5,250–11,250
A. affinis (Leydig)		11	3		1	15	8,100–11,185
A. guttata Sars	(*)	4				4	8,100–9,500
Dunhevedia crassa King	2	1				3	5,400–8,675
Pleuroxus procurvatus Birge		4	1			5	8,150–9,500
P. aduncus Jurine	1					1	5,250
P. denticulatus Birge	3					3	5,250–5,400
Alonella excisa (Fischer)		2				2	8,100–8,475
A. exigua (Lilljeborg)		1				1	9,500
Chydorus sphaericus (O. F. M.)	6	32	9	15	9	71	4,100–12,188
Diaptomus albuquerquensis Herrick	8					8	4,100
D. arapahoensis Dodds				4		4	10,750–11,165
D. claviceps Schacht	2					2	4,100–5,400
D. coloradensis Marsh		19	1	8	1	29	8,675–11,350
D. leptopus, var. *piscinae* Forbes	(*)	27				27	8,100–10,950
D. lintoni Forbes		2				2	9,575
D. nudus Marsh	2	5		(*)		7	5,200–9,300
D. pallidus Herrick	1					1	4,100
D. shoshone Forbes		5	1	26	7	39	9,250–12,188
D. siciloides Lilljeborg	2					2	4,100
Cyclops albidus Jurine	3	10	1	2		16	4,100–11,000
C. bicuspidatus Claus	5	13	10	6	4	38	4,100–11,900
C. serrulatus Fischer	5	18	3	3	1	30	4,100–11,150
C. viridis Jurine	12	24	1	4	4	45	4,100–11,600
Marshia albuquerquensis Herrick	1					1	4,100
Canthocamptus minutis Claus	(*)				1	1	10,200
C. staphylinoides Pearse		3		1		4	9,250–11,350

An (*) indicates that the species has been collected in the zone by other investigators though not appearing in the collections of the writer.

One species in my collections, *Diaptomus arapahoensis* (four lakes), is confined to the zone, though its frequency is insufficient to be of importance as a characteristic species. *Diaptomus shoshone*, though not strictly confined to the zone, belongs primarily here and is the chief differential form. It was found in 33 out of the 43 bodies of water in the alpine zone and only in 6 of the 63 lakes of the montane zone. It was first described from Yellowstone Lake by Forbes, and has since been collected at Pikes Peak by Ward at 11,000 feet, and in the Tolland region, and may be taken as a typical alpine form. I have not found it below 9,250 feet. The species of second importance is *Daphnia pulex* (27 lakes), which, though present in all zones, and having a general distribution throughout the world, seems to have a particular significance in this zone. The variety found here is a very large form with long straight spine and more than the usual number of anal spines and of teeth in the pecten. The striking condition is the frequency with which these two species, *Diaptomus shoshone* and *Daphnia pulex*, are associated together in this zone, so that the two rather than either one may be said to characterize the fauna of the zone. In 39 out of the 43 lakes assigned to this zone, one or both of these species are found, and in 22 cases both of them. This association, as we shall see presently, gives place, in the montane zone, to another equally stable one. Third in frequency of occurrence is *Chydorus sphaericus* (24 lakes), but as it is common in all zones and in all parts of the world it does not seem to have any special significance in this zone. Next in importance comes *Diaptomus coloradensis* (nine lakes), which appears to belong in the lower part of this zone, whence it extends into the montane zone, where it has its greatest abundance. This species, said by Marsh to be common in the mountain lakes of Colorado, is closely related to *D. tyrelli*, a common mountain form in the western United States. Only one other species need be mentioned particularly, *Branchinecta coloradensis* (five pools). This phyllopod characterizes the pools of this zone and in them makes a third member of the *pulex-shoshone* combination. This species, common in the pools of the alpine region, has only once (9,575 feet) appeared in my collections from the montane zone, and this was in a pond where were also the two primary members of the alpine fauna. The species was described from material near Grays Peak at 12,000 feet, has been collected near Leadville at 12,500 feet, and on the slopes of Pikes Peak at 11,000 feet, and ranks as a typical example of a mountain species with a restricted range. One record, however, necessitates somewhat of a changed notion on this point. I have recently received from Prof. Max M. Ellis a collection from St. Vrain, Colorado (5,100 feet), dated May 30, 1912, in which are a considerable number of specimens of this species. This record at once extends its range to the plains, where it is possible that it is found in the early spring, though not during the entire summer. The record does not, however, take away from its significance in the alpine zone, where it is much more common than at any other elevation. The remaining species of this zone, as may be seen from Table 4, are, for the most part, euthermic forms ranging up from the plains.

Montane zone.—To this zone I have assigned 63 bodies of water, nearly all below 11,000 feet (the great majority below 10,500 feet). In spite of peculiarities of different types of lakes, the faunal characters of this zone are well defined and quite distinct from those of either of the others. In this zone I have collected 35 species, 11 of which are confined to the zone, though on the basis of general distribution 3 of these may be expected in the plains. Three other species, evidently belonging primarily to this zone, are found in one or two lakes each, at Boulder, just at the edge of the plains, but not in plains lakes more remote from the mountains. In addition to these species there are the usual euthermic forms, common at all altitudes, which make a large part of the fauna of all zones. On account of the absence of lakes in the foothill region of the mountains (between 5,400 and 8,100 feet) there are certain points about the fauna of this zone in doubt, especially the nature of the transition between montane and plains zones. In describing the fauna of this zone it will be well to treat first the 49 lakes of the morainal type, more or less stagnant in their nature, and later those directly on the stream courses (14 in number).

In the morainal lakes there have been found 34 species (including all but one of those found in the zone), and in this region I think of the morainal lakes as being typical of the zone. The characteristic species, *Diaptomus leptopus*, var. *piscinae* (27 of the 49 lakes), is confined to the zone except for one record by Marsh of its occurrence in the lake on the university campus at Boulder. The most abundant species is *Daphnia longispina* (39 lakes), which, though it is a widespread species in temperate lowlands throughout the world, in our region seems to belong, primarily, to the montane zone, for it is not found at all in the alpine lakes, and on the planes of the State it has so far been found in only one lake near Boulder, close to the mountains. Here, as in the alpine zone, the frequent association of two species (a copepod and a cladoceran) is conspicuous, and the two above mentioned form a pair which, in the montane zone, replaces the *pulex-shoshone* group of the alpine zone. In 43 lakes one or both are found and in 23 both. Though neither member ot this pair has been found in any alpine lake, the members of the alpine pair have been found in this zone, *Daphnia pulex* (14), *Diaptomus shoshone* (5 times), but there is only one case where all four species have been collected from the same lake.

In spite of this and other cases of partial mixing of these two faunas the fact is quite evident that the two arrangements (*pulex-shoshone* and *longispina-leptopus*) are very much more frequent than either of the other possible combinations of these four species, and it is equally clear that one pair belongs primarily to the alpine and the other to the montane zone. These two sets of species are nearly mutually exclusive, the conditions necessary for the one being so different from those demanded by the other that it amounts essentially to mutual repulsion. This is especially true of the two species of *Diaptomus* and to a marked degree also of *Diaptomus shoshone* and *Daphnia longispina*. A third species of importance is *Diaptomus coloradensis* (19 lakes), found also in the alpine zone, which seems about equally well at home in either zone and to have about equal relations to each of the two combinations. It is to be noted, however, that in neither zone is it so abundant as the definitive *Diaptomus* of that zone.

The significance of such combinations of species as the above is that they may be used as a measure of ecological conditions. In our area *Diaptomus shoshone* and *Daphnia pulex* are ecologically similar, as are also the corresponding members of the montane pair, and the two pairs are ecologically dissimilar, though the lack of similarity is not the same in degree between all of these species. Though we are unable to measure in physical and chemical units the complex of conditions required for any of the above species, the frequency of their association together gives us an index for the measurement of the similarity of the conditions demanded. Conditions required by two species may be so similar that one is seldom found without the other, or they may be so unlike that they are as mutually exclusive as if one actually repelled the other. I have reduced to percentages the frequency of association of the members of these two pairs and also of *Diaptomus coloradensis*, which is a frequent associate of both. In Table 5 are shown the association percentages of each of these species in the alpine and montane zones. It is read as follows: *Daphnia pulex* is found in 45 lakes, in 27 per cent of which *Daphnia longispina* is found, in 20 per cent *Diaptomus leptotus*, etc.

TABLE 5.—*Association percentages.*

Name.	*Daphnia pulex.*	*Daphnia longispina.*	*Diaptomus leptopus.*	*Diaptomus shoshone.*	*Diaptomus coloradensis.*	Number of lakes.
Daphnia pulex	....	27	20	58	25	45
Daphnia longispina	25	....	49	8	34	47
Diaptomus leptopus	33	85	....	4	26	27
Diaptomus shoshone	66	10	3	....	30	39
Diaptomus coloradensis	38	55	24	45	....	29

From the above table the high association percentages between the two members of each pair are evident as well as the low correlation between the two species of *Diaptomus* or between *Diaptomus shoshone* and *Daphnia longispina*. Such figures as the above are useful in giving other sorts of information about the inter-relations of the several species, as for instance, the less restricted nature of *Daphnia pulex* and *Diaptomus coloradensis*, evidenced by their more uniform correlation percentages, contrasted with the wide variability of correlation of each of the other three species. In using such figures care must be exercised not to attach to them greater significance than is justified on the basis of the number of localities collected and the frequency of occurrence of the various forms, but in this table I suspect that the significance of the figures is less, rather than greater, than the actual facts, because, in some cases, two species are computed as living in the same lake when one of them is plainly the dominant form and clearly belongs there, while the other one is present in small numbers and barely manages to exist.

In a similar manner I computed correlation percentages between all the species in my collections, and though such figures when arranged in the form of a table were useful in the analysis of my data they do not seem of sufficient importance to publish. I merely suggest this as a possible means of analysis for other data of this sort.

The following northern species, which range southward along the mountain range, are entirely or nearly confined to these lakes, and belong primarily to the montane zone: *Limnetis gouldii* (3 lakes), *Latona setifera* (1), *Holopedium gibberum* (9), *Eurycerus lamellatus* (8), *Acroperus harpae* (11), *Camptocercus rectirostris* (2), *Alonella excisa* (2), and *Alonella exigua* (1). Two other species worthy of mention are *Diaptomus lintoni* (2), described from the Yellowstone region, and *Diaptomus nudus* (5), described from lakes at Pikes Peak at 11,000 feet, apparently under alpine conditions, but in the Tolland region not found above the montane zone. *Simocephalus vetulus* (22), the dominant Cladoceran in marshes and weedy pools of this zone, is widespread and common in all zones except the alpine, from which it may be shut out by the lack of plant growth rather than by extreme climatic conditions, an indirect rather than a direct effect of altitude. *Chydorus sphaericus* and four species of *Cyclops* are common here but have no significance as they are met with everywhere. Other species not of special significance may be learned by reference to Table 4.

Of the other lakes of this zone, the 14 on stream courses, it is difficult to give a good characterization. At first I was inclined to place them in a separate zone, the subalpine, but because of the lack of lakes of this type in elevations below 10,000 feet it is not possible to tell which of their faunal characters are due to altitude. Barker Reservoir (8,200 feet), a lake of the same sort, has somewhat similar faunal characters, a fact which leads me to suppose that their fauna does not give place to a different one in lower altitudes.

That these lakes are definitely distinct from those of the alpine zone is clearly indicated by the fact that while the dominant forms of the alpine lakes are constantly being carried into these lakes by the streams, yet they do not find a footing here, *Daphnia pulex* being found in small numbers in three of them and *Diaptomus shoshone* in but one. It is equally conspicuous that not only the definitive species, but also other important and common forms of the montane morainal lakes are either wanting or very scarce here, *Diaptomus leptopus* being wanting and *Diaptomus longispina*, though found in 8 of the 14, was never abundant. On the positive side we may say that the fauna of these lakes comprises 18 species, usually present in very small numbers, most of which are euthermic forms, found at all altitudes. The only species which attains anything like abundance is *Cyclops bicuspidatus*, found in 10 of the 14 lakes, in 5 of which it is abundant. Not only does it seem more at home here than does any other species, but it is more abundant here than in any other type of lake studied. The reasons for assigning these lakes to the montane zone are unwillingness, on the basis of the present data, to constitute them a separate zone; evident separateness from the alpine lakes; their geographical relations; and the fact that most of their species are also found in the morainal lakes of the montane zone.

These two kinds of lakes I have taken as constituting the montane zone, and because those of the morainal sort are more abundant I have come to think of them as the representative type of the zone, to which I have referred the others. If the latter kind were the more abundant the faunal characters of the zone would be defined quite otherwise than they have been; but in either case, the distinctness from those above and from those on the plains would remain, and the differences seem in either instance to be due to altitude rather than to peculiarities which might equally well be duplicated at any elevation.

As already pointed out, the absence of lakes in the lower portion of the mountain region, a strip about 12 miles wide, makes it impossible to get data to show the nature of the fauna in the foothill region and the transition between montane and plains faunas. The small evidence we have bearing on this question seems to indicate that probably the chief species of the montane zone continue to be the dominant forms through the foothill area, wherever there are bodies of water. The finding of *Diaptomus leptopus*, var. *piscinae* (1), *D. nudus* (2), and *Daphnia longispina* (1), montane forms, in lakes near Boulder, just at the edge of the plains, though not in plains collections more remote from the mountains, seems to indicate that these species, in the foothill region as in the higher lakes, may continue to be important forms.

Plains zone.—My own data concerning the plains lakes are somewhat meager, due to the loss, before I had studied them, of a considerable number of collections. My records are from only 7 lakes in the Boulder region and 11 near La Junta. To get a fairly adequate notion of the fauna of the plains I have, accordingly, had to supplement my own records with all others available, chiefly those of Beardsley from the Greeley region, and still our knowledge of the plains fauna is less complete than of that of the mountains. My own collections from lakes on the plains include 36 species. The total list is 50, and 5 others, though collected only in the mountains, are to be expected also on the plains, making a total considerably larger than that of both mountain zones combined. Of these 55 species, 28 have been collected only in the plains, though a few of these, on the basis of general distribution, are to be expected in the mountains also. The remaining 27 range upward into mountain zones. The few lakes collected in the Boulder region, just at the border between mountains and plains, but really in the plains, seem to have a fauna somewhat resembling that of the montane zone, indicating, as is to be expected, that there is not a sharp dividing line, and that these lakes belong as much to the mountains as to the plains.

Concerning the composition of the fauna it is unnecessary to go into detailed description, as it is made up chiefly of species which are common members of lowland faunas in America and to a considerable extent in Europe and other Old World areas. This is particularly true of the euthermic members of this fauna, but as pointed out previously (Table 3), it is not true to a large extent of the stenothermic members, those 28 species found only in the plains area, of which 17 are confined to the western part of the United States and 6 others to North America. This condition indicates that like the fauna of the mountain lakes, that of the plains is also considerably specialized. This is a condition contrary to expectation, for we are accustomed to think of the plains conditions as the "ordinary" and the mountains as the "exceptional" and so calculated to produce the exceptional fauna. It appears, however, that in the great plains of this country, especially their western portion (probably on account of their arid climate) there exist conditions of a quite specialized nature, differing decidedly from those of lowland countries in general. This may furnish an explanation for the restricted range of a considerable proportion of the species of the plains zone in Colorado. A conspicuous feature of this fauna is the large proportion of Phyllopods (12 species) confined exclusively to the plains zone, none of which has a range extending beyond the semiarid plains of western United States, northern Mexico, and southern Canada, and most of them are much more restricted than that. Though Phyllopods are universally distributed and every portion of the world is likely to have the group represented in its fauna, it is very unusual for so large a proportion of a fauna to fall within this group. Of the 42 North American species of Phyllopods, 16 have been found in Colorado (12 confined strictly to the plains) and 25 are confined to the area west of the meridian of Kansas City. These species are the part of the fauna which differentiates it from that of most lowlands in temperate regions. This type of fauna finds a suitable home in the transient pools of the arid plains, from which the species unable to endure these conditions are excluded. Because other types of lakes and ponds were almost unknown here until the development of irrigation produced them, the more generalized portion of the fauna has not had the same chance to develop, and it is probable that even with the facility of dispersal which characterizes plankton organisms, an equilibrium has not yet been reached, so that we may expect the next period of years to produce considerable changes.

Though the exploration in no part of the area studied has been anything like complete (especially deficient in the plains area) it is pretty evident that three well-defined zones exist, and while farther investigations may change many details, it seems safe to assume that what has been presented here expresses fairly well the main facts. Table 4, page 76, expresses briefly the facts about zonation. It would be of interest to learn how far this zonation may be applicable to other portions of the Rocky Mountain region, and to what extent the dominant species may be the same in other localities, but up to the present, in other mountain areas in this country, insufficient work has been done to give a very definite notion of its plankton Crustacea.

COMPARISON WITH OTHER MOUNTAIN FAUNAS.

Though no extensive work on mountain plankton Crustacea has been done in this country, there has been accomplished in Europe some work of considerable importance, notably in two regions, the Alps and the mountains of the Scandinavian Peninsula.

Important among work in the Alps is that of Zschokke (1900) treating other European mountains as well. Much of his descriptive matter dealing with the nature of lakes and streams, and his photographs of lakes in the Alps, might well be used to illustrate conditions in the higher part of the mountains of the Tolland region. His description of a typical alpine lake essentially describes lakes of our own alpine zone, so that we are justified in making a direct comparison of the fauna. The only conspicuous difference is that in the Alps corresponding conditions are reached at a lower elevation than in the Colorado Rockies. A comparison of the plankton Crustacea beings out a striking similarity also, for though so far separated geographically, a comparison of the 63 species from the Alps with the 44 reported from our own mountains shows 19 species in common (Table 6). Zschokke's data are not presented in such a way as to make it possible to determine if there is a zonation similar to that just described for our own mountains, and a comparison of the greatest recorded elevations for each of the 19 common species, while showing a general agreement, also presents some striking differences which make comparisons on this basis of little direct use. The average difference in greatest elevations is approximately 3,500 feet, which probably expresses the relative values of altitude in the two regions as affecting plankton Crustacea.

TABLE 6.—*Species common to the three mountain regions.*

Name.	Colorado Mountains.	Swiss Alps.	Swedish Mountains.	Name.	Colorado Mountains.	Swiss Alps.	Swedish Mountains.
Holopedium gibberum	*	*	*	*Alona guttata*	*	*	*
Daphnia longispina	*	*	*	*Alona quadrangularis*	......	*	*
Daphnia pulex	*	*	*	*Alonella excisa*	*	......	*
Daphnia hyalina	*	*	......	*Alonella exigua*	*	......	*
Simocephalus vetulus	*	*	*	*Pleuroxus truncatus*	......	*	*
Ceriodaphnia pulchella	*	*	......	*Chydorus sphaericus*	*	*	*
Ceriodaphnia quadrangula	......	*	*	*Cyclops albidus*	*	*	......
Scapholeberis mucronata	*	*	*	*C. bicuspidatus*	*	*	......
Streblocerus serricaudatus	*	......	*	*C. serrulatus*	*	*	*
Macrothrix hirsuticornis	*	*	......	*C. strenuus*	......	*	*
Bosmina longirostris	*	*	......	*C. vernalis*	......	*	*
Eurycerus lamellatus	*	*	*	*C. viridis*	*	*	*
Acroperus harpae	*	*	*	*Diaptomus denticornis*	......	*	*
Alona affinis	*	*	*	*Canthocamptus minutis*	*	*	......
Alona costata	......	*	*				

Ekman (1905), in an extensive account of the plankton Crustacea of the high mountains of northern Sweden, lists 49 species, 15 of which are also in the Colorado mountain list and 19 of them in Zschokke's list from the Alps. In the three mountain lists there are 12 common species, certainly a strikingly large duplication considering the wide separation of the areas. Ekman recognizes three zones, birch, willow, and lichen, which he makes the basis of faunal zones. The limits and characters are shown in Table 7, compiled from his data.

TABLE 7.—*Table of zonation in Swedish mountains.*

Name of zone.	Elevation.	Time open.	Average maximum temperature.	Number of lakes.	Number of species.
Birkenregion (subalpine)	Up to 700 meters (2,300 feet).	3½ to 4 months.	10 to 12 C. 50 to 54 F.	48	45
Grauweiderregion (lower alpine).	To 1,000 meters (3,250 feet).	2 to 3½ months.	10 C. 50 F.	89	39
Flechtenregion (higher alpine)	To 1,350 meters (4,350 feet).	2 months and less.	(?)	43	26

Above 1,350 meters depressions are filled with permanent snow. No fauna.

In determining the character of the entomostracan fauna of a lake, Ekman considers that temperature is of prime importance. He finds that in all zones the smaller bodies of water open earlier in the spring and attain a higher temperature during the summer, so that for temperature conditions and faunal characters the smaller lakes at higher elevations resemble the larger ones at lower altitudes. As a result of this condition, faunal zones can not be drawn definitely on the basis of altitudinal limits, but there is overlapping due to the size difference of lakes. In lakes of the Colorado Rockies I find the temperature difference above referred to, but have been able only indefinitely to correlate it with faunal differences. It is not easy to compare zone for zone with the Colorado lakes, but it is probable that his birch zone agrees with the upper part of my montane zone, and that his other two correspond to my alpine zone, although I have not encountered conditions as severe as those of his highest lakes.

PLACE OF COLORADO FAUNA IN WORLD DISTRIBUTION.

Wesenberg-Lund (1908), in summarizing the present knowledge of the fresh-water plankton of the earth, classifies lakes under the following zones:

(1) Arctic lakes: Those in Arctic America, Greenland, Franz Joseph Land, Spitzbergen, Nova Zembla, and Arctic Siberia.

(2) North European lakes: Scotland, Iceland, Norway, Sweden, Finland, etc.

(3) Central European lakes of the level country.

(4) The Mediterranean lakes.

(5) Tropical lakes: Those of Central Africa and places of similar climate.

To these zones he adds (6) the Central European alpine lakes.

He describes the physical and climatic characters in each zone, and so far as possible gives the constitution of the plankton.

Though a detailed comparison can not be made, it is possible to assign some elements of our Colorado fauna to certain of Wesenberg-Lund's zones. The lakes of the alpine zone, though less extreme than the northernmost of those, belong very close to the arctic lakes. Though there are few common species, the general similarity of the fauna is evident. *Holopedium gibberum*, which he considers as very nearly confined to the arctic regions, is found in our alpine and montane zones. Other species considered as arctic by him are *Daphnia longispina*, *Bosmina longirostris*, *Ceriodaphnia pulchella*, and *Chydorus sphaericus*. All these range southward from the arctic regions. In Colorado they are not by any means the most important nor the highest of our alpine forms, but they do range high in the mountain region. The importance of *Diaptomus* in both faunas is marked, though it is not surprising that there are no common species of this genus. The essential agreement of the climate of our alpine zone to that of the zone occupied by the arctic lakes has been pointed out in the section on climate.

Our montane zone seems to correspond to the North European lakes. The isotherm indicating the mean annual temperature at this elevation in the mountains of Colorado passes through the countries he assigns to this zone. The agreement of faunas is also evident. Certain species, most of which do not reach into the arctic regions, are common in the North European lakes and also in our montane zone. Chief among these are the following: *Latona setifera*, *Daphnia longispina*, *Ceriodaphnia reticulata*, *Simocephalus vetulus*, *S. serrulatus*, *Scapholeberis mucronata*, *Streblocerus serricaudatus*, *Eurycerus lamellatus*, *Camptocercus rectirostris*, *Acroperus harpae*, *Graptoleberis testudinaria*, *Alona guttata*, *Drepanothrix dentata*. These species are common in our montane zone, though not confined to it, and do not commonly reach into the alpine zone. Thus it seems that our two well-defined mountain zones correspond to the two most northerly zones recognized by Wesenberg-Lund. It is probable, however, that the most extreme conditions met with in our alpine zone are less extreme than the most extreme of the arctic zone.

If we carry the comparison further, we may compare the plains zone with the Central European lakes of the level country, except so far as our conditions are specialized and local in their nature due to the arid climate. Wesenberg-Lund comments on the very great similarity (large number of common species) between the plankton of Central Europe and temperate North America.

The above writer is unable, because of the relatively small amount of data, to clearly recognize in America zones corresponding to those of Europe. Judging partly by the mean annual temperatures and partly by the available records of the distribution of plankton Crustacea it appears that the Hudson Bay region and Labrador correspond to the arctic zone, and that the region from Lake Superior and eastward to Newfoundland represents the zone of the North European lakes. Just where lines should be drawn between zones in the western portion of Canada and in Alaska is not clear except that the mountainous nature of this area causes the lines to curve far southward. It is accordingly not possible definitely to refer the different zones represented in the Colorado mountains to their position in the scheme of general distribution on this continent. This much is certain, that the alpine zone is a true southern extension of arctic condition and of arctic fauna along the higher parts of the Rocky Mountains.

The great similarity between the fauna of the higher Rocky Mountains and that of the Alps has already been pointed out. Each resembles the fauna of arctic regions. There is this difference: While the alpine fauna of the Colorado Rockies is a direct southern continuation, without interruption, of an arctic fauna, that of the Alps is separated from the corresponding arctic fauna by intervening lowlands, and rises as an island, surrounded by faunas of warmer climates. This difference of situation does not, however, make any apparent or significant difference in the nature of the two faunas. The conditions and fauna in both cases, as pointed out by Zschokke, are glacial in their nature—in the Alps as a remnant left at the retreat of the glacier, and in the Rockies as a direct southern extension of present glacial conditions in the north.

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TABLE 8.—*List of lakes, with the elevation and fauna of each.*

Fauna columns (as headed): *Branchinecta coloradensis* Packard. [illegible] *packardi* Pearse. *Thamnocephalus platyurus* Packard. *Streptocephalus texanus* Packard. *Streptocephalus coloradensis* Dodds. *Apus aequalis* Packard. *Apus lucasanus* Packard. *Estheria compleximanus* Packard. *Estheria morsei* Packard. *Limnetis gouldii* Baird. *Latona setifera* (O. F. M.). *Holopedium gibberum* Zaddach. *Daphnia pulicaria* Baird? *Daphnia pulex* Deeeer. *Daphnia longispina* O. F. M. *Daphnia hyalina* Leydig. *Scapholeberis mucronata* (O. F. M.). *Simocephalus vetulus* (O. F. M.). *Ceriodaphnia reticulata* Jurine. *Moina brachiata* (Jurine). *Bosmina longirostris* (O. F. M.). *Streblocerus serricaudatus* (Fischer). *Macrothrix laticornis* Norman and Brady. *Eurycercus lamellatus* (O. F. M.). *Camptocercus rectirostris* Schoedler. *Acroperus harpae* Baird. *Graptoleberis testudinaria* (Fischer). *Leydigia quadrangularis* (Leydig). *Alona rectangula* Sars. *Alona affinis* (Leydig). *Alona guttata* [illegible]. [illegible] Birge. [illegible] Jurine. [illegible] Birge. [illegible] (Fischer). [illegible] Lilljeborg. [illegible] F. M.). [illegible] Dodds. [illegible] [illegible] Herrick. [illegible] Lilljeborg. [illegible] [illegible] [illegible] Marsh. [illegible] Herrick. [illegible] [illegible] [illegible] [illegible] Herrick. [illegible] [illegible] Pearse.

Lakes.	Elevation, feet.
[illegible] Pool	11,[illegible]
[illegible]	11,100
Crater Pool	11,000
South Arapahoe Pool	11,200
Jenny Pool No. 1	11,150
Jenny Pool No. 2	11,150
Jenny Pool No. 3	11,1[illegible]
Jenny Pool No. 4	11,1[illegible]
Corona Pool	11,1[illegible]
Long Lost (North)	10,[illegible]
M[illegible] Pool	11,[illegible]
Ice Lake	12,1[illegible]
[illegible] Lake	11,[illegible]
James Peak Lake	11,[illegible]
Echo Lake	11,0[illegible]
Little Eureka Lake	11,[illegible]
South Eureka Lake	11,[illegible]
North Eureka Lake	11,[illegible]
Upper Crater Lake	10,[illegible]
Little Crater Lake	10,[illegible]
Lower Crater Lake	10,5[illegible]
South Crater Lake	10,[illegible]
High Arapahoe Lake	11,[illegible]
Arapahoe [illegible] Lake	11,1[illegible]
South Arapahoe Lake	11,[illegible]
Low Arapahoe Lake (South)	10,7[illegible]
Low Arapahoe Lake (North)	10,750
North Arapahoe Lake	11,350
Willow Lake	11,2[illegible]
South [illegible] Lake	11,[illegible]
Buck Lake	11,[illegible]
Jenny [illegible]	11,[illegible]
Yankee Doodle Lake	[illegible]
Corona Lake	11,[illegible]
Corona [illegible]	11,[illegible]
Epworth [illegible]	11,2[illegible]
Emerald Lake	11,2[illegible]
Snow Lake	11,[illegible]
[illegible] Lake	11,4[illegible]
Green Lake No. 1	11,[illegible]
[illegible]	11,[illegible]
Mount [illegible] Lake	11,[illegible]
[illegible] Lake	11,[illegible]
[illegible]	11,[illegible]
Reynolds Lake	11,[illegible]
Loch Lomond	11,1[illegible]
Double Lake (South)	10,[illegible]
East Crater Lake	10,450
West Forest Lake	10,800
Upper Triple Lake	10,750
Goose Lake	10,590
Island Lake	10,[illegible]
Silver Lake	10,2[illegible]
[illegible] Lake	10,[illegible]
[illegible]	[illegible]
Beaver Reservoir	9,150
Parker Reservoir	8,200
Double Lake (North)	10,[illegible]
East Buck Lake	10,[illegible]
East Forest Lake	10,[illegible]
North Forest Lake	10,[illegible]
Triple Pool No. [illegible]	10,[illegible]
Triple Pool No. [illegible]	10,[illegible]
[illegible]	10,[illegible]
[illegible]	10,10[illegible]
[illegible] Lake	10,[illegible]
Big Lake	[illegible]
[illegible]	[illegible]
[illegible]	9,[illegible]
Hummock Pool	9,[illegible]
Round [illegible]	[illegible]
Mud [illegible]	9,1[illegible]
Wet Pool	9,1[illegible]
Fish [illegible]	9,[illegible]
[illegible]	9,[illegible]
[illegible]	9,[illegible]
[illegible] Lake	9,[illegible]
[illegible]	9,[illegible]
Helen [illegible]	9,[illegible]
[illegible] Pool	9,[illegible]
South [illegible] Lake	9,[illegible]
Upper [illegible] Lake	9,[illegible]
[illegible] Lake	9,[illegible]
Middle [illegible]	9,[illegible]
North [illegible]	9,[illegible]
[illegible] Lake	[illegible]
[illegible] Lake	[illegible]
West Lake	[illegible]
Lily [illegible]	9,[illegible]
[illegible] No. [illegible]	9,2[illegible]
[illegible] No. 1	9,2[illegible]
[illegible]	9,2[illegible]
[illegible] Lake	9,2[illegible]
[illegible] No. 1	8,[illegible]
[illegible] No. 2	8,[illegible]
[illegible]	9,[illegible]
[illegible] Marsh	9,2[illegible]
Lily Marsh	9,[illegible]
[illegible] Pool	8,[illegible]
[illegible] Lake	8,[illegible]
[illegible] Lake	8,[illegible]
[illegible]	8,[illegible]
Pine Glade Marsh	8,1[illegible]
Pine Glade Pond	8,[illegible]
[illegible] Pond	[illegible]
[illegible] Pond	8,[illegible]
[illegible] Lake	[illegible],900
[illegible] Lake	[illegible]
[illegible] Lake	[illegible]
[illegible] Pond	[illegible]
North [illegible]	5,[illegible]
Semper Pond	5,[illegible]
Semper Lake	5,1[illegible]
Mount [illegible] Pool	5,[illegible]
Fort Collins Pool	4,[illegible]
Willows Lake	4,[illegible]
St. Vrain [illegible]	5,1[illegible]
Allen Pond	4,100
Dodds Pond	4,100
Pond No. 15	4,100
Pond No. 33	4,100
Swink Pond	4,100
Pond No. 1	4,100
Pond No. 2	4,100
Norton Pond	4,100
Roadside Pool	4,100
Reservoir No. 1	4,100
Red Lake	4,100

LAKE AT SEMPER, COLORADO (5,400 FEET)

A lake of the plains with the mountains in view in the background

REDROCK LAKE (10,000 FEET)

A montane lake of the morainal type

CRATER LAKES AS SEEN FROM THE CONTINENTAL DIVIDE

Shows an alpine lake in a cirque at timber line (11,000 feet) and several Montana lakes at lower elevations

ICE LAKE (12,188 FEET)

A lake of the alpine zone. Photograph taken August 1, 1914

NEW FLIES OF THE GENUS SARCOPHAGA FROM GUAM AND THE PHILIPPINES.

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This paper, containing descriptions of four new species of *Sarcophaga*, is based on material from the Philippine Islands and Guam belonging to the United States National Museum.

SARCOPHAGA SUBTUBEROSA, new species.

Holotype.—Male, United States National Museum (No. 21497). Bears number 1255; collector, D. T. Fulloway, Guam.

Allotype.—Female, United States National Museum (No. 21497). No record number; collector, D. T. Fulloway; Guam.

Paratypes.—United States National Museum, one male, four females.

Length.—8 to 12 mm.

(*Male*) *Head.*—Viewed from side parafrontals and genae with dark reflections, not intensified on transverse impression. Breadth of front at narrowest part varies from slightly less to slightly greater than one-half eye width; cheek height approximately one third that of eye. Front prominent; frontal vitta at narrowest part of front nearly or fully twice as wide as each parafrontal, its sides parallel or slightly converging backward. Second antennal segment dark; third about twice length of second; arista plumose to beyond middle. Back of head somewhat convex, with one row of black cilia behind eyes, otherwise clothed with whitish or yellowish-white hair that completely covers metacephalon and extends on to posterior part of cheek. Anterior part of latter clothed with black hair. Gena with a row of hairs near lower eye orbit; other hairs, if present, very minute. Palpi dark.

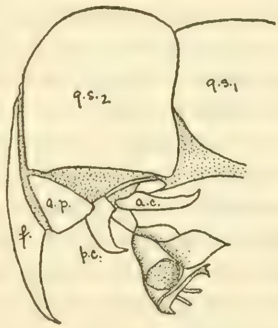

Fig. 1.—Sarcophaga subtuberosa. *a. c.*, anterior claspers; *a. p.*, accessory plate; *f.*, forceps; *g. s.*1, first genital segment; *g. s.*2, second genital segment; *p. c.*, posterior claspers.

Chaetotaxy.—Lateral verticals absent; vibrissae inserted just above line of oral margin; each row of frontals extends below base of vitta and diverges from inner edge of gena.

Thorax.—Mesonotum clothed with rather short, reclinate bristles. Hairs covering anterior spiracle light yellowish except at very base; those of anterior margin of posterior spiracle mostly dark brownish but faintly lighter at very tips; those of spiracular cover light yellowish throughout.

Wings.—Bend of fourth vein a right or very slightly acute angle; anterior cross-vein more basal than end of first longitudinal; third vein bristly; costal spine vestigial; section III of costa about one and one half times section V; alulae fringed with hair; calypters whitish, margins fringed with whitish hair.

Legs.—Dark. Posterior femur clothed beneath with fine hairs that do not become longer and beard-like posteriorly; anterior face with three rows of bristles, those of intermediate row shortest and absent distally; posterior face without ventral row of bristles; tibia straight or slightly curved, only the posterior face with a weak beard of long, coarse hairs on distal two-thirds to three-fourths; tarsus not shorter than the tibia. Middle femur clothed beneath on posterior, proximal half with beard-like growth of long hairs; anterior ventral row of short bristles complete, posterior row represented by "comb" only, which extends back to the long hairs: submesotibial bristle present. Ventral surface of anterior coxa with an irregular row of bristles at each side only.

Chaetotaxy.—Anterior dorsocentrals not weaker than anterior postsuturals and longer than vestiture of prescutum; acrostichals absent; inner presuturals very weak: last two pairs of posterior dorsocentrals much the stronger, anterior to these two or three pairs scarcely longer than vestiture of scutum; prescutellar acrostichals present; scutellar apicals present; three sternopleurals; lower sternopleura with a single row of bristles, otherwise clothed with hair.

Abdomen.—Somewhat conical or slightly oval, clothed above with short, reclinate bristles, beneath with longer, more erect hair that becomes much longer on fourth notum. Vestiture of fourth ventral plate very short and strongly reclinate or decumbent.

Chaetotaxy.—Second segment without marginal bristles; third with two, and with two or three laterals on each side; fourth with a complete row ending ventrally in long hairs.

Genital segments.—Not prominent, usually only second segment and membranous band between it and first showing, ground color usually black or blackish but sometimes brownish. First, sometimes faintly grayish pollinose, in profile slightly arched, marginal bristles absent; second, rotund, very slightly flattened, vestiture slightly longer than that of first; anal area small. Forceps black or blackish, base with long, slightly curly hairs a little longer than vestiture of second segment; prongs approximated for about half their length, tips bare. Connecting membrane, on each side just anterior to "humps," with a row of long hairs.

Genitalia.—Similar to those of *S. tuberosa* Pandellé, *S. sarracenioides* Aldrich, etc. Accessory plates hairy. Fifth ventral plate not distinguishable from that of *S. harpax* Pandellé; base with sharply angular median ridge, in profile its posterior extremity not upturned; lamellae expanded, their inner edges with prominent fringe of bristles.

Female.—These differ from males in the following important characters:

Head.—Breadth of front at its narrowest part equal to or slightly less than eye width. Frontal vitta a little wider than each parafrontal.

Thorax.—Vestiture of scutellum very short, strongly reclinate.

Legs.—Posterior trochanter with slender, apical bristle; bristles of intermediate row of anterior face of femur lacking or a few scarcely differentiated bristles proximally; posterior face usually with two ventral, proximal bristles. Middle femur with complete posterior ventral row of short bristles, "comb" not differentiated.

Chaetotaxy.—Three or four sternopleurals, rarely five.

Abdomen.—Oval; vestiture throughout of short reclinate bristles except that of ventral surface of fourth notum, which is erect and hairy.

Genital segments.—Not protuberant, not visible from above. First segment not divided into two lateral lips but often very slightly carinated (anterio-posteriorly) along the mid-dorsal line, ground color varies from that of abdomen (blackish) to orange brown; often with same pollinose colors as abdomen; spiracles central, but usually concealed by edge of fourth notum. Fifth and sixth ventral plates fused, wider than fourth; fifth usually grayish pollinose, much broader than long, its posterior margin with a few bristles (one or two) at each side; the heavily chitinized portion of sixth polished, consisting of a short, anterior part and two rounded posterior lobes (one on each half), each lobe with apical bristles.

Described from three male and eight female specimens.

Range.—Guam, Philippine Islands.

This fly is of interest primarily as a subspecies of *Sarcophaga tuberosa* Pandellé. It is at once distinguished from other described subspecies by the presence of but a single row of black cilia behind the eyes and the white vestiture on the posterior portion of the cheek. All other subspecies known have three rows of black cilia and the cheek vestiture black. The tip of the forceps prongs of *subtuberosa* are attenuated. At least another subspecies, *S. tuberosa harpax* Pandellé occurs in the Orient.[1] A male and female were included in the material from the Philippines.

[1] Böttcher (Ent. Mitt., vol. 1, 1912, p. 164) reports it from Formosa.

S. subtuberosa is also interesting as an apparent link connecting the *tuberosa* and *haemorrhoidalis* groups of Böttcher.[1] The penis and genital segments are similar to those of the *tuberosa* subspecies of the *tuberosa* group and the fifth ventral plate is like that of *harpax* and *tuberosa*. The single row of black cilia behind the eyes, the white vestiture on the posterior portion of the cheek, and the undivided nature of the first genital segment of the female all suggest the *haemorrhoidalis* group (*S. haemorrhoidalis* Fallen, *S. ruficornis* Wiedemann, *S. falculata* Pandellé, *S. securifera* Villeneuve, etc.)

Three of the female paratypes are from the Philippine Islands, two bear the accession number 1312 (B. Arce, collector), and the other 1306. The allotype is also from the Philippines and is labeled "Acc. No. Bur. Agr. P. I." The remaining female paratypes are from Guam (collector D. T. Fulloway). Females from the Philippines have the first genital segment a dull brownish orange (possibly due to imperfectly hardened reared material), those from Guam have this segment deep brown or blackish.

SARCOPHAGA CRINITA, new species.

Holotype.—Male, United States National Museum (No. 21498). Acc. No. 1537; collector, B. Arce; Philippine Islands.

Allotype.—Female, United States National Museum (No. 21498). Acc. No. 1431; collector, B. Arce; Philippine Islands.

Paratype.—United States National Museum, one male.

Length.—9–10 mm.

Male, head.—Viewed from side parafrontals and genae with dark reflections, transverse impression with a brownish tinge. Breadth of front at narrowest part about three-sevenths that of eye (exactly in three specimens measured); cheek height approximately one-fifth that of eye. Front prominent; frontal vitta at narrowest part of front about twice as wide as each parafrontal, its sides very slightly converging backward. Second antennal segment dark; third about three times length of second; arista plumose on basal half or slightly more. Back of head almost flat or somewhat convex, with three rows of black cilia behind eye, otherwise clothed with silvery-white hair that completely covers metacephalon. Cheek vestiture black except possibly for a few scattered white hairs posteriorly. Gena with a row of bristly hairs near lower eye orbit, other hairs if present very minute. Palpi dark.

Chaetotaxy.—Lateral verticals absent; vibrissae inserted on line with oral margin; each row of frontals extends below base of vitta and diverges from inner edge of gena.

Thorax.—Mesanotum clothed with rather short, reclinate bristles. Hairs covering anterior spiracle dark brown or blackish, though sometimes faintly light colored at tips; those of anterior margin of

[1] Deutsch. Ent. Zeitschr., 1912.

posterior spiracle dark brown or blackish; those of spiracular cover dark colored, sometimes faintly yellowish at tips forming a narrow, yellow border.

Wings.—Bend of fourth vein a right or a very slightly acute angle; anterior cross-vein slightly more basal than end of first longitudinal; third vei bristly (about two-thirds or three-fourths of distance to anterior cross vein); costal spine vestigial; section III of costa equal to or slightly greater than section V; alulae fringed with hair; calypters whitish, margins fringed with white hair.

Legs.—Dark. Posterior femur clothed beneath with short hairs; anterior face with three rows of bristles, those of intermediate row shortest, weak and absent distally, those of lower row few and scattered; posterior ventral row of bristles present on proximal half only: tibia straight or slightly curved, beards absent: tarsus approximately same length as tibia. Middle femur with short, scattered hairs beneath; anterior and posterior ventral rows of bristles complete, bristles of their distal halves weak and inconspicuous, "comb" not developed: submesotibial bristle present. Ventral surface of anterior coxa with an irregular row of bristles at each side only.

FIG. 2.—SARCOPHAGA CRINITA. (SAME LETTERING AS IN FIG. 1.)

Chaetotaxy.—Dorsocentrals strongly reclinate. Anterior dorsocentrals quite long, slightly longer than anterior pairs of postsuturals; acrostichals present; inner presuturals absent: four pairs posterior dorsocentrals, the two anterior pairs much the weaker though considerably longer than vestiture of scutum; praescutellar acrostichals present; scutellar apicals present: three sternopleurals: lower sternopleura with bristles only.

Abdomen.—Somewhat conical or slightly oval, clothed above with short, reclinate bristles, beneath with longer, more erect hair that does not become longer on fourth notum. Vestiture of fourth ventral plate shortest and strongly reclinate or decumbent.

Chaetotaxy.—Second segment without marginal bristles; third with two; fourth with complete row.

Genital segments.—Not prominent, usually only second segment and membranous band between it and first showing. First, ground color, brownish, faintly grayish pollinose, in profile slightly arched, marginal bristles absent, vestiture short and sparse: second, very noticeably flattened, blackish, vestiture longer than that of first; anal area small and extending above middle of posterior surface. Forceps black or blackish, base without upward flap-like extensions or at most these are short and inconspicuous, vestiture shorter than that of second segment; prongs approximated for about two-thirds their length, then separated and bent prominently forward, each tip with a minute tooth.

Genitalia.—Accessory plates subtriangular, hairy. Fifth ventral plate concealed in specimens examined by overlapping of ventral edges of fourth notum. Claspers short and slender; anterior pair curved forward and slightly expanded at very tip.

Female.—These differ from males in the following important characters:

Head.—Breadth of front at its narrowest part slightly greater than one-half eye width. Frontal vitta equal to or slightly wider than each parafrontal.

Legs.—Intermediate row of bristles of anterior face of posterior femur at most represented by a few slender, weak bristles proximally.

Abdomen.—Oval; vestiture throughout of short, reclinate bristles.

Genital segments.—Not protuberant, not visible from above. First genital segment divided into two lateral lips, ground color, black or blackish and more or less grayish pollinose.

Described from three male and two female specimens.

Range.—Philippine Islands.

In all three male specimens examined the lower row of bristles of the anterior face of the third femur consisted of four bristles, two near the center and one distal and one proximal to these that were farther from the central bristles than these were from each other.

SARCOPHAGA ORIENTALIS, new species.

Holotype.—Male, United States National Museum (No. 21499).

Length.—14 mm.

Male, head.—Viewed from side parafrontals and genae with dark reflections, not intensified on transverse impression. Breadth of front at narrowest part about one-half eye width; cheek height approximately one-third that of eye. Front prominent; frontal vitta at narrowest part of front about same width as each parafrontal, its sides slightly converging backward and the margins somewhat effaced below ocellar triangle. Second antennal segment dark; third at least twice length of second; arista plumose to beyond middle. Back of head slightly convex, with three rows of black cilia behind eyes, otherwise clothed with whitish hair that completely covers metacephalon. Cheek vestiture black. Gena with row of short hairs close to lower eye orbit, continued as very minute hairs up on to parafrontals. Palpi dark.

Chaetotaxy.—Lateral verticals present; vibrissae inserted on line with oral margins; each row of frontals extends below base of vitta and diverges slightly from inner edge of gena.

Thorax.—Mesanotum clothed with short reclinate bristles. Hairs covering anterior and posterior spiracles dark except at tips.

Wings.—Bend of fourth vein a slightly acute angle; anterior cross-vein nearer end of first than end of second longitudinal; third vein bristly; costal spine vestigial; section III of costa slightly greater than section V; calypters whitish, margins fringed with whitish hair.

Legs.—Dark. Posterior femur clothed beneath with long, fine hairs, that become longer and beard-like posteriorly; anterior face with well-developed upper and intermediate rows of bristles, lower row represented by only two bristles at distal end and with longer, slender, bristle-like hairs proximal to them: posterior face without ventral row of bristles: tibia with long, well developed anterior and posterior beards, latter the longer and more dense: anterior face with a single slender, median bristle (besides those near median dorsal ridge) on distal portion: tarsus not shorter than tibia. Middle femur clothed beneath on posterior, proximal half with pronounced beard-like growth of long hairs; anterior, ventral row of short bristles present only on distal half, posterior row represented only by strong "comb": tibia clothed beneath on distal half with long hair that tends to become beard-like anteriorly and posteriorly; submeso-tibial bristle absent. Ventral surface of anterior coxa with a row of bristles at each side only.

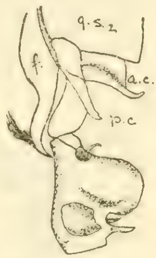

FIG. 3.—SARCOPHAGA ORIENTALIS. (SAME LETTERING AS IN FIG. 1.)

Chaetotaxy.—Anterior dorsocentrals short, but longer than vestiture of praescutum; acrostichals and inner presuturals absent: only last two pairs postsutural dorsocentrals well developed; prescutellar acrostichals present: scutellar apicals present: three sternopleurals, strong: lower sternopleura with long bristle-like hair.

Abdomen.—Clothed above with short reclinate bristles, beneath with longer erect hairs that become still longer on fourth notum.

Chaetotaxy.—Second segment without dorsal, marginal bristles; third with two dorsal and on each side two lateral.

Genital segments.—Second segment shining black, first dull and brownish. First, in profile slightly arched, marginal bristles absent, vestiture shorter and finer than on second; second, rotund, slightly flattened, vestiture on center long and somewhat bristle-like, anal area small. Forceps black, separated from slightly beyond base, tips bent forward and a little convergent; base with long, fine hairs; at forward bend near tip of prongs each with a tuft of prominent bristles (see in profile).

Genitalia.—Claspers blackish, anterior pair very broad. Distal portion of penis brownish, with very large, lateral, chitinous processes extending anteriorly.

Described from one male specimen collected by B. Arce and bearing label, "Acc. No. 1317, Bur. Agr. P. I."

Range.—Philippine Islands.

The parafrontals, genae, and posterior eye orbits are golden pinollose. The abdomen of the type-specimen is so distorted that the ventral plates can not be seen. The genital segments are mounted on a cardboard point and pinned with the specimen.

SARCOPHAGA KNABI, new species.

Holotype.—Male, United States National Museum (No. 21500).

Paratype.—United States National Museum (No. 21500), one male.

Length.—10–12 mm.

Male, head.—Parafrontals and genae dull brassy to bright golden pollinose, also posterior eye orbits. Breadth of front at narrowest part slightly more than one-half eye width; cheek height approximately two-fifths that of eye. Front not prominent; frontal vitta at narrowest part of front about twice width of each parafrontal, its sides slightly converging backward. Second antennal segment dark; third about twice length of second; arista plumose to beyond middle. Back of head somewhat convex, with one row of black cilia behind eyes, otherwise clothed with whitish, yellowish hair that completely covers metacephalon. Cheek clothed with whitish or yellowish hairs. Gena with row of small hairs close to lower eye orbit. Palpi dark.

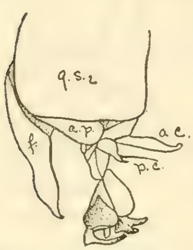

FIG. 4.—SARCOPHAGA KNABI. (SAME LETTERING AS IN FIG. 1.)

Chaetotaxy.—Lateral verticals may be weakly developed; vibrissae inserted on line with oral margin; each row of frontals scarcely if at all extending below base of vitta, the lowermost pairs a little divergent.

Thorax.—Mesonotum clothed with short reclinate bristles. Spiracular cover very light colored.

Wings.—Bend of fourth vein a right or slightly acute angle; anterior cross-vein under middle of section III of costa; latter equal to at least sections V and VI; third vein bristly; costal spine vestigial; calypters whitish, margins fringed with white hair.

Legs.—Dark. Posterior femur clothed beneath with short, fine hair that ends posteriorly in a row of bristle-like hairs; upper row of bristles of anterior face complete, intermediate row represented by a few bristles centrally, lower row of short, well separated bristles; tibia with anterior and posterior beards of long, slender hairs, latter somewhat the stronger; anterior face without bristles (except near median dorsal ridge); tarsus shorter than tibia. Middle femur clothed beneath with short, fine hair; anterior, ventral row of short bristles complete, posterior row represented only by ''comb''; submesotibial bristle present; anterior coxa with irregular row of bristles at each side only.

Chaetotaxy.—Anterior dorsocentrals weak, about as strong as anterior postsuturals; acrostichals and inner presuturals absent; only last two pairs posterior dorsocentrals strong, anterior to these two or three very weak pairs (probably two usually); prescutellar acrostichals present; scutellar apicals present; three sternopleurals; lower sternopleura with bristles and bristle-like hairs.

Abdomen.—Clothed above with short, reclinate bristles, beneath with slightly longer more erect hair. Vestiture of fourth ventral plate short and decumbent. Fifth ventral plate divided, basal portion ridged.

Chaetotaxy.—Second segment without marginal bristles, third with two and with two laterals on each side, fourth with complete row ending ventrally in long hairs.

Genital segments.—First dark pollinose (not normally visible); second blackish or brownish, subshining. Second, slightly flattened, vestiture of fine hair and shorter than that of base of forceps. Forceps-prongs shining, brownish, and becoming blackish toward tips, each of latter ending in a small, claw-like tooth directed forward; base clothed with long, dense hair.

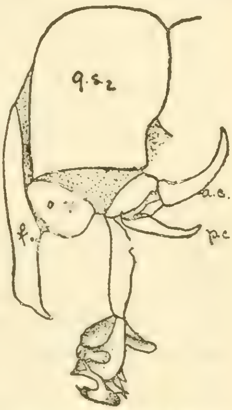

FIG. 5.—SARCOPHAGA RUFICORNIS. (SAME LETTERING AS IN FIG. 1.)

Described from two male specimens.

Range.—Philippine Islands.

The holotype bears the following label: "Acc. No. 108, Bur. Agr., P. I.," the paratype, "Acc. No. 136, Bur. Agr., P. I."

Among the material examined is one female specimen which may be the female of this species and bears the label, "Probably female of *Sarcophaga knabi* R. Pkr." The original label reads as follows: "Acc. No. 146, Bur. Agr., P. I."

Among the described species included in the lot from the Philippines were a male and female, probably of *Sarcophaga ruficornis* Wiedemann. a male and female of *S. tuberosa harpax* Pandellé, and a male of *S. orchidea* Böttcher. *S. ruficornis* has been known only from India; and, since no figure of the genital segments now exists in the literature, one presented in this paper (fig. 5). *S. orchidea* was described from Formosa.

ON TWO SPECIES OF FISHES FROM THE YALU RIVER, CHINA.

By Isaac Ginsburg,
Aid, Division of Fishes, United States National Museum.

The United States National Museum has received, through the kindness of Mr. Arthur de C. Sowerby, a very desirable and representative series of fresh-water fishes from Manchuria collected by himself. The following descriptions of two species from the Yalu River are deemed of sufficient interest to ichthyologists to warrant their publication.

HEMIBARBUS LONGIROSTRIS (Regan).

Acanthogobio longirostris Regan, Proc. Zool. Soc. London, 1908, p. 60, pl. 3, fig. 3.

Hemibarbus labeo Berg, Faun. Russ. Poiss., vol. 3, 1914, p. 631 (in synonymy).

Two specimens 105 and 155 mm. long are evidently this species. Berg places it in the synonymy of *Hemibarbus labeo* Bleeker with a query. However, it seems to be a valid species. Compared with specimens of the same size of *H. labeo* and *H. maculatus*, the following differences are found. The scales are larger, the formula being 41–44, $\frac{5\frac{1}{2}}{3}$, while in the older species it is 47–52, $\frac{6\frac{1}{2}\text{–}8}{4\text{–}5}$. The suborbital ring and preopercle are much wider, and contain large muciferous cavities. The exposed muscular part of the cheek at the angle of the preopercle is one-half or less the vertical diameter of the pupil, while in the other species it is equal to the vertical diameter of the pupil or more than that. In coloration the present species is nearest to *H. maculatus*. The dorsal and caudal fins are spotted with black, but there is no regular row of large black spots on the sides. The sides are dotted irregularly with small black spots which, in the smaller specimen, are connected with more or less indistinct lines forming reticulations.

Regan records the pharyngeal teeth as being in two rows, and on that account placed the species in *Acanthogobio*. However, the pharyngeal bone from one side of the large specimen was dissected out and the teeth were found to be 5. 3. 1. The small tooth of the inner row of the type was probably broken off in dissecting, or else the pharyngeal teeth in this species are subject to variation. Since the other species of *Hemibarbus* uniformly have three rows of pharyngeal teeth the first assumption is probably correct.

RHINOGOBIUS SOWERBYI, new species (Gobiidae).

D. VI, 9; A 9; Sc. 35–36/9–10.

Body elongate, cylindrical anteriorly, compressed posteriorly. Head depressed, longer than wide and wider than deep. Snout blunt, rounded, gibbous. Mouth somewhat oblique, medium; maxillary reaches to a vertical through anterior third of eye. Lips thick, cheeks tumid. Interorbital space concave, about as wide as horizontal diameter of eye. Teeth in three rows in each jaw, erect; outer row somewhat enlarged, compressed, usually truncate, slightly bent backward. Outer row extends to somewhat less than an eye diameter before the angle of mouth, inner rows end considerably before. Tongue entire, rounded. Anterior nostril with a very short tube placed in a slight depression; it is almost but not quite on a level with the lower margin of the eye, and is nearer the posterior margin of the upper lip than the anterior margin of the eye. Posterior nostril without raised border placed in front of eye and on a horizontal through its middle. Cheeks, opercles, top of head, and nape, scaleless and without raised muciferous papillae, the naked area extending to a vertical through insertion of pectoral; 6–8 embedded cycloid scales on dorsum before spinous dorsal. At the sides of the dorsum directly over opercle two rows of embedded scales extend further forward, to the cheeks. Belly entirely naked to origin of anal. Scales on body well developed, imbricated; all are ctenoid and of nearly the same size, except those on the dorsal aspect anterior to the origin of the spinous dorsal. 35–36 scales from upper, posterior angle of the opercle to base of caudal. 9–10 rows from origin of anal to second dorsal, counting upwards and backwards. Gill openings restricted; isthmus wide, the insertion of the gill membrane on the isthmus on a vertical through about the middle of opercle. Outer edge of shoulder girdle with neither a fleshy ridge nor papillae. Pectoral fins with a scaleless, somewhat muscular base; the fins rounded, reaching vent; the upper rays connected by membrane, not silklike. Ventrals completely united, infundibuliform, the interspinal membrane well developed, emarginate; the disk is broader than long and reaches midway between its origin and vent. Dorsal fins separated by a space about equal to diameter of eye. The fourth spine the longest, about two in head, the second, third, and fifth spines nearly as long as fourth, first spine considerably shorter, last spine shortest. The posterior rays of second dorsal and anal longest; they reach the base of the rudimentary caudal rays in the paratype, but do not quite reach so far in the type. Origin of anal fin slightly posterior to that of second dorsal, both fins ending on same vertical. Caudal rounded, not prolonged. Anal papilla oblong, triangular, slightly bifid in type, truncate in paratype, its length about equal to half diameter of eye.

Head brownish, nape marbled with darker. One or two very indistinct longitudinal lines on upper part of opercles, two or three such lines on nape directly over opercle, more distinct. The exposed part of every scale with a large brown spot anteriorly, the margin yellowish. Fins dusky, the spinous dorsal darkest. Dorsals, anal and caudal margined with light yellowish; a rather indistinct yellow band at base of pectoral. Five very indistinct crossbars on body behind pectorals. An oblong spot more or less distinct at base of caudal. The entire body and fins are stippled with very minute dark spots.

Two specimens from the Yalu River collected by Arthur de C. Sowerby.

Holotype.—68 mm. long. Cat. No. 76734, U.S.N.M.

Paratype.—65 mm. long. Cat. No. 76734–*A*, U.S.N.M.

This species is very near *Rhinogobius nagoyae*, Jordan and Seale,[1] rom Nagoyae, Japan. It differs from that species in that the fourth dorsal spine is the longest instead of the second. The longest spine in the present species is about one-half the head instead of nearly equal to it. The soft dorsal and caudal lack the regular rows of spots present in the older species.

Measurements.	Holotype.		Paratype.	
	Mm.	*Per cent.*	*Mm.*	*Per cent.*
Total length	68	....	65	....
Length without caudal	55	....	52	....
Length of head	17.5	31.8	15.75	30.3
Width of head (directly behind eyes)	12	68.6	10	63.5
Depth of head (directly behind eyes)	7.5	42.8	7.25	46.1
Length of snout	6	33.0	5.5	34.9
Horizontal diameter of eye	3	17.1	3	19.0
Greatest height	11.5	20.9	9.5	18.3
Least height	7	12.7	6	11.5
Length of caudal peduncle (end of anal to base of caudal on mid line)	13	23.6	11.5	22.2
Tip of snout to spinous dorsal	22	36.4	20	38.5
End of second dorsal to rudimentary rays of caudal	9.5	17.3	10	19.3
Tip of snout to vent	32.5	59.0	29.5	56.7
Vent to rudimentary rays of caudal	18	32.7	18	34.6
Base of spinous dorsal	10	18.2	9.75	18.8
Base of second dorsal	10	18.2	9.5	18.3
Base of anal	7.5	13.6	7.5	14.4
Length of caudal	13	23.6	13	25
Length of ventral	7.75	14.1	7.75	14.9
Length of pectorals	13.5	24.6	13	25

[1] Proc. U. S. Nat. Mus., vol. 30, 1906, p. 147.

FOSSIL PLANTS FROM BOLIVIA AND THEIR BEARING UPON THE AGE OF UPLIFT OF THE EASTERN ANDES.

By Edward W. Berry,
Of the Johns Hopkins University, Baltimore.

INTRODUCTION.

The present contribution includes a description of the fossil plants from two well-known localities in Bolivia—the copper district of Corocoro and the silver and tin district of Potosi—both classic localities that have been worked since the sixteenth century. The rather definite results regarding the age of these deposits has not only an important bearing on the time of mineralization in these regions, but is of the greatest value in indicating the period of elevation of the Andes, which is shown to be much later and more profound than has hitherto been supposed. This study is based upon material collected in 1915 by Profs. J. T. Singewald, jr., of the Johns Hopkins University, and Benjamin L. Miller, of Lehigh University. The types and figured specimens have been presented to the United States National Museum. A discussion of the results of this study is followed by a description of the flora, and by an account of a new species of Brachiopod contributed by Prof. Charles Schuchert, of Yale University.

PRESENT PHYSIOGRAPHY AND CLIMATE.

A brief outline of the present physiography, geology, and climate of Bolivia are necessary to an understanding of the bearing of the fossil floras discussed in the following pages on the geological history of the region.

Although lying wholly within the Torrid Zone the combination of elevation, mountain barriers, and prevailing winds has had a most profound influence on the climate, and consequently upon the flora and fauna. Except for certain transverse and irrigated valleys and the relatively low and barren Coast Range the country bordering the Pacific (now belonging to Chile) is a desert of shifting sands. This is bounded on the east by the Western Andes or Cordillera Occidental, which parallels the coast at a distance of from 50 to 100 miles.[1]

[1] The relatively low Coast Range is omitted, as it is of no importance in the present connection.

The western Andes consist chiefly of Mesozoic deposits, together with innumerable lava flows and ash beds of the great series of high volcanoes, whose greatest activity appears to have been reached in very late geologic times. The Cordillera Occidental, with many peaks between 19,000 and 21,000 feet in altitude, forms the western ramparts of the high Bolivean plateau or "altaplanicie," which extends from the Vilcanota massif of Peru southward to the Argentine frontier—a distance of about 500 miles and with an average width of about 80 miles. It has an average elevation of between 12,000 and 13,000 feet, and is bleak and inhospitable in the north (the "puna"), and arid and barren toward the south—the desert of Lipez—with saline depressions, and ridges and peaks rising through the flat mantle of Pleistocene and Recent deposits.

The eastern ramparts of the "altaplanicie" are formed by the somewhat fanned-out chains of the eastern Andes or "Cordillera Real," consisting largely of folded Paleozoics with granitic cores and other igneous intrusives, in part at least of late Tertiary age, forming a series of high peaks, a number of which reach above 21,000 feet. It is about 250 miles from the western range of the Cordillera Real to the Sierra de Cochabamba and the Sierra de Misiones, which form the eastern boundary of this imposing mountain mass. It is in the midst of this extremely rugged montane country that Potosi rises to a height of 15,381 feet, surrounded on all sides by much higher peaks.

Three-fifths of the area of Bolivia lies east of the Cordillera Real, and forms a part of the Amazon and Paraguay drainage basins. The latter region consists of gently undulating forests, low alluvial grass-covered plains (llanos), great swamps, and flooded bottom lands.

Little can be said of the details of either the existing climate or vegetation of much of Bolivia. The lowlands east of the mountains, comprising the Provinces of El Beni, Santa Cruz, Chuquisaca, and Tarija, together with the eastern mountain valleys below 5,000 feet, are termed "yungas" (a climatic term) and have a humid tropical climate. The higher valleys of the eastern Andes between 5,000 and 9,500 feet, where they are situated so as to receive the moisture-laden northeast trade winds, have a subtropical character. Above 9,500 feet and up to 11,000 feet the climate is in general temperate and suitable for raising vegetables and cereals. Between 11,000 feet and 12,500 feet in the mountains, and consequently including the high plateau, is the "puna" or region of cold and aridity, with two seasons—a cold summer or autumn and a winter. The air is cold and dry and the growing season is too short for anything except oca (Oxalis) quinoa (Chenopodium), potato, barley, and coarse grasses.

Above 12,500 feet and extending to the snow line (about 17,500 feet) is the "puna brava," a bleak inhospitable region of shepherds and miners, and with arctic rosette plants and a few grasses.

POTOSI.

Cerro Rico de Potosi or Potosi Mountain lies immediately southeast of the town of Potosi in the northern part of the Province of that name, in the eastern Andes or Cordillera Real, which forms the eastern boundary of the high plateau of Bolivia. The mountain, which has a height of 15,381 feet, consists of a core of rhyolite surrounded by conglomerates, shales, and tuffs. Fossil plants are abundant in the latter on the northeast slope of the mountain and also in some of the mine tunnels.

Silver was discovered at Potosi in 1544, and mining for this metal and latterly for tin has been in operation for over 350 years. An account of the region has recently been published by Miller and Singewald,[1] who collected the fossils that are the basis of the present contribution.

COROCORO.

Corocoro is near the western edge of the high plateau (altiplanicie) of Bolivia in a group of low structural hills such as not infrequently project through the flat surficial deposits of the plateau. It lies a short distance south of the Arica-La Paz Railroad in the Province of La Paz, about 100 kilometers southwest of the town of La Paz and at an altitude of slightly more than 13,000 feet. It is about 2° north and 2° 40′ west of Potosi. The country rock is a thick and much faulted series of prevailingly red, gypsiferous and ferruginous shales, sandstones, and conglomerates. Copper has been mined at Corocoro since before the arrival of the Spaniards in the sixteenth century, and a general account of the district has recently been published by Singewald and Miller.[2]

AGE OF THE COROCORO ROCK.

Opinions regarding the age of this series have ranged from Carboniferous to Tertiary. These have not been based upon paleontologic evidence, however, since no fossils have hitherto been known from the series. Messrs. Singewald and Miller collected fossil plants from a sandy tuff northwest of Corocoro and obtained the cast of a footprint from a specimen collected by Fernando Dorian, manager of the Corocoro Copper Mines (Ltd.) along the railroad between Tarejra

[1] Miller and Singewald, Mining Conditions at Potosi, Bolivia. Eng. and Min. Journ., vol. 103, 1917, pp. 255–260.

[2] Singewald and Miller, The Corocoro Copper District of Bolivia, Eng. and Min. Journ., vol. 103, 1917, pp. 171–176.

and Corocoro. The latter, according to Prof. R. S. Lull, probably represents an Upper Triassic amphibian. Unfortunately the stratigraphic relations between the two outcrops is unknown, but there is no reason to doubt Professor Lull's determination or the possible presence of rocks of Triassic age in the vicinity.

The fossil plants are, however, of more immediate interest, since they occur in the horizon of the "vetas," and hence fix the age of the immediate country rock and mineralization as late Tertiary. While the fossil plants are neither abundant nor well preserved, sufficient species can be identified to fix the horizon as very nearly the same as that at Potosi, and hence determine the age of the copper-bearing rocks rather definitely as late Tertiary.

The plants which I have identified are the following: *Polystichum bolivianum, Acacia uninervifolia, Mimosa arcuatifolia, Mimosites engelhardti, Cassia ligustrinaformis, Copaifera corocoriana, Terminalia singewaldi.*

All but the last two are present at Potosi. The Copaifera and Terminalia are both represented by fruits. The latter is very similar to the not uncommon fruits of *Terminalia antiqua* from Potosi, and the leaflets of a species of Copaifera that might represent the same species as the fruits from Corocoro are present at Potosi. Thus the parallelism between the two floras is extremely close.

When a meager flora like that found at Corocoro is compared with a more extensive flora like that at Potosi, the age might differ appreciably, and yet the more common species of the larger flora might be expected to be present in the smaller. When, however, it is not only the commonest species of the larger that are found in the smaller, but also forms like the Polystichum found in a single specimen in both, additional indication of contemporaneity is afforded. Furthermore all of the Corocoro plants are represented in the modern flora by closely related species east of the mountains and all of the genera are still found in the same general region where climatic conditions differ from those prevailing at the present time on the high plateau of Bolivia. The latter region, because of its altitude and consequent coldness, and the aridity due to the interposition of the lofty eastern Andes in the path of the prevailingly eastern tradewinds, is practically treeless and in striking contrast with the conditions at the time the fossil flora was living in this region, all of the seven recorded species except the Polystichum being arborescent and some of them usually large trees. If the evidence for the Pliocene age of the Potosi flora is regarded as conclusive then there can be no doubt but that the Corocoro flora is also Pliocene, and this age is thereby established for the copper-bearing rocks of this mining district.

BOTANICAL CHARACTER.

The present contribution enumerates 85 different species of plants from Bolivia, of which 82 come from the tuffs of the historic Cerro de Potosi. Collections from these tuffs studied by Engelhardt in 1887 and 1894 resulted in making known 44 species of fossil plants, and Britton in 1893 added 11 species. The flora as at present known is remarkable for the great predominance of small individuals in it and for the large numbers and variety of its Leguminosae. It contains the representatives of 6 Pteridophytes (all ferns), 1 coniferophyte (a Podocarpus) and 75 angiosperms, of which 3 are Monocotyledons and the balance Dicotyledons. Of the latter there are 8 of doubtful affinities, 5 Gamopetalae, and 59 Choripetalae. The Dicotyledonae represent 41 genera in 20 families and 13 orders. The largest genus is Cassia with 10 species. The most abundant individual forms are *Myrica banksioides* and *Calliandra obliqua.* Much the largest order is the Rosales, represented by the families Saxifragaceae, Cunoniaceae, Mimosaceae, Caesalpiniaceae, and Papilionaceae, containing altogether 47 species, the great majority belonging to the last three families. There are 13 species of Mimosaceae representing the genera *Acacia*, *Inga*, *Pithecolobium*, *Mimosa*, *Mimosites*, *Calliandra*, and *Enterolobium.* There are 17 species of Caesalpiniaceae representing the genera *Cassia*, *Caesalpinia*, *Caesalpinites*, *Copaifera*, *Bauhinia*, and *Peltophorum.* There are 12 species of Papilionaceae, representing the genera *Amicia*, *Machaerium*, *Dalbergia*, *Desmodium*, *Drepanocarpus*, *Aeschynomene*, *Sweetia*, *Lonchocarpus*, and *Platypodium.* There are thus 9 genera of Papilionaceae, 6 of Caesalpiniaceae, and 7 of Mimosaceae. No other families are represented by more than two genera and most of them have but a single genus present. Similarly all of the nonleguminous genera except *Myrica* and *Weinmannia* are represented by a single species.

There are three or four species of *Myrica* in the fossil flora of Potosi, the only common and clearly defined of which is *Myrica banksioides* Engelhardt, and I am not sure but that *Myrica wendtii* Britton and *Myrica engelhardtii* Britton are not simply large and small variants of this species. *Myrica potosina* Britton is not a *Myrica*, and while *Myricophyllum*, species Engelhardt, is clearly distinct from all of the preceding and apparently represents a perfectly good *Comptonia*-like *Myrica*, it is represented by such incomplete material that little can be said about it.

Myrica is a very old generic type with a large number of fossil species, ranging in age from the Mid-Cretaceous to the present. The still existing species are relatively few in number, are widely scattered geographically, and represent survivors from a Tertiary cosmopolitan distribution.

Myrica has about 35 existing species and is widely distributed in the warmer parts of both hemispheres. Although we commonly think of *Myrica* as a temperate type, the bulk of the existing species are decidedly warm temperate and upland tropical[1] types. The subgenus *Morella* comprises nearly all the existing species, and its area of distribution includes southeastern Asia from Japan and China through the East Indies. In Africa it extends from Abyssinia to Madagascar and the Cape throughout the eastern watershed. In Europe a single species extends from southern Portugal to the Azores and Canaries. In America one species (*carolinensis*) reaches northward to Nova Scotia; another (*cerifera*) extends northward to Maryland; and two species on the Pacific coast extend the range northward to Oregon. The balance of the species occur throughout the Antilles, Central America, and northwestern South America. Only one species, usually considered as a subgenus, is cold temperate in its distribution. The latter, *Myrica gale*, ranges from Kamchatka to Lappland, Britain, and western France in the Palarctic region, and from Newfoundland to southern Alaska in the Nearctic region, where it extends southward to Virginia. Thus eastern North America is the only region where there is any considerable overlapping of the two subgenera. These features are brought out on the accompanying sketch map, and the conclusion is reached that *Myrica gale* is a late Tertiary or Pleistocene Holarctic radiation from what was a distinctly warm temperate group of species, and this conclusion is more or less corroborated by the geological history of the genus—the bulk of the fossil species representing the *Morella* section of the genus, or the allied genus *Comptonia*, which is sometimes made a third subgenus of *Myrica*, and which has but a single existing species of eastern North America, although cosmopolitan in the Tertiary. *Myrica* is not uncommon in the warm temperate and subtropical Tertiary coastal floras of southeastern North America.

There are several shrubby species of *Myrica* in the Inter-Andean region of Central Peru (*Myrica variibractea* De Candolle, *M. weberbaueri* De Candolle) which range upward to 3,000 meters. Whether these extend southward as far as the Potosi region I do not know, but *Myrica xalapensis* is found in eastern Bolivia in the Santa Cruz region, and is doubtless more wide ranging than the meager records indicate.

The fossil ferns are too few and incomplete to merit any special comment. The grasses are represented by three types, and the presence of flowering scales of a species of *Festuca* is notable, since the known fossil grasses usually comprise stem or leaf fragments. The fragment of a palm, while too incomplete to arouse botanical interest, is important ecologically and serves to establish the presence of this essentially tropical type in the flora. Genera not otherwise

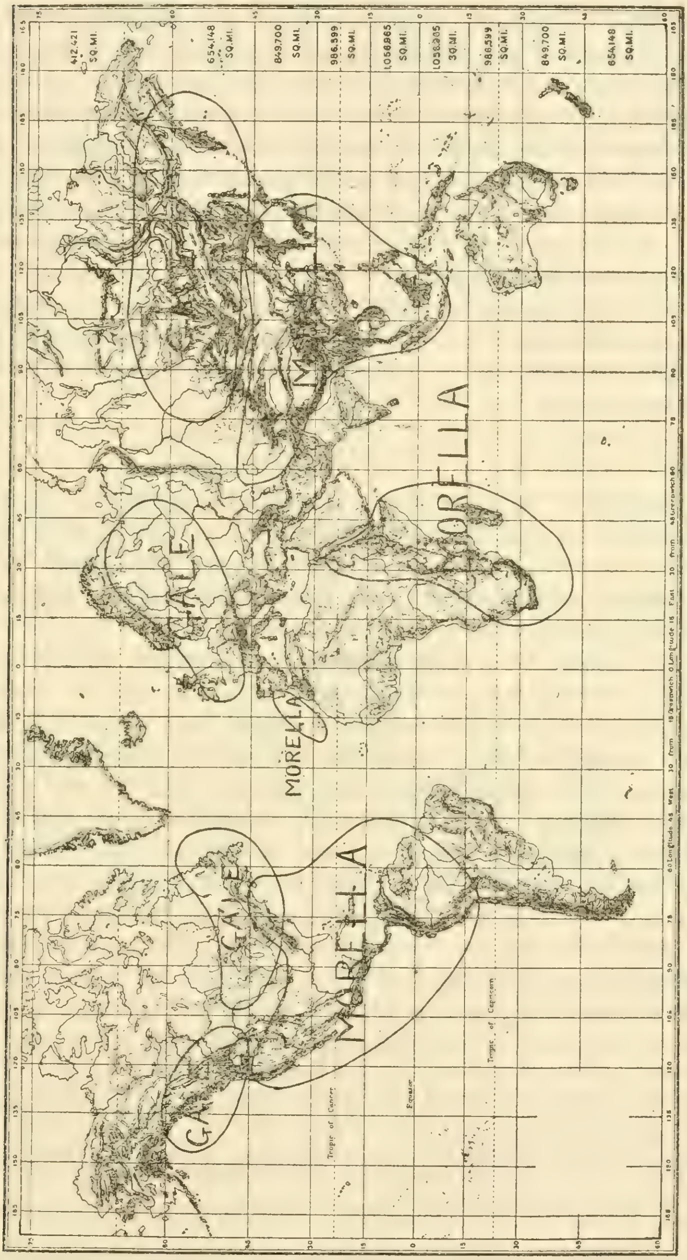

FIG. 1.—MAP SHOWING THE EXISTING DISTRIBUTION OF THE SUBGENERA OF MYRICA.

known in the fossil state and all South American in the existing flora include *Ruprechtia* of the Polygonaceae; *Escallonia* of the Saxifragaceae; *Enterolobium* of the Mimosaceae; *Peltophorum* of the Caesalpiniaceae; *Amicia*, *Drepanocarpus*, *Aeschynomene*, *Sweetia*, and *Platypodium* of the Papilionaceae; *Porlieria* of the Zygophyllaceae; *Myrteola* of the Myrtaceae; and *Cuphea* of the Lythraceae. The family Combretaceae is represented both at Potosi and Corocoro by the characteristic fruits of species apparently belonging to the Diptera section of Terminalia—an old genus with a large number of modern tropical and subtropical species and still present in eastern Bolivia. In lieu of a more extended botanical analysis the reader is referred to the accompanying table of fossil species with their existing relatives. This, together with the facts introduced in the systematic account of the fossils, will serve to complete the botanical picture and also supply the pertinent facts regarding the geological history of the various fossil types.

CORRELATION.

The number of Tertiary plants described from South America is inconsiderable, so that there is no means of direct comparison between the Potosi flora and other fossil floras except with those that are remote geographically, and such comparisons become increasingly hazardous the nearer the approach to the Recent.

Tertiary plants have been known from southern Chile (Coronel) since 1891,[1] and a flora of apparently the same age is present at several localities in the extreme southern part of the continent.[2] These all appear to fall in the earlier Tertiary, De Lapparent regarding them as Eocene (probably Sparnacian) and Dusén, following Wilckens, regarding them as probably Oligocene. At the opposite end of the continent Engelhardt[3] has described a considerable flora from Colombia (Santa Ana, Cáucathale) and Ecuador (Tablayacu, Loja Basin). These are simply designated as Tertiary by Engelhardt, Wolf,[4] and others. From certain resemblances to the flora from Panama recently studied I am disposed to regard the Loja coals as the same age as the plant bearing beds of Panama, which are either Oligocene or early Miocene, and in any event much older

[1] Engelhardt, H., Ueber Tertiärpflanzen von Chile, Abh. Senck. Naturf. Gesell., vol. 16, Hft. 4, 1891, pp. 629-692, pls. 1-14. Engelhardt, H., Bemerkungen zu chilenischen Tertiärpflanzen. Abh. Sitz. Naturw. Gesell. Isis in Dresden, 1905, pp. 69-82, pl. 1.

[2] Gilkinet, A., Quelques plantes fossiles des terres Magellaniques. Resultats voyage du S. Y. *Belgica* en 1897-1899, 1909. Dusen, P., Ueber die tertiare Flora der Magellansländer. Svenska Exped. till Magellansländerna, vol. 1, 1899, pp. 87-107, pls. 8-13.

[3] Engelhardt, H., Ueber neue Tertiärpflanzen Süd-Amerikas, Abh. Senck. Naturf. Gesell., vol. 19, 1895, pp. 1-47, pls. 1-9.

[4] Wolf, Teodoro, Geografia y Geologia del Ecuador, 1892. Wolf, T., and Rath, G. vom, Zeits. Deutsch. Geol. Gesell., vol. 28, 1876, pp. 391-393.

than the Potosi flora. I have heard of fossil plants in the lake beds of Saõ Paulo through von Ihering, who wrote me of collections having been sent to Kurtz at Cordoba some years ago, but these have apparently never been described. The only other South American Tertiary plants known to me, aside from the record of leaf impressions, apparently uncollected, on the island of Trinidad,[1] are the Pliocene plants from the province of Bahia (Brazil), briefly reported upon by Krasser[2] and Bonnet.[3] Ettingshausen at the time of his death had in preparation an illustrated account of this flora with autotypic reproductions of the related existing species, but this unfortunately was never completed.

It is obvious, then, that the familiar method of ascertaining the age of the Potosi flora by direct comparison with fossil floras of known age in the same general region or even on the same continent is impossible, and it is necessary to rely on a comparison of the Potosi flora with that found in the vicinity of Potosi and on the high plateau of Bolivia at the present time in order to get a measure of the differences in the environments between the two, and then to determine the degree of resemblance between the Potosi flora and that existing in any other part of South America at the present time, and to endeavor to deduce from these criteria its probable age.

It is perhaps needless to more than mention the existing flora at Potosi or on the high plateau near Corocoro since the rainfall is scanty and both regions are practically treeless and totally incapable of supporting the fossil flora found at these two localities. From a cursory study of Engelhardt's and Britton's determinations I long ago catalogued the Potosi flora as Pliocene, and when I began the study of the collections made by Singewald and Miller, the great resemblance of the majority of the forms, to be mentioned in detail in subsequent paragraphs, to those still existing in the rain forests of eastern Bolivia or to characteristic types of the Amazon Basin, led me to even consider these fossil floras as possibly as young as the older Pleistocene. I do not think that the resemblance to the recent flora east of the Andes is overestimated, but the remarkable discovery of a marine Brachiopod in the Potosi tuffs added another factor. It is obvious that the fossil plants could not have grown at Potosi or Corocoro had the front range of the Andes at that time been elevated sufficiently to precipitate the moisture-laden winds that come from the east. At the present time the eastern slopes of the Cordillera Real are very different climatologically and consequently

[1] Wall and Sawkins, Report on the Geology of Trinidad. Mem. Geol. Surv. Gt. Britain, London, 1860, pp. 35-52.

[2] Krasser, F., Konstantin von Ettingshausens studien über die fossile Flora von Ouricanga in Brazilien. Sitz. k. Akad. Wiss. Wien, vol. 112, Abh. 1, 1903, pp. 852-860.

[3] Bonnet, Ed., Contribution à la flore pliocéne de la province de Bahia (Brésil). Bull. Mus. d'hist. Nat. Année 1905, p. 510-512.

floristically from the western or leeward slopes and the plateau lands behind them. The first has almost daily rains and is forested to the timber line. The second are so dry that they permit the growth of only drought-resisting grasses and low scrub, and over very large areas there is no vegetation whatever. Consequently it might seem that a moderate reduction in elevation would have permitted some of the moisture-laden winds to pass and made possible the Potosi and Corocoro floras. When, however, it was found that the former was associated with a marine form, also of very modern aspect, it was realized that the change of elevation involved had actually amounted to about 2½ miles.

The admirable physiographic studies of Bowman in the Peruvian Andes,[1] as well as less detailed studies farther south, furnish distinct evidence of glaciation thought to be late Pleistocene because of the freshness of the deposits and the related topographic forms. Moreover his evidence of the profound erosion as indicated by the mature topography below the present rough summit topography leads him to regard the Andes as having undergone progressive elevation throughout the Tertiary, and he concludes that there has been a change of elevation in the late Tertiary amounting to about 5,000 feet.

It would seem then, that if the physiographic history of the region is correct, in even its broader outlines, the fossil floras are pre-Pleistocene in age. The Bahia Pliocene flora, previously mentioned comprises about 70 forms, none of which have been adequately described and none at all have been figured so that comparisons with the Potosi flora rest entirely upon names. Notwithstanding this difficulty it may be noted that the following genera, all of which should be determinable with reasonable certainty, are common to the Potosi flora and the Pliocene flora of Bahia: *Inga*, *Cassia*, *Copaifera*, *Dalbergia*, *Terminalia*, and *Weinmannia*. All are, of course, typical members of the tropical flora of the Amazon Basin and hence this agreement may be without any special significance. At the same time it is worth noting that if this resemblance is worth anything it tends to confirm the evidence independently reached by a comparison of the Potosi flora with the existing flora of tropical South America east of the Andes. That comparison may now be briefly sketched.

I have assembled in the accompanying table the fossil species in one column, the most closely related existing species in another column, and the range of the latter in a third column. Where the resemblance of fossil to living species was not extremely close or where I lacked material for adequate comparison I have named no existing species so that the resemblances are underestimated rather than adequately emphasized and the table is therefore much more

[1] Bowman, Isaiah, The Andes of Southern Peru. Amer. Geogr. Soc., 1916.

significant than similar tables ordinarily constructed by paleobotanists for like purposes. Thus of the 82 species of plants recorded from Potosi, after deducting the 16 indefinite forms referred to form genera such as *Antholithus*, *Carpolithus*, *Poacites*, *Phragmites*, *Palmophyllum*, *Pecopteris*, *Rubiacites*, *Cypselites*, and *Leguminosites*, 54 of the Potosi species out of the 66 remaining are so similar to living forms that in a majority of cases it would have done but little violence to the facts to have identified them as fossil occurrences of these existing forms. Without elaboration then it may be stated that the fossil flora is preponderantly modern in its aspect, and this similarity to the existing flora of the American tropics is too great to warrant considering the fossil flora as older than the late Tertiary. I know of no described flora as young as even the late Miocene that is as homogenous and does not contain some exotic elements or some genera that are not still found in the same general region. Summarizing, it may be noted that the Potosi fossil flora contains no species not closely related to still existing species, no genera not still found in the same general region, several genera not otherwise known fossil, and an abundant representation of relatively modern types and localized genera, as for example those of the Papilionaceae.

One has only to go eastward or northeastward a few hundred miles from Potosi to find what is essentially the same flora as that found fossil, existing, however, under climatic conditions quite different from those prevailing at the present time at Potosi or upon the high plateau of Bolivia.

Categorical conclusions regarding the exact physical environment of the fossil flora can not be deduced, but certain more general statements are warranted. The number of fossil forms definitely correlated with existing forms is 54. Forty-six of these fossil forms are represented in the existing flora of the Amazon Basin, and many of these extend greater or less distances into eastern Bolivia, such details as are available being introduced under the systematic description of the species. A number of these range northward to Central America and the Antilles and some are more characteristic of the Orinoco or northwestern part of the Amazon Basin than of that part in the latitude of Bolivia. In two or three cases where the existing species closest to the fossil is confined to this more northerly region, as in *Polystichum* and *Myrica*, these genera are represented in the existing flora of Bolivia by other species of the genus, material of which has not been available for comparison.

In the whole fossil flora enumerated comprising a representation of 85 species only the following can be regarded as Andean or West Coast forms: *Festuca*, *Escallonia*, *Amicia*, *Polystichum*, *Porliera*, *Euphorbia*, and *Myrteola*. This is a relatively small number and of these *Festuca*, *Escallonia*, *Polystichum*, *Porliera*, and *Euphorbia* are represented outside the Andean region, leaving only *Amicia* and *Myrteola* as typically Andean plants. Plants of extra-tropical climatic requirements in that they are montane forms and hence live under temperate temperatures or in arid situations include *Festuca*, *Escallonia*, *Amicia*, *Polystichum*, *Porliera*, *Euphorbia*, and *Myrteola*, the same genera previously enumerated as Andean in character. *Polystichum* and *Escallonia* are not certainly indicative of temperate conditions nor is *Euphorbia*, although the latter as well as *Porliera* indicate more or less aridity. It is not possible to determine what the relation of these few forms is to the predominantly humid and tropical character of the bulk of the Potosi flora. Possibly it is to be explained by local aridity of sandy areas of soil under a tropical sun, or there may have been elevations near to the basin of sedimentation that would explain this element of the fossil flora. The absence of large-leafed species in the flora as a whole and the vast predominance of compound leaves with small leaflets, may also have been due to a sandy substratum.

While botanists may justly object to the reference of some of the Potosi forms to one genus rather than another when several alternatives are presented, and this comment is especially applicable to the leaflets of the Leguminosae which are so abundant in the Potosi deposits, none, I think, can oppose the conclusion that whatever the opinion of students regarding the validity of some of the identifications, in no case does this uncertainty in any number of specific cases alter the outstanding result of this study, namely, that the fossil flora found in the tuffs at Potosi is very similar to existing assemblages found in eastern Bolivia or at various other places in the Amazon Basin, or that the conditions of existence for the fossil flora must have been similar to that under which those existing floras with which it has been compared are flourishing and quite different from the environmental conditions prevailing at the present time within the eastern Andes of Bolivia or on the high plateau or in fact anywhere west of the region of heavy rains on the eastern slopes of the front range.

From a consideration of all the evidence available it is concluded that the flora is Pliocene in age and that the major elevation of the eastern Andes of Bolivia and the high plateau took place in the late Pliocene and throughout the Pleistocene and that the extensive mineralization of this region also took place during this same period.

Fossil species.	Potosi.	NW. of Potosi.	Corocoro.	Most closely related existing species.	Range.
Polystichum bolivianum	×	......	×	*Polystichum triangulum* (Linnaeus) Fée.	West Indies.
Lomariopsis tertiaria	×	......	......	*Lomariopsis sorbifolia* (Linnaeus.)	Guatemala and Antilles to Brazil.
Lomariopsis, (?) sp	×	......	......	......	
Acrostichum linearifolium	×	......	......	*Acrostichum lineare* Fée	Brazil.
Gymnogramme, (?) sp	×	......	......	*Gymnogramme trifoliata* Desveaux.	Peru and Brazil.
Pecopteris, sp	×	......	......	......	
Podocarpus fossilis	×	......	......	*Podocarpus lamberti* Klotz	Brazil.
Festuca, sp	×	......	......	*Festuca*, spp	Andean.
Poacites, sp	×	......	......	......	
Phragmites, sp	×	......	......	......	
Palmophyllum, sp	......	×	......	......	
Myrica banksioides	×	......	......	*Myrica microcarpa* Bentham	West Indies.
Myrica engelhardtii	×	......	......	......	
Myrica wendtii	×	......	......	......	
Myricophyllum, sp	×	......	......	......	
Ruprechtia braunii	×	......	......	*Ruprechtia laurifolia* Martius.	Brazil.
Carpolithus viornaformis	×	......	......	*Viorna*, spp	South America.
Capparis multinervis	×	......	......	*Capparis jacobinae* Maricaud.	Brazil.
Escallonia wendtii	×	......	......	*Escallonia*, spp	Andean and elsewhere in South America.
Weinmannia brittoni	×	......	......	*Weinmannia glabra* De Candolle.	Southern Mexico, West Indies, and northern South America.
Weinmannia potosina	×	......	......	......	
Acacia uninervifolia	×	......	×	*Acacia paradoxa* De Candolle	Tropical South America.
Acacia dimidiato-cordata	×	......	......	*Acacia fasciculata* Kunth	Brazil.
Acacia tenuifolia	×	......	......	*Acacia pedicellata* Bentham	Eastern Bolivia and Brazil.
Inga ochseniusi	×	......	......	*Inga blanchetiana* Bentham	Brazil.
Pithecolobium brittonianum.	×	......	......	*Pithecolobium dulce* Bentham.	West Indies and northern South America.
Pithecolobium tertiarum	×	......	......	*Pithecolobium trapezifolium* Bentham.	Colombia, Guiana, and Brazil.
Mimosa arcuatifolia	×	......	×	*Mimosa invisa*, Martius and.	Southern Mexico and West Indies to Brazil.
				Mimosa lupulina Bentham	Brazil.
Mimosa montanoides	×	......	......	*Mimosa montana* Humboldt, Bonpland, Kunth.	Peru.
Mimosites engelhardti	×	......	×	......	
Calliandra obliqua	×	......	......	*Calliandra macrocephala* Bentham.	Brazil.
Calliandra ovatifolia	×	......	......	*Calliandra leptopoda* Bentham.	Do.
Enterolobium grandifolium.	×	......	......	*Enterolobium timbouva* Martius.	West Indies to Brazil and eastern Bolivia.
Enterolobium parvifolium	×	......	......	*Enterolobium schomburgkii* Bentham.	Panama to Brazil.
Cassia singewaldi	×	......	......	......	
Cassia rigidulifolia	×	......	......	*Cassia mucronata* Sprengel	Brazil.
Cassia obscura	×	......	......	*Cassia rotundifolia* Persoon	Mexico and West Indies to Brazil.
Cassia wendtii	×	......	......	......	
Cassia membranacea	×	......	......	......	
Cassia ligustrinaformis	×	......	×	*Cassia ligustrina* Linnaeus	Tropical South America.
Cassia cultrifoliaformis	×	......	......	*Cassia cultrifolia* Humboldt, Bonpland, Kunth.	Northern South America.
Cassia cristoides	×	......	......	*Cassia crista* Jacquin	Central America and West Indies to Brazil.
Cassia chrysocarpoides	×	......	......	*Cassia chrysocarpa* Desveaux	Guiana and Brazil.
Cassia franckei	×	......	......	*Cassia dentata* Vogel	Brazil.
Caesalpinia gmehlingi	×	......	......	*Caesalpinia pulcherrima* Swartz.	Mexico and West Indies to Brazil.
Caesalpinia sessilifolioides.	×	......	......	*Caesalpinia microphylla* De Candolle.	Brazil.
Caesalpinites potosianus	×	......	......	......	
Copaifera potosiana	×	......	......	*Copaifera trapezifolia* Hayne	Amazon Basin.
Copaifera corocoriana	......	......	×	......	
Bauhinia potosiana	×	......	......	*Bauhinia*, spp	Eastern Bolivia.
Peltophorum membranaceum.	×	......	......	*Peltophorum vogelianum* Bentham.	Brazil.
Amicia antiqua	×	......	......	*Amicia Lobbiana* Bentham	Andean (Bolivia).
Machaerium eriocarpoides	×	......	......	*Machaerium eriocarpum* Bentham.	East Bolivia and Brazil.
Machaerium milleri	×	......	......	......	
Dalbergia potosiana	×	......	......	......	
Dalbergia chartacea	×	......	......	*Dalbergia variabilis* Vogel	Peru, Guiana and Brazil.
Dalbergia (?) *antiqua*	×	......	......	*Dalbergia riparia* Bentham	Amazon Basin.
Desmodium ellipticum	×	......	......	*Desmodium barbatum* Bentham.	Southern Mexico and West Indies to Brazil.
Drepanocarpus franckei	×	......	......	*Drepanocarpus lunatus* Mayer.	Do.
Aeschynomene bolivianum	×	......	......	*Aeschynomene falcatum* De Candolle.	Mexico to Brazil.

Fossil species.	Potosi.	NW of Potosi.	Corocoro.	Most closely related existing species.	Range.
Sweetia tertiaria	×	......	......	*Sweetia elegans* Bentham	Brazil.
Lonchocarpus obtusifolius	×	......	......	*Lonchocarpus obtusus* Bentham.	Do.
Platypodium potosianum.	×	......	......	*Platypodium elegans* Vogel	Panama to Brazil and East Bolivia.
Leguminosites (?) *globularis.*	×	......	......	......	
Leguminosites, sp	×	......	......	......	
Porlieria tertiaria	×	......	......	*Porlieria*, spp	Andean and extra Andean arid.
Euphorbia, (?) sp	×	......	......	*Euphorbia*, spp	Arid South America.
Passiflora canfieldi	×	......	......	*Passiflora*, spp	Eastern Bolivia.
Myrteola potosiana	×	......	......	*Myrteola*, spp	Andean.
Terminalia antiqua	×	......	......	*Terminalia*, spp	Tropical South America.
Terminalia singewaldi	......	......	×	.....do	Do.
Cuphea antiqua	×	......	......	*Cuphea*, spp	Eastern Bolivia.
Gaylussacia tertiaria	×	......	......	*Gaylussacia ledifolia* Martius.	Brazil.
Apocynophyllum potosianum.	×	......	......	......	
Jacaranda potosina	×	......	......	*Jacaranda cuspidifolia* Martius.	Do.
Rubiacites nummularioides.	×	......	......	......	
Cypselites potosianus	×	......	......	......	
Carpolithus engelhardti	×	......	......	......	
Carpolithus, sp. nos. 1 to 5.	×	......	......	......	
Antholithus quinquepartitus.	×	......	......	......	
Spined stem	×	......	......	......	

SYSTEMATIC DESCRIPTIONS.

The following description of the new species of brachiopod is contributed by Prof. Charles Schuchert, of Yale University:

DISCINISCA SINGEWALDI, new species.

This common and very interesting inarticulate brachiopod is related to the lamellose and nonradially striate *Discinisca lamellosa* (Broderip)[1] which lives in less than 60 feet of water all along the South American coast from Chile to Panama. The new species is small for the genus and differs from all other forms in that there is a more or less distinct and flat false area beneath the elevated beak or umbo of the dorsal valve. The outline of the shells varies from circular to oval; the dorsal valve is moderately convex with the umbo marginal or nearly so, and the abundant lamellae all terminate in decidedly projecting bands; the ventral valve is more or less flat, less distinctly lamellose, and the pedicle cleft is open from the umbo, which is situated at about one-third the length of the shell, to the posterior margin.

A nearly circular shell measures 10 mm. long, 11 mm. wide, and 4 mm. high. An oval specimen measures 9 mm. long, 7 mm. wide, and 2.5 mm. high.

Locality and geologic age.—These shells were collected by Professors Singewald and Miller at Huakachi Hill, near Potosi, Bolivia, at an elevation of 13,500 feet above the level of the Pacific Ocean. In regard to the age of the strata yielding these brachiopods, it can be

[1] See Davidson, Trans. Linnean Soc. London, Zoology, vol. 4, 1888, pp. 197–200; and Blochmann, Untersuchungen über den Bau der Brachiopoden, Jena, 1900, pp. 69–70.

said that they appear to be of late Tertiary age and either of Miocene or Pliocene time. This conclusion is based on the close relation of *D. singewaldi* to *D. lamellosa*. Since Miocene time *Discinisca* has been abundant, and the striate-lamellose group is common in the Miocene of the Atlantic and eastern Gulf States (*D. lugubris*), and occurs rarely in the Coos Bay formation of the Pacific States (*D. oregonensis*). To-day this group of Disciniscas is common all along

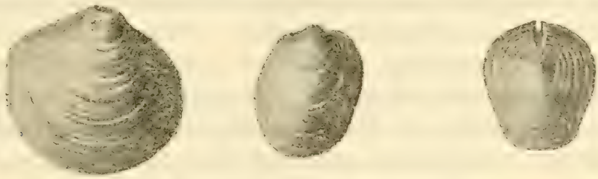

FIG. 2.—DISCINISCA SINGEWALDI SCHUCHERT.

the Pacific coast of South America (*D. laevis*, *D. cumingii*, *D. strigata*), and the lamellose section is also represented (*D. lamellosa*).

It is a great surprise to learn that these shells were collected at 13,500 feet above the sea, for this means that the Andes in the region of Bolivia have been raised that much since Miocene or even Pliocene time. No brachiopod has ever adapted itself to fresh waters, though Lingulas continue to live in the much freshened waters of the present sea margin. The evidence is clear that *D. singewaldi* is a marine animal, living in shallow waters whose depth probably did not exceed 60 feet. The exact age of the species and of the beds in which it occurs must be determined from other evidence, though they appear to be referable to either Miocene or Pliocene time.

Cotypes.—In the Peabody Museum of Yale University.

PTERIDOPHYTA.

Order FILICALES.

Family POLYPODIACEAE.

Genus POLYSTICHUM Roth.

POLYSTICHUM BOLIVIANUM, new species.

Plate 15, fig. 1.

Description.—Frond character unknown. Pinnules small, inequilaterally trilobate, short stalked. Length, 9 mm.; maximum width, 5.5 mm. Margin entire or with an occasional mucronate tooth, distinctly not spinulose. Texture coriaceous. The pinnule on one side above the middle shows an outwardly directed, conical, acuminate pointed lobe subtending an open rectangular sinus. On the other side one-third of the distance from the base is a similar conical acuminate lobe slightly larger than that of the opposite side, subtending a similar sinus. About halfway to the tip of the pinnule on this side there is a second vestigial lobe or mucronate tooth above which the margin curves inward to the conical acuminate tip of the pinnule. The venation is largely immersed in the thick lamina. At the base three veins diverge at acute angles of about 20° on one side and 30° on the other, the lateral ones ending in the tips of the lateral lobes and the median one in the tip of the pinnule. A few subordinate dichotomously forking veinlets are faintly seen. On subordinate branches from these three primary veins on each side are impressions of round sori with a slightly raised center, about 0.25 mm. in diameter.

This fern is very obviously a species of *Polystichum*, the characters of which as a whole are very well known. When it comes to making comparisons with existing species of *Polystichum* difficulties are almost unsurmountable for several reasons—namely, the inadequate amount of fossil material, the variability of the recent species, the lack of sufficient comparative material, and the difficulty of connecting mere names of recent species with actual specimens.

Polystichum is a large genus in the existing flora found on all the continents, and hence with a cosmopolitan distribution. It contains many vague or but little understood species and many extremely variable and polymorphous forms. It is found in both the tropical and boreal regions (Greenland, Antarctica) and on many high mountains, and its present distribution is clearly indicative of a long geoogical history which is almost entirely unknown.

Maxon, in a recent revision [1] of the West Indian species, recognizes 19 species in that region. He has been good enough to examine the fossil for me and considers it an ally of the historic and extremely variable *Polystichum triangulum* (Linnaeus) Fée. The latter, as far as known, is now strictly West Indian in its distribution. In Jamaica it is common in rocky situations up to 1,800 meters. Other West Indian species whose pinnules are more or less closely similar to the fossil are the Cuban species *Polystichum decoratum* Maxon, *Polystichum heterolepis* Fée, and the Jamaican *Polystichum rhizophorum* (Jenman) Maxon.

There are a number of existing species in South America, some ranging from the Antilles into Brazil and others ranging from Central America into the Andean region, while still others are confined to South America. I have examined specimens of *Polystichum flexum* (Kuntz) Phillippi, from Juan Fernandez, *Polystichum capense* (Willdenow) J. Smith, from Chile and *Polystichum mohrioides* (Bory) Presl from the Falkland Islands. These, while they show the generic likeness of the fossil, are not specifically close to it. Of the three the last is most like the fossil, but it is more dissimilar than the West Indian species previously enumerated. Other existing South American species which I have not seen include *Polystichum dubium* (Hooker) Diels of the Andes of Ecuador and Peru, which is markedly different from the fossil in its pinnate and anastomosing veinlets

[1] Maxon, W. R., Contr. U. S. Natl. Herb., vol. 13, pt. 1, 1909, pp. 25-39, pls 2-9.

Another variable form *Polystichum denticulatum* (Swartz) J. Smith of neotropical South America has reduced forms in the higher Andes, as, for example, the var *rigidissimum* described by Hooker from Colombia; but this type also seems to be remote from the fossil.

The resemblances between the fossil form and still existing West Indian species I regard as valid evidence of relationship, and while it is probable that the types mentioned from the latter region are represented in the rainforest along the eastern foothills of the present Andes, this resemblance is sufficient, it seems to me, to stamp the fossil as a form that dwelt as either an epiphyte or a rock dwelling form in a region less desiccated and warmer than that inhabited by such modern forms as *Polystichum mohrioides* (Bory) Presl of southern Chile and Patagonia, or *Polystichum denticulatum*, var *rigidissimum* Hooker of the high Andes of Colombia.

This species is represented by a pinnule and a sori bearing counterpart from Potosi and by the fragment of a pinnule from Corocoro.

Cotypes.—Cat. No. 35078 *a* and *b*, U.S.N.M.

Genus LOMARIOPSIS Fée.

LOMARIOPSIS TERTIARIA Engelhardt.

Lomariopsis tertiaria ENGELHARDT, Sitz. Naturw. Gesell. Isis in Dresden, 1894, Abh. 1, p. 4, pl. 1, fig. 3.

Description.—This species was described from Potosi by Engelhardt, who compared it with the existing *Lomariopsis sorbifolia* Linnaeus which ranges from Guatemala and the Antilles to Brazil. It has not been recognized in the collections studied by me.

Lomariopsis is a characteristic type of the tropical forests of both hemispheres, with relatively few but highly polymorphic existing species.

LOMARIOPSIS, (?) species, Engelhardt.

Lomariopsis, (?) species, ENGELHARDT, Sitz. Naturw. Gesell. Isis in Dresden, 1894, Abh. 1, p. 4, pl. 1, fig. 2.

Description.—A fragment of a larger form, apparently based on the single specimen figured, was described from Potosi by Engelhardt. It has not been recognized in the other collections, and while the generic reference is probably correct the material is much too restricted for definite characterization.

Genus ACROSTICHUM Linnaeus.

ACROSTICHUM LINEARIFOLIUM Engelhardt.

Acrostichum linearifolium ENGELHARDT, Sitz. Naturw. Gesell. Isis in Dresden, 1894, Abh. 1, p. 4, pl. 1, fig. 4.

Description.—This species, which was based on an inadequate amount of material, has been briefly described by Englehardt, who compared it with the existing *Acrostichum lineare* Fée of Brazil.

Without seeing the original material it is impossible to arrive at a conclusion regarding its validity. There are some small fragments in the present collection that appear to have the venation of *Acrostichum* and these may represent this species.

Genus GYMNOGRAMME Desveaux.

GYMNOGRAMME, (?) species, Engelhardt.

Gymnogramme, (?) species, ENGELHARDT, Sitz. Naturw. Gesell. Isis in Dresden, 1894, Abh. 1, p. 4, pl. 1, fig. 1.

Description.—This somewhat questionably identified form was described from Potosi by Engelhardt and has not been recognized in the more recent collections. It was compared with the existing *Gymnogramme trifoliata* Desveaux, a tropical species of Peru and Brazil. *Gymnogramme* has numerous existing species in South America, to which region it is practically confined, and it is well represented in the drier regions of the higher Andes from Colombia to Bolivia.

Genus PECOPTERIS Brongniart.

PECOPTERIS, species, Engelhardt.

Pecopteris, species, ENGELHARDT, Sitz. Naturw. Gesell. Isis in Dresden, 1894, Abh. 1, p. 5, pl. 1, fig. 15.

Description.—A small undeterminable fragment of a fern is described and figured from Potosi by Englehardt under the above noncommital name, more properly restricted to Paleozoic fern-like forms. Its botanical affinity is not determinable.

CONIFEROPHYTA.

Order TAXALES.

Family TAXACEAE.

Subfamily PODOCARPEAE.

Genus PODOCARPUS L'Heritier.

PODOCARPUS FOSSILIS Engelhardt.

Plate 15, fig. 2.

Podocarpus fossilis ENGELHARDT, Sitz. Naturw. Gesell. Isis in Dresden, 1894, Abh. 1, p. 5, pl. 1, fig. 12.

Description.—Leaves sessile, linear-lanceolate and falcate in outline, acutely pointed at both ends. Margins entire. Texture very coriaceous. Length, about 4 cm.; maximum width, in the middle part of the leaf, about 3 mm. Midrib stout, impressed on the upper surface. Secondaries longitudinally parallel, 5 or 6 equally spaced in each half of the lamina.

This characteristic species is represented by fragments in the present collection, but a complete leaf is reproduced from Engelhardt's figure. It is clearly referable to *Podocarpus*, belonging to the section *Eupodocarpus* of Endlicher, and is comparable with the existing *Podocarpus lamberti* Klotzsch of middle and southern Brazil.

The existing species of *Podocarpus* number over 40 species and they are as dominant representatives of the Coniferales in the Southern Hemisphere as are the pines in the northern. They extend northward to China and Japan through the East Indian region and to Jamaica and Central America in the Western Hemisphere, and have representatives in all three of the great southern land masses, as well as in Madagascar and New Zealand. This distribution is suggestive of a long geological history in keeping with which certain forms from the British Jurassic and Lower Cretaceous and the American Lower Cretaceous are referred to the genus *Nageiopsis* and considered as the prototypes of the *Nageia* section of *Podocarpus*, which should probably be raised to its former position of generic rank. Some 15 or more fossil species of *Podocarpus* have been described chiefly from the European Tertiary, and no conclusively identified fossil forms, other than the present species, have been discovered on the American continents. The section *Eupodocarpus* (Endlicher) to which the present fossil species belongs comprises over 30 existing species, almost as widely distributed as the genus, with several West Indian and South American species, but found also in Africa, Asia, Australia, and New Zealand. All of these are much alike and the fossil might be successfully compared with almost any one of them. *Podocarpus* is not found at the present time west of the front range of the Andes, but is represented by two or more species in the forests of the eastern slopes, the so-called Ceja region of Herzog.[1] In northern Peru it is also found in the lateral valleys inside the front range, the most widespread form being *Podocarpus oleifolius*, a shrubby or arborescent form, which in latitude 6° reaches altitudes up to 3,300 meters on the eastern slopes of the central Cordillera.

ANGIOSPERMOPHYTA.

Class MONOCOTYLEDONAE.

Order POALES.

Family POACEAE.

Genus FESTUCA Linnaeus.

FESTUCA, species.

Plate 15, figs. 3, 4.

Description.—Flowering scales rounded on the back, about 7 mm. long, longitudinally veined, awned. The latter about as long or twice as long as the scale.

[1] Herzog, Th., Pflanzenformationen Ost Bolivias, 1910.

These remains are clearly those of a grass. Several specimens of different sizes are present, one slightly smaller and with two awns. They are too incomplete for accurate characterization and are supposed to represent a fossil species of *Festuca*, although they may represent the allied genus *Bromus* Linnaeus.

The existing species of *Festuca* are mostly tufted perennials and comprise upwards of 100 species, found on all the continents in temperate situations and represented by tall species in the Ecuador Andes. *Bromus* has about half as many existing species, is nearly as widely distributed, but more prevailingly in the Northern Hemisphere, although present in South America. It is temperate in habitat, although sparingly present in montane equatorial regions.

Cat. No. 35079, U.S.N.M.

Genus POACITES Brongniart.

POACITES, species, Engelhardt.

Poacites, species, ENGELHARDT, Sitz. Naturw. Gesell. Isis in Dresden, 1894, Abh. 1, p. 5, pl. 1, fig. 5.

Description.—Fragments of the leaves of grasses are occasional in the Potosi deposits. Engelhardt records and figures one under the above name. They are not botanically determinable and are of interest merely in indicating the presence of grasses in the Potosi flora already more definitely indicated by the forms which I have referred to *Festuca*.

Genus PHRAGMITES Trinius.

PHRAGMITES, species.

Plate 15, fig. 5.

Description.—A fragment of a finely striated stem with short internodes indicates the presence of a rather large grass in the Potosi flora. It is referred to *Phragmites* as a form genus for fossil grasses of unknown generic affinity, and the remains are entirely too incomplete to be characterized.

Cat. No. 35080, U.S.N.M.

Order ARECALES.

Family ARECACEAE.

Genus PALMOPHYLLUM Brongniart.

PALMOPHYLLUM, species.

Description.—A small fragment of the basal part of a leaf of a small fan palm was collected from shales near La Palca mill about 12 kilometers northwest of Potosi.

It is too incomplete for generic identification, and its stratigraphic position with relation to the Potosi tuffs is also unknown.

Class DICOTYLEDONAE.

Order MYRICALES.

Family MYRICACEAE.

Genus MYRICA Linnaeus.

MYRICA BANKSIOIDES Engelhardt.

Plate 15, figs. 6, 7.

Myrica banksioides Engelhardt, Sitz. Naturw. Gesell. Isis in Dresden, 1887, Abh. 5, p. 36, pl. 1, figs. 10, 14; 1894, Abh. 1, p. 5, pl. 1, figs. 6, 7, 14, 17.—Britton, Trans. Amer. Inst. Min. Eng., vol. 21, 1893, p. 256, figs. 5–8.

Description.—Leaves linear lanceolate in outline, frequently falcate, gradually narrowed to the acuminate tip and to the narrowly cuneate base. Length ranging from 3 cm. to 8 cm. Maximum width, in the middle part of the leaf, ranging from 4 mm. to 9 mm. Margins sometimes nearly entire, usually toothed; the basal one-third is usually entire, above which irregularly developed and more or less distant serrate teeth are present. The teeth may be small and straight-serrate or large and salient-serrate, separated by regularly curved sinuses, or small and directed upward, thus approaching aquiline-serrate. The smaller specimen figured in the present report or Engelhardt's figure 14 (1894) illustrate the unequal character and maximum size of the teeth. The teeth of the opposite margins may show differences in character as illustrated in my smaller figure cited above. The texture is coriaceous. In the very abundant material no petioles are preserved. The midrib is stout and prominent on the lower surface of the leaf. The secondaries are numerous, subparallel, thick, and more or less immersed in the leaf substance; they diverge from the midrib at angles of about 45° and are generally rather straight in their courses. Each marginal tooth is traversed by a craspedodrome secondary. Where marginal teeth are not developed the secondaries are camptodrome, and there are usually one or more camptodrome secondaries between adjacent craspedodrome secondaries. The tertiary venation is obscure and largely immersed.

This unmistakable species of *Myrica* is the most abundant fossil in the present collections, except for the minute leaflets of *Calliandra obliqua* Engelhardt, and it appears to have been equally abundant in the collections studied by both Engelhardt and Britton. Engelhardt [1] compared it with *Myrica banksiaefolia* Unger,[2] of the Oligocene and Miocene of Europe, and with *Myrica polymorpha* Schimper,[3] of the Oligocene of Europe, and said to be present in the upper Eocene of

[1] Sitz Naturw. Gesell, Isis in Dresden, 1887, Abh. 5, p. 36.
[2] Unger, Foss. Fl. v. Sotzka, 1850, p. 160, pl. 27, figs. 3, 4.
[3] Schimper, Pal. Végét., vol. 2, 1872, p. 536.

Wyoming. Such comparisons are not worth much, however, since there are a large number of described fossil species from a variety of horizons that are very similar to the present species. Among recent species it is said to much resemble *Myrica microcarpa* Bentham of Jamaica. I have been unable to see specimens of *Myrica variibractea* De Candolle and *Myrica weberbaueri* De Candolle, which occur in the existing flora of the interandean region of central Peru.

Plesiotypes.—Cat. Nos. 35081, c5082, U.S.N.M.

MYRICA ENGELHARDTII Britton.

Myrica engelhardtii Britton, Trans. Amer. Inst. Min. Eng., vol. 21, 1893, p. 258, fig. 19.

Description.—Leaves of small size, sessile, obtusely pointed at the apex, narrowly cuneate at the base. Margins with remote, small serrate teeth. Length, about 2.5 cm.; maximum width, about 6 mm. Midrib stout, slightly curved. Secondaries thin, numerous, regularly spaced, straight, subparallel, craspedodrome; about 17 pairs diverge from the midrib at wide angles and terminate in the marginal teeth.

This species was described from Potosi by Britton and was based upon the single specimen figured. It is not contained in the collections studied by me.

In view of its rarity and small size and in consideration of the variability of the very abundant *Myrica banksioides* Engelhardt, it seems probable that *Myrica engelhardtii* is simply a small leafed variant of that species.

MYRICA WENDTII Britton.

Myrica wendtii Britton, Trans. Amer. Inst. Min. Eng., vol. 21, 1893, p. 258, figs. 1–4, 20.

Description.—Leaves relatively large, lanceolate or oblong lanceolate in outline and frequently falcate. Apex narrowly pointed, almost invariably broken away. Base narrowly cuneate. Margins entire at the base; throughout the greater part of their length coarsely and irregularly serrate, the teeth varying from aquiline to salient or straight serrate. Midrib stout, prominent no the lower surface of the leaf. Texture coriaceous. Length, 6 cm. to 10 cm.; maximum width, in the middle part of the leaf, 1 cm. to 2 cm. Secondaries thin, numerous, subparallel, craspedodrome, diverging from the midrib at wide angles, nearly straight in their outward course, terminating in the marginal teeth.

This species was apparently abundant in the collections studied by Britton, but is sparingly represented by fragmentary material in the collections studied by me. It is possible that it may merely represent unusually large forms of the common and variable *Myrica banksioides* Engelhardt.

Genus MYRICOPHYLLUM Saporta.

MYRICOPHYLLUM, species, Engelhardt.

Myricophyllum, species, ENGELHARDT, Sitz. Naturw. Gesell. Isis in Dresden, 1894, Abh. 1, p. 6, pl. 1, fig. 24.

Description.—Incomplete material of a linear leaf, with a stout midrib, prominently toothed margin, and stout secondaries diverging from the midrib at wide angles, every second or third one ending in a marginal tooth; the balance camptodrome.

The only known specimen is the small fragment figured by Engelhardt. It is clearly distinct from the other members of the Potosi flora, and apparently represents a striking Comptonia-like *Myrica*.

Order POLYGONALES.

Family POLYGONACEAE.

Genus RUPRECHTIA C. A. Meyer.

RUPRECHTIA BRAUNII Engelhardt.

Plate 15, fig. 8.

Ruprechtia braunii ENGELHARDT, Sitz. Naturw. Gesell. Isis in Dresden, 1894, Abh. 1, p. 6, pl. 1, fig. 19.

Description.—Leaves linear lanceolate in outline. Apex gradually narrowed, acuminate. Base acuminate, inequilateral. Margins entire, more or less undulate. Texture coriaceous. Length, about 6.25 cm. Maximum width, at or below the middle, about 9 mm. Petiole not preserved. Midrib thin but prominent on the lower surface of the leaf, inclined to be flexuous. Secondaries numerous, thin but prominent, ascending, somewhat irregularly spaced; they diverge from the midrib at angles of about 40° and are camptodrome.

The present species may be compared with the leaves of the existing *Triplaris salicifolia* from southern Brazil which C. A. Meyer refers to *Ruprechtia* and with *Ruprechtia laurifolia* Martius of eastern Brazil. *Ruprechtia* is a genus, not otherwise known in the fossil state, with about 20 existing species of shrubs and trees of tropical and subtropical regions of South America.

Plesiotypes.—Cat. No. 35125, U.S.N.M.

Order RANALES.

Family RANUNCULACEAE.

Genus CARPOLITHUS Allioni.

CARPOLITHUS VIORNAFORMIS, new species.

Plate 15, fig. 9.

Description.—A fruit referable of the Ranunculaceae and apparently representing a one-seeded ovate achene with a long slender curved naked style. Achene about 1 mm. long, rounded at the base and pointed distad. Style about 7 mm. long.

This well-marked form is very suggestive of certain existing species commonly referred to the genus *Clematis*, especially some of the subtropical species sometimes referred to the genus *Viorna* Reichenbach. As there are other genera in this family with similar fruits and the material is not available for extended comparisons with recent South American forms, it is referred to the form genus *Carpolithus*.

Holotype.—Cat. No. 35083, U.S.N.M.

Order PAPAVERALES.

Family CAPPARIDACEAE.

Genus CAPPARIS Linnaeus.

CAPPARIS MULTINERVIS Engelhardt.

Plate 15, fig. 10.

Capparis multinervis ENGELHARDT, Sitz. Naturw. Gesell. Isis in Dresden, 1894, Abh. 1, p. 7, pl. 1, fig. 18.

Description.—Leaves short petioled, linear, with an obtusely rounded tip and a cuneate base. Margins entire. Texture coriaceous. Length 6 or 7 cm. Maximum width, midway between the apex and the base, 7 to 12 mm. Petiole stout, curved, about 3 or 4 mm. in length. Midrib stout, straight except basally, where it is curved, prominent on the lower surface of the leaf. Secondaries numerous, widely but regularly spaced, stout and somewhat prominent; 15 to 18 opposite to alternate pairs diverge from the midrib at wide angles, sometimes as great as 75° in the median part of the leaf, but averaging somewhat less generally; they are nearly straight and subparallel in their outward course for three-fourths of the distance to the margin, where they curve upward in a broad camptodrome arch to join the secondary next above. The tertiaries are mostly obsolete, occasionally they are seen but not sufficiently to determine the areolation.

A single specimen, somewhat larger than that figured by Engelhardt, is contained in the present collection. *Capparis*, although with usually well-marked characters of both form and venation, has a practically unknown geological history. An unquestionable species from the lower Eocene of the southern United States[1] is very similar to the present species. A second and somewhat doubtfully determined form was recorded by Unger from the European Miocene. The genus comprises about 100 existing species of shrubs and small trees of the equatorial region and, although present in the Eastern Hemisphere, the bulk of the forms occur in the American Tropics, especially in Central and South America. The Potosi species is

[1] Berry, E. W., Lower Eocene Floras of southeastern North America. U. S. Geol. Surv. Prof. Paper 91, 1916, p. 218, pl. 44, figs. 1-3; pl. 52, fig. 5.

very similar to a number of existing forms, among which may be mentioned *Capparis domingenesis* Strengel and *Capparis longifolia* of the West Indies, *Capparis augustfolia* Humboldt, Bonpland, and Kunth of Central America and *Capparis jacobinae* Moricaud of Brazil. In the existing flora of Bolivia there are several species of Capparis, in the Thornbush or Gran Chaco country of eastern Bolivia, and other species occur in the Andean outliers of Santa Cruz and Cochabamba.

Plesiotype.—Cat. No. 35084 N.S.N.M.

Order ROSALES.

Family SAXIFRAGACEAE.

Genus ESCALLONIA Linnaeus.

ESCALLONIA WENDTII Britton.

Plate 15, fig. 11.

Escallonia wendtii Britton, Trans. Amer. Inst. Mining Eng., vol. 21, 1893, p. 254, figs. 14, 15.

Description.—Leaves of medium size, ovate or elliptical in outline with a bluntly pointed apex and a broadly cuneate base. Margins crenulate above, the teeth becoming gradually more widely spaced below the middle and passing by an insensible transition into small widely spaced serrate teeth, which eventually become obsolete, the lower one-third of the margins being entire. Length 4 to 4.5 cm. Maximum width, midway between the apex and the base, 2.25 to 2.5 cm. Petiole missing or absent. Midrib stout and prominent, slightly curved. Secondaries thin, about nine pairs diverge from the midrib at angles of about 45°, somewhat unequally spaced, subparallel and camptodrome. Tertiaries not made out.

This species was described by Britton from the two specimens figured by him and is not contained in the collections from Potosi studied by me.

Escallonia contains about 50 existing species of shrubs or small trees, confined to and widespread in South America, with many Andean species.

If correctly identified it is one of the few fossil forms found at Potosi that would not be out of place in a dry montane environment, but as other of the numerous existing species are found in somewhat different environments east of the present mountains, its significance is equivocal.

Family CUNONIACEAE.

Genus WEINMANNIA Linnaeus.

WEINMANNIA BRITTONI Engelhardt.

Plate 15, fig. 12.

Weinmannia brittoni ENGLEHARDT, Sitz. Naturw. Gesell. Isis in Dresden, 1894, Abh. 1, p. 6, pl. 1, fig. 16.

Description.—Leaflets small, sessile, ovate or obovate in general outline, with a narrowed acuminate base and a broadly rounded apex. Margins with a few relatively large serrate teeth in the upper part, entire toward the base. Texture coriaceous. Length, about 1 cm. Maximum width, in the middle part of the leaflet, about 5.5 mm. Midrib stout, slightly curved. Secondaries thin, few in number, subparallel, diverging from the midrib at angles of about 45°, craspedodrome.

This small species was described from Potosi by Engelhardt and is apparently unrepresented in the other collections. It was compared with the existing *Adesmia muricata* De Candolle (Leguminosae), but more particularly with *Weinmannia glabra* De Candolle, a species found from the West Indies and southern Mexico throughout northern South America (Colombia, Venezuela, Guiana.)

The genus *Weinmannia* contains about 75 existing species of shrubs or trees, of which over half are confined to temperate and tropical South America and not uncommon in the warmer parts of the Andean region. The remaining species are found in Madagascar, Australia, New Zealand, and Oceanica. Upwards of a score of fossil species have been described, mostly from Europe and North America, and well-preserved and undoubted forms are present in the Miocene lake deposits at Florissant, Colorado.

WEINMANNIA POTOSINA (Britton).

Plate 15, fig. 13.

Myrica potosina BRITTON, Trans. Amer. Inst. Min. Eng., vol. 21, 1893, p. 258, figs. 9, 10.

Description.—Leaflets sessile, lanceolate in outline, with an acute apex and a more or less inequilateral rounded to cuneate base. Margins finely serrate, entire at the base. Texture subcoriaceous. Length ranging from 1.5 to 2.25 cm. Maximum width, midway between the apex and the base, ranging from 5 to 7 mm. Midrib stout, prominent, more or less curved. Secondaries thin but prominent, numerous, regularly spaced, subparallel, craspedodrome.

This species, at first regarded as a *Lomatia*, was described from Potosi by Britton as a new species of *Myrica*. It was apparently unrepresented in the collections studies by Engelhardt, but is represented by two specimens in the collections studied by me. I can not see in these forms any relation to *Myrica* and regard them as representing a species of *Weinmannia,* thus making two species of this genus in the Potosi flora. It is well marked specifically from the other species of *Weinmannia,* which is a smaller, more coarsely toothed leaflet with a narrow base and rounded apex.

Plesiotypes.—Cat. No. 35126, U.S.N.M.

Family MIMOSACEAE.

Genus ACACIA Willdenow.

ACACIA UNINERVIFOLIA Engelhardt.

Plate 15, figs. 14, 15.

Acacia uninervifolia ENGELHARDT, Sitz. Naturw. Gesell. Isis in Dresden, 1894, Abh. 1, p. 11, pl. 1, figs. 10, 11, 20.

Description.—Leaflets or phyllodes sessile, somewhat variable in size, slightly or not at all inequilateral, lanceolate to linear lanceolate in outline, with an equally acuminate apex and base. Margins entire Texture coriaceous. Length, ranging from 1 to 2.25 cm. Maximum width, in the middle of the leaflet, ranging from 1 to 3.5 mm. Midrib relatively stout and prominent on the lower surface of the leaflets. Secondaries thin, numerous, regularly spaced and subparallel; about 15 pairs diverge from the midrib at angles of about 45°, curving regularly upward and ultimately camptodrome. Tertiary venation obsolete by immersion.

This species is common at Potosi and also occurs sparingly at Corocoro. It was described by Engelhardt[1] in 1894, who compared it with the phyllodes of the existing *Acacia paradoxa* De Candolle. Engelhardt's figure 20 shows a relatively shorter and wider form and may represent a leaflet of *Machaerium eriocarpoides* Engelhardt.

The present species is similar to *Mimosites Engelhardti* Berry, *Machaerium eriocarpoides* Engelhardt, and *Enterolobium grandifolium* Engelhardt. It is relatively longer and narrower than any of these and may be readily distinguished by the accompanying illustrations showing its extremes of size.

Plesiotypes.—Cat. No. 35085, 35086, U.S.N.M.

ACACIA DIMIDIATO-CORDATA Engelhardt.

Plate 15, figs. 16, 17, 18.

Acacia dimidiato-cordata ENGELHARDT, Sitz. Naturw. Gesell. Isis in Dresden, 1894, Abh. 1, p. 11, pl. 1, fig. 51.

Description.—Leaves even pinnate, leaflets small, sessile, elliptica in outline, with a rounded apex and an inequilateral base. Margins full and rounded, entire. Texture subcoriaceous. Length ranging from 2 to 8 mm. Maximum width ranging from 1 to 4 mm. Midrib

[1] Sitz. Naturf. Gesell. Isis in Dresden, 1894, Abh. 1, p. 11.

thin, scarcely distinguisable from a secondary which diverges from it at an acute angle at the base and sweeps upward nearly to the tip where it becomes lost in the tertiary areolation made up of acute proximal forks and distal camptodrome arches.

This peculiar species is abundant at Potosi and it appears to be identical with the single leaflet imperfectly figured by Engelhardt. In one case a pair of terminal leaflets are preserved in attachment, showing that the leaves were even pinnate. The majority of the leaflets approach the maximum of size and often fail to show the characteristic venation, which I assume was the case in the leaflet figured by Engelhardt. This venation is characteristic of certain modern species of *Acacia* and *Calliandra* and resembles modern species like *Acacia Roemeriana, Acacia fasciculata* Kunth [1] of Brazil or *Acacia crassifolia* A. Gray of Mexico.

Plesiotype.—Cat. No. 35087 to 35089, U.S.N.M.

ACACIA TENUIFOLIA Engelhardt.

Acacia tenuifolia Engelhardt, Sitz, Naturw. Gesell. Isis in Dresden, 1894, Abh. 1 p. 11, pl. 1, figs. 45, 46.

Description.—Leaflets small, sessile, oblong lanceolate, nearly equilateral, equally acutely pointed at both ends. Margins entire. Length, 1 to 1.25 cm. Maximum width, in the middle part of the leaflet, 4 to 5 mm. Midrib thin, straight. Secondaries about five thin camptodrome pairs.

This species is only doubtfully represented in the present collections. It is compared by Engelhardt with the existing *Acacia pedicellata* Bentham of eastern Bolivia and Brazil.

Genus INGA Willdenow.

INGA OCHSENIUSI Engelhardt.

Plate 15, fig. 19.

Inga ochseniusi Engelhardt, Sitz. Naturw. Gesell. Isis in Dresden, 1894, Abh. 1, p. 11, pl. 1, figs. 39, 40.

Description.—Leaflets small, sessile, inequilateral, elliptical in outline, nearly equally rounded at both ends, but the base much more inequilateral than the apex. Margins entire. Texture coriaceous. Length, about 11 mm. Maximum width, about 5 mm. Midrib stout, curved. Secondaries thin, numerous, camptodrome; those on the narrower side of the leaflet more ascending and forming a more acute angle with the midrib than those on the broader side.

This species was described by Engelhardt and has not been recognized in the other collections from Potosi. It was compared with the existing *Pithecolobium diversifolium* Bentham, *Inga flabelliformis*

[1] This species is usually known as *Mimosa fasciculata* Bentham having transferred it to the genus *Mimosa*.

Martius, and *Inga balnchetiana* Bentham, and is closest to the last, a Brazilian species.

The genus *Inga* contains a considerable number of fossil species and is found as early as the Upper Cretaceous in North America. There are several well-marked forms in the lower Eocene of the Mi-s sissippi embayment region. The existing species, upward of 200 in number, are confined to the American Tropics and reach their maximum of abundance and variation in the Brazilian region where about 66 species are already known. Tropical Peru ranks next in number of species with about 30. All of the five sections of the genus are represented in the existing flora of Bolivia with a total of 12 known species, all of which, so far as I know, being confined to eastern Bolivia.

Genus PITHECOLOBIUM Martius.

PITHECOLOBIUM BRITTONIANUM, new species.

Plate 15, fig. 20.

Cassia chrysocarpoides BRITTON, Trans. Amer. Inst. Min. Eng., 1893, fig. 36 (not figs. 29–35, 37).

Description.—Leaflets sessile, inequilateral, elliptical in general outline, with an emarginate tip and an inequilateral base which is straight on one side and full and rounded on the other. Length about 1.6 cm. Maximum width, about midway between the apex and the base, about 11.5 mm. Margins entire, full. Texture coriaceous. Midrib stout, curved, prominent on the lower surface of the leaflet. Secondaries numerous, subparrallel, comptodrome. Tertiaries obsolete.

This species is based on leaflets collected by Wendt and questionably referred by Britton to *Cassia chrysocarpoides* of Engelhardt[1] to which they are not related. It is the second species of *Pithecolobium* to be recorded from Potosi and is based upon more complete material than *Pithecolobium tertiarium* Engelhardt.[2] The fossil forms that have been referred to this genus are few in number, and include, in addition to the species already cited, two well-marked species from the lower Eocene and one from the lower Oligocene of the Mississippi embayment and a fourth species from the Tertiary of Colombia. The present Potosi species is very similar to *Pithecolobium oligocaenum* Berry[3] from the lower Oligocene of Louisiana.

The genus comprises considerably over 100 existing species, many of which are large trees and found in all tropical countries. Three-fourths of the species are confined to America, where they range from the West Indies and Central America to southern Brazil. Among

[1] Engelhardt, H., Sitz. Naturf. Gesell. Isis in Dresden, 1887, Abh. 4, p. 37, fig. 15.
[2] Idem., 1894, Abh. 1, p. 12.
[3] Berry, E. W., U. S. Geol. Survey Prof. Paper 98M, 1916 p. 239, pl. 55, fig. 10

the forms that I have seen *Pithecolobium dulce* Bentham of the West Indies and northern South America, may be mentioned as a closely similar form to *Pithecolobium brittonianum.* In Bolivia the genus is, so far as I know, found only east of the Andes in eastern Bolivia, where the flora is essentially similar to that of the Amazon basin. *P. scalare*, *P. saman*, and *P. sophoricarpum* are found along the banks of the Rio Piral, Rio Yapacani, and Rio Grande; *P. scalare* and *P. sophoricarpum* occur in the broken growth on the savannas of Santa Cruz and the last named is a member of the subandean woods that clothe the eastern slopes of the "Cordillera Real."

Holotype.—Cat. No. 35140, U.S.N.M.

PITHECOLOBIUM TERTIARIUM Engelhardt.

Pithecolobium tertiarium ENGELHARDT, Sitz. Naturw. Gesell. Isis in Dresden, 1894, Abh. 1, p. 12, pl. 1, fig. 33.

Description.—Leaflets rhombic with truncated inequilateral apex and an unknown base. Margins entire. Texture coriaceous. Somewhat larger than *Pithecolobium brittonianum* Berry and with a characteristic *Pithecolobium* venation.

This species was based upon a single fragmentary specimen and is not contained in the present collections, and thus may be regarded as of rare occurrence in the Pliocene flora of Potosi. It was compared by its describer with the existing *Pithecolobium trapezifolium* Bentham of Colombia, Guiana, and Brazil.

Genus MIMOSA Linnaeus.

MIMOSA ARCUATIFOLIA Engelhardt.

Plate 15, fig. 21.

Mimosa arcuatifolia ENGELHARDT, Sitz. Naturw. Gesell. Isis in Dresden, 1894, Abh. 1, p. 10, pl. 1, figs. 52–54.

Description.—Leaflets small, sessile, linear-lanceolate, arcuate, inequilateral, with a bluntly pointed apex and base, the latter slightly wider than the apex. Margins entire. Texture subcoriaceous. Length, 3 to 4 mm. Maximum width, in the middle part of the leaflet, about 1 mm. Venation obsolete except for the thin arcuate midrib.

This species is fairly abundant at Potosi and occurs also at Corocoro. It is distinguished with difficulty from the smaller leaflets of the more abundant *Calliandra obliqua*, with which Engelhardt in all probability confused it. The present species is, however, less linear, somewhat more slender and arcuate, with a less oblique base, and lacks the three primaries of *Calliandra obliqua.* According to Engelhardt it is very similar to the existing *Mimosa invisa* Martius, which ranges from southern Mexico and the West Indies to Brazil, or *Mimosa lupulina* Bentham of the last region. It may also be compared with

Mimosa microcephala Bonpland and with *Mimosa pectinata* Kunth. It has also less aptly been compared with the existing *Parkinsonia aculeata* Linnaeus.

Plesiotype.—Cat. No. 35090, U.S.N.M.

MIMOSA MONTANOIDES Engelhardt.

Mimosa montanoides ENGELHARDT, Sitz. Naturw. Gesell. Isis in Dresden, 1894, Abh. 1, p. 10, pl. 1, fig. 64.

Description.—Leaves small, even pinnate. Leaflets tiny, obovate, entire, 2 to 3 mm. in length by 0.5 to 1.5 mm. in maximum width, sessile.

This somewhat rare form was described by Engelhardt and is apparently absent in the other collections from Potosi. It is of somewhat doubtful botanical affinity, but is compared by its describer with the existing Peruvian species, *Mimosa montana* Humboldt, Bonpland, and Kunth.

Genus MIMOSITES Bowerbank.

MIMOSITES ENGELHARDTI, new name.

Plate 15, fig. 22.

Mimosites linearis ENGELHARDT, Sitz. Naturw. Gesell. Isis in Dresden, 1894, Abh. 1, p. 13, pl. 1, figs. 21, 35 (not *M. linearifolius* Lesquereux, 1878= *M. linearis* Knowlton, 1898).

Description.—Leaflets sessile, linear-lanceolate, slightly inequilateral, with an acuminate-cuspidate tip and an acuminate base. Margins entire. Texture coriaceous. Length, 12 to 15 mm. Maximum width, 2 to 3 mm. Midrib relatively stout. Secondaries obsolete by immersion.

The name of this species appears to be preoccupied by the *Mimosites linearifolius* of Lesquereux [1] from the Green River Eocene of Wyoming which Knowlton [2] amended to *Mimosites linearis* in 1898. While Engelhardt named his form in 1894, it seems desirable to rename it in order to avoid confusion, and I therefore take the liberty of calling it *engelhardti* as a slight token of esteem for the labors of M. Engelhardt.

This species is abundant at Potosi, always in the form of detached leaflets, and it occurs sparingly at Corocoro. It is very similar and liable to be confused with other leguminous leaflets found at Potosi—namely, *Acacia uninervifolia* Engelhardt, *Machaerium eriocarpoides* Engelhardt, and *Enterolobium grandifolium* Engelhardt. The first is more narrowly elongate and lanceolate, with more prominent camptodrome secondaries. The second is relatively shorter and wider, petiolulate, more lanceolate, and with more prominent secondaries. The third is larger, more inequilateral and more lanceolate.

Plesiotypes.—Cat. No. 35091, U.S.N.M.

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[1] Lesquereux, L., Tertiary Flora, 1878, p. 300, pl. 59, fig. 7.

[2] Knowlton, F. H., Bull. 152 U. S. Geol. Survey, 1898, p. 144.

Genus CALLIANDRA Bentham.

CALLIANDRA OBLIQUA Engelhardt.

Plate 15, figs. 23–29.

Calliandra obliqua ENGELHARDT, Sitz. Naturw. Gesell. Isis in Dresden, 1894, Abh. 1, p. 15, pl. 1, fig. 55.

Description.—Leaflets small, variable in size, oblong in outline, sessile or subsessile, acutely pointed, with a very inequilateral, obliquely truncate, or subcordate base. Margins entire. Texture coriaceous. Length ranging from 7 to 28 mm.; width ranging from 2 to 8 mm. Venation consisting of usually three primaries diverging from the base, sometimes with subordinate veins from the base, connected by circles toward the tip and connected by cross veinlets. A fragment of a leaf shows three pairs of opposite leaflets.

The leaflets of this species are the most abundant forms found at Potosi, and each parting of the tuffs is strewn with them. They are variable in size, and unless the venation can be seen are indistinguishable from the leaflets of *Mimosa arcuatifolia* Engelhardt; in fact, Engelhardt figured but a single leaflet of *Calliandra obliqua*, which is near its maximum size, and he probably confused the smaller leaflets with *Mimosa arcuatifolia.*

The venation is typical of *Calliandra*, but is also shared by some species of *Acacia*. The present species is said by Engelhardt to be practically identical with the existing *Calliandra macrocephala* Bentham, of Brazil. It is also identical with an unnamed *Calliandra* figured by Schenk.[1] It may also be compared with the existing *Calliandra parviflora* Bentham.

The modern species of *Calliandra* comprise over a hundred shrubs and small trees of tropical and subtropical America, with a few outlying species in farther India, Ceylon, and Madagascar. The genus is well represented in eastern Bolivia, and some species extend westward to the subandean zone of the eastern slopes, but so far as I know none occur in or west of the *Cordillera Real* or eastern Andes.

Plesiotypes.—Cat. No. 35128–35134, U.S.N.M.

CALLIANDRA OVATIFOLIA Engelhardt.

Calliandra ovatifolia ENGELHARDT, Sitz. Naturw. Gesell. Isis in Dresden, 1894, Abh. 1, p. 12, pl. 1, fig. 56.

Description.—Leaflets inequilateral, sessile, orbicular or broadly elliptical in outline, not much longer than wide. Apex more nearly equilateral than the base. Margins entire. Texture coriaceous. Midrib stout, curved. Secondaries numerous, thin, subparallel, diverging from the midrib at wide angles.

[1] Palaeophytologie, 1890, p. 693, fig. 5.

This species, of somewhat doubtful validity, is not represented in the present collection. It was compared by Engelhardt with the existing Brazilian species *Calliandra leptopoda* Bentham.

Genus ENTEROLOBIUM Martius.

ENTEROLOBIUM GRANDIFOLIUM Engelhardt.

Plate 15, fig. 30.

Enterolobium grandifolium ENGELHARDT, Sitz. Naturw. Gesell. Isis in Dresden, 1894, Abh. 1, p. 12, pl. 1, fig. 60.

Description.—Leaflets sessile, falcate-lanceolate in outline, with a shortly acuminate inequilateral tip and a bluntly pointed very inequilateral base. Margins entire. Texture subcoriaceous. Length about 1.6 cm. Maximum width, midway between the apex and the base, about 4 mm., one-fourth on one side of the midrib and three-fourths on the opposite side. Midrib mediumly stout, curved. Secondaries mostly obsolete by immersion, a few subparallel with the lower lateral margins and camptodrome are made out with difficulty.

The present species is not common in the collections. It is very similar to the existing *Enterolobium timbouva* Martius, a Brazilian species ranging northward to the West Indies, and recorded by Herzog[1] from the hill country of Velasco, in eastern Bolivia. The genus is a small one closely related to *Inga* and *Pithecolobium*, with about half a dozen known existing species of trees with even pinnate small leaves, confined to tropical America and found from the West Indies and Central America to Brazil. Except for the two species recorded from Potosi it is unknown in the fossil state.

Enterolobium grandifolium is readily distinguished from the associated small, falcate, slightly petiolulate, *Enterolobium parvifolium*. It is somewhat like the broader forms referred by Engelhardt to *Acacia uninervifolia* as well as similar to *Mimosites engelhardti* Berry and *Machaerium eriocarpoides* Engelhardt. It is, however, somewhat larger than these, falcate and much more inequilateral.

ENTEROLOBIUM PARVIFOLIUM Engelhardt.

Plate 15, fig. 31.

Enterolobium parvifolium ENGELHARDT, Sitz. Naturw. Gesell. Isis in Dresden, 1894, Abh. 1, p. 12, pl. 1, fig. 61.

Description.—Leaflets slightly petiolulate, linear falcate, inequilateral. Apex bluntly pointed to slightly cuspidate, slightly inequilateral. Base inequilaterally pointed. Margins entire. Texture coriaceous. Length ranging from 1 to 1.5 cm. Maximum width, in the middle part of the leaflet, about 2.5 mm. Midrib stout, curved. Secondaries obsolete, a few camptodrome ones diverging at wide angles occasionally seen.

[1] Herzog, Th., Pflanzenformationen Ost Bolivias, Englers Bot. Jahrb., vol. 44, 1910.

This species, represented by several specimens from Potosi, is much smaller, more falcate, and relatively more slender than the associated *Enterolobium grandifolium* Engelhardt. Among the associated forms it approaches closest to *Machaerium eriocarpoides* Engelhardt, in which, however, the leaflets are straighter, relatively wider, lanceolate instead of linear, the petiolule is longer, and the secondaries are less obsolete and more ascending.

Enterolobium parvifolium may be compared with the existing *Enterolobium schomburgkii* Bentham, which ranges from Panama to Brazil, and which it greatly resembles. I have figured an excessively falcate leaflet, the majority are less falcate and more like the specimen figured by Engelhardt.[1]

Plesiotype.—Cat. No. 35093, U.S.N.M.

Family CAESALPINIACEAE.

Genus CASSIA Linnaeus.

CASSIA SINGEWALDI, new species.

Plate 15, figs. 32–34.

Cassia chrysocarpoides Britton (not Engelhardt), Trans. Amer. Inst. Mining Eng., vol. 21, 1893, p. 252 (part), figs. 30–33 (not figs. 29, 34, 35).

Description.—Leaflets obovate to elliptical in outline with a broadly rounded equilateral or nearly equilateral tip and a markedly inequilateral base, which is somewhat variable in outline. In some leaflets one margin narrows almost straightly, while the other is broadly rounded; in others both margins are full and that on one side resembles half of the base of a cordate leaflet: and every gradation between these two extremes are present. Margins entire, generally slightly undulate. The leaf substance is not thick, but the leaflets appear stiff and subcoriaceous in texture. A short expanded petiolule is present in some of the leaflets that it has not been found possible to differentiate from this species by means of any other characters, but the majority are sessile with an expanded base of the midrib.

Length ranging from 3.3 to 3.5 cm. Maximum width, at or above the middle, ranging from 1.4 to 1.75 cm. Midrib stout, prominent on the underside of the leaflet. Secondaries relatively stout; about 12 pairs diverge from the midrib at angles of from 40 to 70°, being more ascending in the narrower more obovate leaflets, and less ascending in the elliptical leaflets or in the fuller side of the leaflets. The secondaries are approximately evenly spaced and subparallel: they are for the most part rather straight in their courses and are camptodrome in the marginal region. The tertiaries are thin, but well marked, as shown in the figures, forming an open polygonal or often

[1] Sitz. Naturw. Gesell. Isis in Dresden, 1894, Abh. 1, p. 12, pl. 1, fig. 61.

nearly rectangular areolation. The leaflets have the appearance of having had a glaucous surface, but this may be due to their preservation.

This species is based upon material collected by Singewald and Miller and on certain of the leaflets figured by Britton and referred to *Cassia chrysocarpoides* Engelhardt. Of the latter the form with a petiolule refigured in the present connection may be of another species, but is otherwise indistinguishable. *Cassia chrysocarpoides* Engelhardt is relatively much shorter and broader with a more pointed tip and with thinner and more curved secondaries.

It is named for Dr. J. T. Singewald, jr., of the Johns Hopkins University.

Cotype.—Cat. No. 35092 U.S.N.M.

CASSIA RIGIDULIFOLIA Engelhardt.

Plate 16, fig. 1.

Cassia rigidulifolia ENGELHARDT, Sitz. Naturw. Gesell. Isis in Dresden, 1894, Abh. 1, p. 10, pl. 1, fig. 34.

Description.—Leaflets sessile, but slightly inequilateral, obovate in outline, with a retuse apex and a cuneate base. Margins entire, full and evenly rounded. Texture coriaceous. Length about 2.5 cm. Maximum width, midway between the apex and the base, about 1 cm. Midrib stout and straight, prominent. Secondaries widely spaced, stout, about six pairs diverge from the midrib at wide angles of about 55 to 60°, pursue a nearly straight course two-thirds of the distance to the margin and then arch upward in a broad camptodrome loop. Tertiaries mostly obsolete.

This species was compared by Engelhardt with the existing *Cassia mucronata* Sprengel of Brazil, and it is also much like various fossil species referred to *Cassia*. On the other hand it is much like various existing and fossil species referred to *Dalbergia*, *Gastrolobium*, etc.

CASSIA OBSCURA Engelhardt.

Cassia obscura ENGELHARDT, Sitz. Naturw. Gesell. Isis in Dresden, 1894, Abh. 1, p. 10, pl. 1, fig. 50.

Description.—Leaflets small, sessile, oval in form, with entire margins. Length, 6 mm. Maximum width, at or below the middle, about 5 mm. Apex rounded. Base obliquely inequilateral. Midrib straight. Secondaries, 4 or 5 camptodrome pairs.

This obscure form is evidently leguminous, but its affinity with *Cassia* is uncertain. It is not represented in the present collection, nor in that studied by Britton. It was compared by Engelhardt with the existing *Cassia rotundifolia* Persoon, a widespread form in tropical America which ranges from Mexico and the West Indies to Brazil.

CASSIA WENDTII Britton.

Plate 16, figs. 2–4.

Cassia wendtii BRITTON, Trans. Amer. Inst. Min. Eng., vol. 21, 1893, p. 254, figs. 52–58, 1893.

Description.—Leaflets slightly petiolulate, small, variable, oblong-elliptical and inequilateral in outline, broadly rounded or obtusely pointed and nearly equilateral at the apex, cuneate and generally inequilateral at the base. Margins entire. Texture subcoriaceous. Length, ranging from 1 to 2 cm. Maximum width, at or below the middle, ranging from 5 to 7 mm. Petiolule short, less than 1 mm. in length. Midrib slender. Secondaries thin, numerous, about 10 regularly spaced, camptodrome pairs.

This species is readily distinguishable from the other species of Cassia described from Potosi. It is, however, liable to be confused with *Drepanocarpus franckei* described by Engelhardt from this deposit, and it is not certain that the two are distinct. The latter is, however, more nearly elliptical and equilateral, with a more evenly rounded apex and base, and is sessile instead of petiolulate. The present species is close to various fossil and existing species of *Cassia*, *Caesalpinia*, etc.

Plesiotypes.—Cat. Nos. 35094, 35095, 35096, U.S.N.M.

CASSIA MEMBRANACEA Engelhardt.

Plate 16, figs. 5, 6.

Cassia membranacea ENGELHARDT, Sitz. Naturw. Gesell. Isis in Dresden, 1894, Abh. 1, p. 9, pl. 1, fig. 31, 32.

Cassia ligustrinoides BRITTON (not Engelhardt), Trans. Amer. Inst. Min. Eng., vol. 21, 1893, figs. 46–48 (not figs. 21–27).

Description.—Leaflets sessile, ovate in outline, generally but slightly inequilateral, bluntly pointed at both ends. Margins entire, generally full and equally rounded. Substance thin. Length ranging from 2.7 to 4 cm. Maximum width, generally midway between the apex and the base, ranging from 1 to 1.6 cm. Midrib stout, prominent. Secondaries thin, 8 to 10 pairs diverge from the midrib at angles of 45° or less and form a diminishing series of camptodrome arches subparallel with the lateral margins. Tertiaries thin, more or less percurrent and intermediates crossing to form a more or less quadrangular open areolation. A large leaflet is figured, which is abnormally inequilateral and widest above the middle.

The present species is not abundant in the collections. It was compared by Engelhardt[1] with the existing *Peltophorum vogelianium* Bentham of Brazil. Among the Potosi forms of Cassia it is closest to *Cassia chrysocarpoides* Engelhardt, differing in its more narrowly

[1] Sitz. Naturw. Gesell. Isis in Dresden, 1894, Abh. 1, p. 9.

elongated form and more pointed apex and base. It differs from *Dalbergia chartacea* Engelhardt and *Sweetia tertiaria* Engelhardt in the same particulars, and there are minor differences in the venation.

Plesiotype.—Cat. No. 35097, U.S.N.M.

CASSIA LIGUSTRINAFORMIS, new name.

Plate 16, figs. 7, 8.

Cassia ligustrinoides ENGELHARDT, Sitz. Naturw. Gesell. Isis in Dresden, 1887, Abh. 5, p. 37, pl. 1, fig. 16; 1894, Abh. 1, p. 10, pl. 1, fig. 27.—BRITTON, Trans. Amer. Inst. Min. Eng., vol. 21, 1893, p. 252, figs. 21, 22, 24, 25, 46–48, 63 (?), not figs. 23, 26, 27, 1893; (not Schrank, Denks. Akad. Muench., vol. 6, 1816, p. 179.

Description.—Leaflets sessile, inequilateral, lanceolate in outline, with a pointed nearly equilateral tip and a slightly blunter pointed, inequilateral base. Margins entire, evenly rounded. Texture subcoriaceous. Length ranging from 3.5 to 5.5 cm. Maximum width, midway between the apex and the base, ranging from 9 mm. to 1.5 cm. Midrib mediumly stout, generally curved, not especially prominent. Secondaries thin but prominent, numerous; about 10 opposite to alternate pairs diverge from the midrib at angles averaging about 45° and are camptodrome. Tertiaries thin but well marked.

This is a common and characteristic form in the Potosi collections much like numerous previously described fossil species and many still existing species of this large genus, especially the existing *Cassia ligustrina* Linnaeus after which it was named. It is also found at Corocoro. Britton has referred several forms to this species which fall beyond its limits of variation, and this is especially true of the small petiolate leaves shown in his figures 26 and 27. Engelhardt's name is preoccupied by Schrank, 1816. *Cassia* is abundant and varied at Potosi being represented by no less than 10 species. *Cassia chrysocarpoides* Engelhardt is much shorter and wider, *Cassia cristoides* Engelhardt is a much smaller spatulate form, *Cassia wendtii* Britton is very much smaller and oblong elliptical in form, *Cassia singewaldi* Berry is a broadly elliptical form. *Cassia rigidulifolia* Engelhardt is a large retuse form, *Cassia obscura* Engelhardt is a very small obscure form, and *Cassia membranacea* is very similar to the present species, but with slightly wider thinner leaves with more numerous secondaries.

Plesiotypes.—Cat. Nos. 35135, 35136, U.S.N.M.

CASSIA CULTRIFOLIAFORMIS, new species.

Plate 16, fig. 9.

Description.—Leaves bifoliate. Leaflets inequilateral obovate, coriaceous, with a widely rounded apex and a gradually narrowed sessile base. Margins entire. Texture coriaceous. Length about 1 cm. Maximum width, above the middle, about 4 to 5 mm. The upper margin is nearly straight, the outer margin is full and rounded.

Venation thin; several fine primaries diverge from the base at acute angles and take a subparallel course, forking at intervals and frequently inosculating to form narrow elongate meshes that give the leaflet the appearance of close set parallel veins, ultimate loops camptodrome along the margin.

This handsome and well-marked species is scarcely to be distinguished from the existing *Cassia cultrifolia* Humboldt, Bonpland, and Kunth of the northern South American Tropics, differing merely in the character of the base, which is narrowly cuneate instead of equilateral. It may also be compared with the existing *Cassia bifoliolata* with which the differences are more obvious. It is also very similar to the existing *Acacia crassifolia* A. Gray, but smaller and less expanded.

Holotype.—Cat. No. 35098, U.S.N.M.

CASSIA CRISTOIDES Engelhardt.

Plate 16, figs. 10, 11.

Cassia cristoides Engelhardt, Sitz. Naturw. Gesell. Isis in Dresden, 1887, Abh. 5, p. 37, pl. 1, fig. 13.—Britton, Trans. Amer. Inst. Min. Eng., vol. 21, 1893, p. 252, figs. 40–43 (not fig. 44).

Description.—Leaflets sessile, but slightly inequilateral, elongate obovate in outline, with a broadly rounded or slightly emarginate apex and a cuneate base. Margins entire. Texture subcoriaceous. Length ranging from 2.5 to 3 cm. Maximum width, in the middle part of the leaflet, ranging from 8 to 11 mm. Midrib stout and prominent. Secondaries thin, numerous, ascending, camptodrome; eight or nine subopposite to alternate pairs diverge from the midrib at regular intervals at angles of about 45° and sweep upward subparallel.

This species is comparable with the existing *Cassia crista* Jacquin which ranges from the West Indies and Central America to Brazil. Except for the truncated or emarginate apex it is much like the associated *Cassia wendtii* Britton. It belongs to the same group of leaflets as *Cassia ligustrinaformis* Berry, *Cassia singewaldi* Berry, *Cassia membranacea* Engelhardt and *Cassia chrysocarpoides* Engelhardt. The emarginate forms are much like the retuse *Cassia rigidulifolia* Engelhardt in outline but differ strikingly in venation. It is also much like *Platypodium potosianum* Engelhardt in form, but larger and sessile instead of petiolulate.

CASSIA CHRYSOCARPOIDES Engelhardt.

Plate 16, figs. 12, 13.

Cassia chrysocarpoides Engelhardt, Sitz. Naturw. Gesell. Isis in Dresden, 1887, Abh. 5, p. 37, pl. 1, fig. 15; 1894, Abh. 1, p. 9, pl. 1, fig. 30.—Britton, Trans. Amer. Inst. Min. Eng., vol. 21, 1893, p. 252, figs. 29, 34, 35 (not figs. 30–33).

Description.—Leaflets sessile or short petiolulate, slightly oval or ovate in form, the two ends nearly equally rounded, the apex slightly more so and at times the lamina is slightly narrowed distad. Margins entire, full and evenly rounded, the lamina on one side about 1 mm. wider than on the opposite side. Texture subcoriaceous. Length about 2.8 cm. Maximum width, midway between the apex and the base, about 1.6 cm. Petiolule when present stout, about 1.5 mm. long. Midrib rather stout and prominent, nearly straight. Secondaries regularly spaced, subopposite to alternate; about 10 pairs diverge from the midrib at angles of about 45° to 50°, curve regularly upward in a subparallel manner and are camptodrome. Tertiaries thin, arched in the marginal region and largely percurrent internally. Areolation indistinct.

This well marked species is sparingly represented in the present collections but appears to have been abundant in some of the earlier collections. It is very close to the existing *Cassia chrysocarpa* Desveaux of Brazil and Guiana. Among the numerous fossil species of *Cassia* described from Potosi the only one liable to be confused with the present species is *Cassia membranacea* Engelhardt, a thinner, narrower, more elongated and more pointed form. Similar species in other genera are *Dalbergia chartacea* Engelhardt, which is narrower, more elongated, and more pointed, and *Sweetia tertiaria* Engelhardt, which is more narrowed distad and with more numerous straighter secondaries.

Plesiotype.—Cat. No. 35099, U.S.N.M.

CASSIA FRANCKEI (Engelhardt).

Phyllites franckei ENGLEHARDT, Sitz. Naturw. Gesell. Isis in Dresden, 1887, Abh. 5, p. 38, pl. 1, fig. 12; 1894, Abh. 1, p. 13.—BRITTON, Trans. Amer. Inst. Min. Eng., vol. 21, 1893, p. 258, fig. 61.

Description.—Leaflets sessile, lanceolate in outline, falcate, with an acute apex and a cuneate base. Margins dentate, entire toward the base. Length about 5.5 cm. Maximum width, at or below the middle, about 1.4 cm. Midrib stout, curved. Secondaries numerous, thin, ascending, camptodrome.

This species was based upon incomplete material described from Potosi by Engelhardt and not represented in the other collections. Engelhardt referred it to the noncommital form-genus Phyllites, but called attention to its resemblance to the existing *Cassia dentata* Vogel of the Brazilian tropics. This resemblance is so very great that I have ventured to refer this form to the genus *Cassia*.

Genus CAESALPINIA Linnaeus.

CAESALPINIA GMEHLINGI Engelhardt.

Plate 16, fig. 14.

Caesalpinia gmehlingi ENGLEHARDT, Sitz. Naturw. Gesell. Isis in Dresden, 1894, Abh. 1, p. 9, pl. 1, fig. 29.

Description.—An elliptical sessile leaflet, nearly equilateral, with entire margins. Length about 1.4 cm. Maximum width, in the middle part of the leaflet, about 9 mm. Midrib thin. Secondaries about 6, subopposite, camptodrome pairs diverging from the midrib at wide angles.

This species is not represented in the present collections. It was compared by Engelhardt with the wide ranging existing species *Caesalpinia pulcherrima* Swartz, which extends from the West Indies and Mexico to Brazil and is also recorded from the Galapagos and Sandwich Islands.

Among the Potosi species the present is very similar in size, outline, and venation to the more elliptical leaflets of *Cassia chrysocarpoides* Engelhardt.

CAESALPINIA SESSILIFOLIOIDES, new species.

Plate 16, fig. 15.

Description.—Leaflets small, sessile, markedly inequilateral, elliptical in outline, with a rounded slightly mucronate and nearly equilateral tip and a broadly rounded inequilateral base. Margins entire, full, and evenly rounded. Leaf substance thin but firm. Length, about 4 mm. Maximum width, midway between the apex and the base, about 2.75 mm. Midrib thin, conspicuously expanded at the extreme base. Secondaries thin, ascending, camptodrome, 5 on the narrower side of the leaflet and 7 on the broader side. The latter side 40 to 50 per cent wider than the opposite side.

This well-marked species is represented by but a single specimen and there is thus no opportunity of ascertaining its limits of variation. It is almost identical in character with the leaflets of the existing *Caesalpinia sessilifolia* of Central America or *Caesalpinia microphylla* De Candolle of the Brazilian region. It may also be compared with the tropical American *Cassia rotundifolia* Persoon.

Holotype.—Cat. No. 35127, U.S.N.M.

Genus CAESALPINITES Saporta.

CAESALPINITES POTOSIANUS, new species.

Plate 16, fig. 16.

Description.—Leaflets petiolulate, small, nearly equilateral, oblong-lanceolate in outline, with a rapidly narrowed and bluntly pointed apex and a rounded base. Margins entire. Texture coriaceous. Length ranging from 6 to 8 mm. Maximum width, in the middle part of the leaflet, 1.5 to 2 mm. Petiolule stout, curved, about 0.5 mm. in length. Midrib thin, not prominent. Secondaries obsolete by immersion in the substance of the leaflet.

This species is represented by several specimens, which on account of the obsolete venation are referred to the form genus *Caesalpinites* for generically indeterminate leaflets of the Caesalpiniaceae. These leaflets suggest a variety of existing Leguminosae and might with equal propriety be referred to the form genus *Mimosites* of the Mimosaceae. I have been influenced in referring them to *Caesalpinites* by the great abundance of Caesalpiniaceae in the Potosi flora and by their equal predominance in the existing flora of the Amazon Basin, with which the Potosi flora shows so much similarity and from which it appears to have been derived.

There are a number of other species in the Potosi flora that greatly resemble the present one. Among these I might mention the superficially identical *Calliandra obliqua* Engelhardt, which, however, is more pointed, sessile, with a very obliquely inequilateral base and several digitate primaries. *Mimosa arcuatifolia* Engelhardt is identical in form but smaller and sessile. *Enterolobium parvifolium* Engelhardt is larger, relatively narrower, more elongate, more pointed at both ends and prevailingly falcate. *Machaerium eriocarpoides* Engelhardt is larger and stouter, more pointed at both ends, and with a well-marked secondary venation. *Enterolobium grandifolium* Engelhardt is also much larger and stouter, more lanceolate, sessile, and very inequilateral, so that there is no doubt that *Caesalpinites potosianus* represents a distinct leguminous species.

Holotype.—Cat. No. 35100, U.S.N.M.

Genus COPAIFERA Linnaeus.

COPAIFERA POTOSIANA, new species.

Plate 16, fig. 17.

Description.—Leaflets sessile, inequilaterally trapezoidal in outline, bluntly pointed at both ends. Length, about 1.75 cm. Maximum width, midway between the apex and the base, about 8 mm. Margins entire. Texture coriaceous. Midrib stout, curved, prominent on the lower surface of the leaflets. Secondaries numerous, thin, mostly immersed, ascending, camptodrome. Tertiaries obsolete by immersion.

The present species is somewhat suggestive of *Pithecolobium* as well as some of the smaller leafed species of *Inga*, as, for example, *Inga trapezifolia* De Candolle, but the venation is somewhat different. The fossil leaflets, which are not uncommon at Potosi, are similar to those of the existing *Copaifera trapezifolia* Hayne, and are not unlike those of *Copaifera langsdorffii* Desfontaines of the Amazon basin, which is recorded from near Mapiri, Bolivia.

The genus *Copaifera* comprises about 16 existing species of the equatorial region of Africa and America, ranging from the West Indies to the Amazon basin in the latter region. Four of the species are African and the balance are American. A number of fossil species, based for the most part upon the characteristic pods, have been described. The genus is present in the early Tertiary of Chile [1] and during the middle Eocene it extended northward as far as Texas,[2] and was present in the Mediterranean region of Europe in the Oligocene and Miocene.

A pod of a species of Copaifera, possibly belonging to the same species which furnished the leaflets upon which *Copaifera potosiana* is based, are represented at Corocoro, Bolivia.

Holotype.—Cat. No. 35137, U.S.N.M.

COPAIFERA COROCORIANA, new species.

Plate 16, fig. 18.

Description.—Pod of small size, nearly orbicular in outline, greatly compressed, pedunculate, obliquely cuspidate tipped, single seeded. Length, about 1 cm. from the top of the recurved cuspidate tip to the top of the peduncle. Horizontal diameter, about 8 mm. Peduncle stout, about 4 mm. long. Seed lenticular, nearly orbicular, compressed, about 4 mm. in diameter. Pod tardily, if at all, dehiscent; its surface minutely wrinkled.

The present species is somewhat smaller than the normal size of the pods in the existing species which I have seen, and it is also smaller than those of the described fossil species. It may represent the fruit of the same tree as the leaflets from Potosi described as *Copaifera potosiana.*

Holotype.—Cat. No. 35141, U.S.N.M.

Genus BAUHINIA Linnaeus.

BAUHINIA POTOSIANA, new species.

Plate 17, figs. 1, 2.

Description.—Leaves small, bifoliate. Leaflets unsymmetrical oblanceolate or obovate, 2.1 cm. in length by 5.5 mm. in maximum width. Margins entire. Leaf-substance thin. The stout slightly upward curved midrib forms the distal margin of the leaflet, only the outside part of the lamina being developed. The latter is full and evenly rounded. The apex is unsymmetrically rounded and the base is cuneate. The midrib [3] gives rise to three secondaries which diverge at acute angles and are subparallel both with each other and with the margin of the leaflet. The lowest is thin and parallel with the margin, close to which it arches from tip to tip of outwardly directed tertiaries from the second secondary. The latter, which is much stouter than the other two, traverses the median portion of the lamina, parallel to and somewhat nearer to the margin than to the midrib. It forks twice or thrice, sending off subordinate veins at acute angles, which form elongated camptodrome loops.

[1] Engelhardt, H., Abh. Senck. Naturf. Gesell., vol. 16, 1891, pt. 4, p. 681, pl. 5, fig. 8; pl. 7, fig. 4.
[2] Berry, E. W., Torreya, vol. 15, 1915, pp. 41–44, fig. 5.
[3] This is probably morphologically an upper secondary, the true midrib being obsolete.

The tertiaries form elongated meshes, all of which in the upper half of the leaflet are arched distad and pointed proximad.

This characteristic form bears some resemblance to certain leaflets of *Acacia* and *Calliandra*, as well as to the leaflets of some species of *Cassia*, as, for example, the South American *Cassia cultrifolia* Humboldt, Bonpland, and Kunth. While the form is not distinctive, the venation is typically that of *Bauhinia*, to which genus I have referred it. It is smaller than, perhaps, the majority of existing species of *Bauhinia*, but there are a number that resemble it closely in size both among recent species, as, for example, *Bauhinia uniflora*, and among fossil species, as, for example, *Bauhinia marylandica* Berry.

This remarkable genus, abundantly represented by butterflylike leaves in the Upper Cretaceous of North America, comprises upward of 200 existing species of trees or high-climbing shrubs widely distributed in the Tropics of both hemispheres. About 40 per cent of the recent species are American, where they range from the West Indies and Mexico to southern Brazil. South America contains more species than any other continent, although both Africa and Asia have numerous species. *Bauhinia* is common in eastern Bolivia, but does not, as far as I know, occur farther west than the well-watered subandean eastern slope of the Cordillera, although a small-leafed species, *Bauhinia microphylla*, is present in the thornbush country or Gran Chaco region.

Cotypes.—Cat. Nos. 35101, 35102, U.S.N.M.

Genus PELTOPHORUM Vogel.

PELTOPHORUM MEMBRANACEUM Engelhardt.

Plate 17, fig. 3.

Peltophorum membranaceum ENGELHARDT, Sitz. Naturw. Gesell. Isis in Dresden, 1894, Abh. 1, p. 9, pl. 1, fig. 47.

Description.—Leaflets small, sessile, inequilateral, ovate in general outline, with a bluntly pointed apex and an obliquely cuneate base. Margins entire. Length, about 8 mm. Maximum width, in the middle part, about 3.5 mm., one side one-third wider than the other. Midrib mediumly stout, curved proximad. Secondaries thin, about three ascending camptodrome pairs.

This species was described from Potosi by Engelhardt, and is not present in the other collections from Bolivia. The peculiar outline serves to readily distinguish it from the other members of the Potosi flora. It has been compared with the existing *Peltophorum vogelianum* Bentham of the Brazilian region.

The genus *Peltophorum*, not otherwise known in the fossil state, comprises about eight species of trees common to the tropics of both hemispheres.

Family PAPILIONACEAE.

Genus AMICIA Humboldt, Bonpland, and Kunth.

AMICIA ANTIQUA Britton.

Plate 17, figs. 4, 5.

Amicia antiqua Britton, Trans. Amer. Inst. Min. Eng., vol. 21, 1893, p. 252, figs. 11, 45.

Description.—Leaflets sessile, narrowly or broadly cuneate in general outline, with an emarginate apex. Length ranging from 2 to 3 cm. Maximum width in the apical part of the leaflet ranging from 0.75 to 1.4 cm. Margins entire, slightly undulate. Texture coriaceous. Midrib mediumly stout, slightly flexuous, prominent on the lower surface of the leaflets. Secondaries thin, numerous, ascending, camptodrome. Tertiaries obsolete.

This species was described by Britton from a limited amount of material collected by Wendt and is not contained in the recent collection made by Singewald and Miller. It may be compared with the existing *Amicia lobbiana* Bentham found at high altitudes in the Peruvian and Bolivian Andes (1,800–3,000 meters).

The genus *Amicia*, not otherwise known fossil, comprises five or six species of shrubs or undershrubs of the Andean region, ranging from Mexico to Bolivia.

The identification of the present species is somewhat questionable upon general grounds, for while the fossil agrees with the existing leaflets of *Amicia*, and it is quite natural to identify the fossil leaflets with a recent genus of the same general region, the fact that the vast majority of the fossil forms found at Potosi are related to existing forms of the more humid regions of eastern Bolivia and the Amazon Basin, raises the question whether the present leaflets may not be more properly referable to some other leguminous genus with similar leaflets, such as would more naturally be expected to occur under such conditions and in such an association, as, for example, the genus *Dalbergia*.

Genus MACHAERIUM Persoon.

MACHAERIUM ERIOCARPOIDES Engelhardt.

Plate 17, fig. 6.

Machaerium eriocarpoides Engelhardt, Sitz. Naturw. Gesell. Isis. in Dresden, 1894, Abh. 1, p. 8, pl. 1, fig. 28.

Description.—Leaflets petiolulate, lanceolate in outline, nearly equilateral, with an equally pointed apex and base. Margins entire. Texture subcoriaceous. Length, 1.2 to 1.4 cm. Maximum width, midway between the apex and the base, 2.5 to 3.25 mm. Petiolule stout, 0.5 to 1 mm long. Midrib stout. Secondaries thin, regularly spaced, subparallel; six or seven pairs diverge from the midrib at angles of about 45° and are camptodrome. Tertiaries obsolete by immersion.

This species is not uncommon in the present collection. While similar to several other fossil species found at Potosi, it may be distinguished from *Acacia uninervifolia* Engelhardt by its petiolule, greater width and fewer secondaries; from *Enterolobium grandifolium* Engelhardt by its petiolule, its smaller size, more prominent secondaries and more equilateral form; from *Mimosites engelhardti* Berry by its wider, less elongated, and more lanceolate form, by its petiolule and more prominent secondaries. According to Engelhardt it is very similar to the existing Brazilian species *Machaerium eriocarpum* Bentham. This species is recorded by Herzog [1] from the hill country of Velasco and from the broken woods along the Rio Pirai and Rio Yapacani, in eastern Bolivia.

The existing species of *Machaerium* comprise over 60 trees or high climbing shrubs, with small pinnate leaves, confined to the American Tropics, where they range from the West Indies and Central America to southern Brazil. Their maximum display is in the Amazon region, and they do not appear to be represented in the present mountain region of Bolivia.

The known fossil species are few in number and comprise, in addition to the present form, three Oligocene and a Miocene species in central and southern Europe.

Plesiotype.—Cat. No. 35103, U.S.N.M.

MACHAERIUM MILLERI, new species.

Plate 17, fig. 7.

Description.—Leaflets petiolulate, oblong-obovate, nearly equilateral, with a broadly rounded apex and a cuneate base. Margins entire. Texture subcoriaceous. Length about 2 cm. Maximum width, at or slightly above the middle, about 7 mm. Petiolule stout, curved, 2 to 2.5 mm in length. Midrib stout, curved. Secondaries thin, numerous; they diverge from the midrib at angles of about 45° and pursue a nearly straight ascending course, forking and anastomosing, and eventually lost in the camptodrome areolation of the marginal region.

This well-marked form suggests comparisons with various existing species of *Leptolobium* and *Platypodium*, both of which are represented in the Potosi flora. The venation, however, appears to ally it more closely with the reticulate veined species of *Machaerium*. It is readily distinguished from the associated *Machaerium eriocarpoides* Engelhardt, which is a lanceolate leaflet with relatively distant and regularly curved camptodrome secondaries. Among other forms

[1] Herzog, Th., Pflanzenformationen Ost Bolivias, Englers Bot. Jahrb., vol. 44, 1910.

from Potosi there is some resemblance to *Platypodium potosianum* Engelhardt, which is about the same size but generally wider with fewer regularly curved camptodrome secondaries. There is also a more distant resemblance to *Cassia wendtii* Britton, which is more inequilateral, with a shorter petiolule, fewer and better marked camptodrome secondaries, generally more pointed tip and widest below the middle. Named for the collector, Prof. B. L. Miller, of Lehigh University.

Holotype.—Cat. No. 35104, U.S.N.M.

Genus DALBERGIA Linnaeus (son).

DALBERGIA POTOSIANA, new species.

Plate 17, fig. 8.

Description.—Leaflets sessile, obovate in general outline, with a broadly rounded deeply emarginate apex and a broadly cuneate base. Margins full, entire. Leaf substance thin but firm. Length, about 1.5 cm. Maximum width, above the middle, about 5 mm. Midrib very stout, curved. Secondaries very thin, about three to five camptodrome pairs. Tertiaries mostly obsolete. Areolation fine, its details obscure.

This well-marked species is clearly distinct from the other members of the Potosi flora and not close to *Dalbergia chartacea* Engelhardt, which has larger, ovate leaflets. It is very similar to a large number of existing and fossil species of *Dalbergia*, to which a large number of fossil leaflets and pods have been referred. A pod from Potosi is referred to this genus by Engelhardt, but its determination is not above suspicion.

The existing species of *Dalbergia* number about 80 forms, occurring in both the Oriental and Occidental Tropics. There are a large number of species in the Amazon Basin.

Holotype.—Cat. No. 35105, U.S.N.M.

DALGERGIA CHARTACEA Engelhardt.

Dalbergia chartacea Engelhardt, Sitz. Naturw. Gesell. Isis in Dresden, 1894, Abh. 1, p. 8, pl. 1, fig. 25.

Description.—Leaflets ovate, bluntly pointed at the apex, with a broadly cuneate base, nearly equilateral, with full and evenly rounded entire margins. Texture coriaceous. Length, about 2.5 cm. Maximum width, midway between the apex and the base, about 11 mm. Midrib straight and mediumly stout. Secondaries thin; about six pairs diverge from the midrib at angles of about 45°; they range from opposite to alternate and pursue a subparallel camptodrome course. Tertiaries mostly obsolete.

This somewhat doubtfully determined form is not represented in the present collections. It was compared by Engelhardt with the existing *Dalbergia variabilis* Vogel of tropical Peru, Guiana, and Brazil. In both outline and venation the present leaflets are distinguished with difficulty from those of the associated species *Cassia membranacea* Engelhardt and *Sweetia tertiaria* Engelhardt. The first are slightly narrower and more elongate, and the last, while similar in size and outline, are slightly broader with straighter, more numerous secondaries.

DALBERGIA (?) ANTIQUA Engelhardt.

Plate 17, fig. 9.

Dalbergia antiqua ENGELHARDT, Sitz. Naturw. Gesell. Isis in Dresden, 1894, Abh. 1, p. 8, pl. 1, fig. 23.

Description.—An oval pod, pointed at both ends, with a coriaceous integument and extended peduncle with a persistent calyx. About 2.5 cm. long and 1 cm. wide in the median region.

The character of this pod is more suggestive of *Cassia* than *Dalbergia*, hence I have questioned Engelhardt's generic reference. It is not represented in the present collections, but was compared by Engelhardt with the existing *Dalbergia riparia* Bentham of the Amazon Basin.

Genus DESMODIUM Desveaux.

DESMODIUM ELLIPTICUM Engelhardt.

Desmodium ellipticum ENGELHARDT, Sitz, Naturw. Gesell. Isis in Dresden, 1894, Abh. 1, p. 8, pl. 1, figs. 42–44.

Description.—Leaflets sessile or short petiolulate, elliptical in outline, slightly inequilateral. Apex and base about equally rounded. Margins entire. Length, about 9 mm. Maximum width, midway between the apex and the base, about 6 mm. Midrib slender, curved. Petiolule, when present, about 1 mm. long, stout. Secondaries thin, three or four camptodrome pairs diverging from the midrib at wide angles.

This species is not represented in the present collection. It was compared by Engelhardt with the existing *Desmodium barbatum* Bentham, which is widely distributed from the West Indies and southern Mexico to Brazil. In the existing flora *Desmodium* is a large genus with between 150 and 200 species of herbaceous and shrubby plants widely distributed in the tropics of both hemispheres and with a few extratropical species in both regions.

Genus DREPANOCARPUS Meyer.

DREPANOCARPUS FRANCKEI Engelhardt.

Plate 17, figs. 10, 11.

Drepanocarpus franckei ENGELHARDT, Sitz, Naturw. Gesell. Isis in Dresden, 1894, Abh. 1, p. 7, pl. 1, figs. 36–38.

Description.—Leaflets sessile, elliptical in outline, nearly equilateral, with a broadly rounded apex and a similarly rounded, sometimes obliquely, inequilateral base. Margins entire. Texture coriaceous. Length ranging from 10 to 13 mm. Maximum width, midway between the apex and the base, 4 to 5 mm. Midrib stout, prominent below, channeled above, relatively straight. Secondaries prominent, numerous, subparallel, camptodrome.

This species is well marked and readily distinguished from the other members of the Potosi flora. It is comparable with the existing *Drepanocarpus lunatus* Meyer, a widespread form ranging from the West Indies and southern Mexico to Brazil, and recorded also from tropical West Africa. *Drepanocarpus* is not otherwise known in the fossil state. The existing species comprise 8 to 10 trees or high climbing shrubs, all of which are confined to tropical America with the single exception noted above.

Genus AESCHYNOMENE Linnaeus.

AESCHYNOMENE BOLIVIANUM (Engelhardt).

Plate 17, fig. 12.

Hedysarum bolivianum ENGELHARDT, Sitz. Naturw. Gesell. Isis in Dresden, 1894. Abh. 1, p. 7, pl. 1, figs. 62, 63.

Description.—Leaflets small, sessile, obovate in outline, with a broadly rounded tip and an acuminate base. Margins entire. Texture membranaceous or chartaceous. Leaf substance thin. Length, about 7 mm. Maximum width, in the middle part of the leaflet, about 3.5 mm. Midrib thin, curved. Secondaries thin, numerous, equally spaced, subparallel, camptodrome.

This species was described by Engelhardt, who compared it with the existing and polymorphous *Aeschynomene falcatum* De Candolle, which ranges from Mexico to Brazil. It has not been recognized in the other collections from Potosi. I have transferred this form to the genus *Aeschynomene* with the recent species of which Engelhardt compared it and which it resembles more closely than it does *Hedysarum*. The latter is a genus with over three score existing species of herbs or shrubs of the temperate regions of Europe, Asia, Africa, and North America. The genus *Aeschynomene*, on the other hand, is confined to the tropics of both hemispheres, with numerous existing species of herbs or shrubs, well represented in the Brazilian region.

Genus SWEETIA Sprengel.

SWEETIA TERTIARIA Engelhardt.

Plate 17, fig. 13.

Sweetia tertiaria ENGELHARDT, Sitz. Naturw. Gesell. Isis in Dresden, 1887, Abh. 5, p. 38, pl. 1, fig. 11; 1894, Abh. 1, p. 9, pl. 1, fig. 26.—BRITTON, Trans. Amer. Inst. Min. Eng., vol. 21, 1893, p. 254, fig. 79.

Description.—Leaflets sessile, nearly equilateral, ovate in general outline, with a rounded or emarginate apex and a cuneate base.

Margins entire. Texture subcoriaceous. Length, ranging from 2.5 to 3.5 cm. Maximum width, in the middle part of the leaflet, ranging from 1.3 to 1.7 cm. Midrib stout and straight. Secondaries thin, numerous, camptodrome.

This species was contained in both the collections from Potosi studied by Engelhardt, but has not been recognized in the other collections. It is clearly distinct from the other members of the Potosi flora, and was compared with the existing *Sweetia elegans* Bentham, a Brazilian species. Britton's reference of this fossil to the genus *Swertia* was simply a typographic error.

The genus *Sweetia* consists of about 10 existing species of trees confined to the South American Tropics and ranging from Guiana to southern Brazil. It is not otherwise known in the fossil state.

Genus LONCHOCARPUS Humboldt, Bonpland, and Kunth.

LONCHOCARPUS OBTUSIFOLIUS Engelhardt.

Plate 17, fig. 14.

Lonchocarpus obtusifolius ENGELHARDT, Sitz. Naturw. Gesell. Isis in Dresden, 1894, Abh. 1, p. 7, pl. 1, fig. 22 (not Engelhardt, 1895).

Description.—Leaflets elliptical in outline, slightly inequilateral, narrowed from below the middle to the broadly rounded base. Margins entire. Texture subcoriaceous. Length, about 2.4 cm. Maximum width, below the middle, about 1.4 cm. Midrib thin, straight. Secondaries thin, about 5 subopposite, camptodrome pairs. A few percurrent tertiaries visible.

This species was described from Potosi by Engelhardt, who compared it with the existing *Lonchocarpus obtusus* Bentham of the Brazilian region. It is sparingly represented in the present collections. It has also been recorded by Engelhardt [1] from the Tertiary of Ecuador, although the two occurrences represent different species. It is somewhat similar to three other Potosi species of Leguminosae—namely, *Dalbergia chartacea* Engelhardt, *Sweetia tertiaria* Engelhardt, and *Cassia chrysocarpoides* Engelhardt. The first is relatively narrower and longer, widest in the middle, not narrowed distad more than proximad and more pointed; the second is also widest in the middle, not more narrowed distad than proximad and with more numerous and less ascending secondaries; the third is widest in the middle, more pointed, not more narrowed distad than proximad, and with more numerous and less ascending secondaries.

Lonchocarpus is a genus with upward of 70 existing species of trees and high climbing shrubs of the tropical regions of America, Africa, and Australia, with more than half the existing forms confined to America. Several fossil species have been recorded, includ-

[1] Engelhardt, H., Abh. Senck. Naturf. Gesell., vol. 19, p. 17, pl. 3, fig. 1, 1895.

ing one from the Tertiary of Ecuador,[1] one from the late Tertiary of New Jersey,[2] and one from the Pleistocene of Cuba.

Plesiotype.—Cat. No. 35106, U.S.N.M.

Genus PLATYPODIUM Vogel.

PLATYPODIUM POTOSIANUM Engelhardt.

Plate 17, figs. 15–17.

Platypodium potosianum ENGELHARDT, Sitz. Naturw. Gesell. Isis in Dresden, 1894, Abh. 1, p. 12, pl. 1, fig. 41.

Cassia cristoides BRITTON (not Engelhardt), Trans. Amer. Inst. Min. Eng., vol. 21, 1903, fig. 44, (not figs. 40–43).

Cassia chrysocarpoides BRITTON (not Engelhardt), Trans. Amer. Inst. Min. Eng., vol. 21, 1893, fig. 37 (not figs. 29–36).

Description.—Leaflets petiolulate, oblong elliptical to oblong-obovate, with a nearly equilateral broadly rounded to very slightly emarginate apex and a slightly narrowed rounded or bluntly pointed considerably inequilateral base. Margins entire. Texture subcoriaceous. Length, ranging from 1.3 to 1.8 cm. Maximum width, at or somewhat above the middle, ranging from 7 to 8 mm. Petiolule stout, curved, about 2 mm. in length. Midrib relatively stout and prominent. Secondaries numerous, well marked, subparallel, camptodrome; seven to nine pairs diverge from the midrib at angles of about 45°. Tertiaries mostly obsolete except for ascending subordinates between and subparallel with the secondaries.

The present species is very close to the existing *Platypodium elegans* Vogel, which ranges from Panama to Brazil and eastern Bolivia. It resembles somewhat the smaller leaflets of *Cassia cristoides* Engelhardt *Cassia chrysocarpoides* Engelhardt and is about the same size as *Cassia wendtii* Britton. The latter, is, however, nearly sessile and pointed at both ends.

The genus *Platypodium* is not otherwise known in the fossil state. The existing species are few in number and comprise trees with even or odd pinnate small leaves confined to the Southern American Tropics and chiefly developed in the Amazon and Orinoco basins.

Plesiotype.—Cat. No. 35107, U.S.N.M.

LEGUMINOSAE INCERTAE SEDIS.

Genus LEGUMINOSITES Bowerbank.

LEGUMINOSITES (?) GLOBULARIS Engelhardt.

Leguminosites (?) *globularis* ENGELHARDT, Sitz. Naturw. Gesell. Isis in Dresden, 1894, Abh. 1, p. 13, pl. 1, fig. 59.

Description.—A globular seed about 4 mm. in diameter, referred tentatively to the Leguminosae by Engelhardt and not contained in the other collections from Potosi.

[1] Engelhardt, Abh. Senck. Naturf. Gesell., vol. 19, p. 17, 1895.

[2] Hollick, A., Bull. Torrey Bot. Club, vol. 23, 1896, p. 49, pl. 259, figs. 6–8.

LEGUMINOSITES, species.

Plate 18, fig. 1.

Description.—A small leguminous leaflet, ovate in form, with a rounded tip and greatly inequilateral base. Margin entire. Length, about 3 mm. Maximum width about 1 mm. Midrib stout and curved. A stout ascending secondary from its base on each side gives the leaflet a triveined appearance. Distad there are two pairs of thin camptodrome secondaries.

This may be a distinct species. As it is represented by only a single specimen, it is not considered wise to make it the basis of a new species, especially as it may represent a variant of the abundant *Calliandra obliqua* Engelhardt.

Holotype.—Cat. No. 35108, U.S.N.M.

Order GERANIALES.

Family ZYGOPHYLLACEAE.

Genus PORLIERIA Ruiz and Pavon.

PORLIERIA TERTIARIA Britton.

Plate 18, figs. 2, 3.

Porlieria tertiaria BRITTON, Trans. Amer. Inst. Min. Eng., vol. 21, 1893, p. 251, figs. 71–75.

Mimosites, species, ENGELHARDT, Sitz. Naturw. Gesell. Isis in Dresden, 1894, Abh. 1, p. 11, pl. 1, figs. 48, 49.

Description.—Leaves opposite, subsessile, evenly pinnate in my specimens, but odd pinnate in the type material. General outline elliptical or obovate. Length, ranging from 6 to 9 mm. Maximum width, at or above the middle, 3 to 5 mm. Leaflets sessile by a but slightly narrowed base, 8 or 9 subopposite to alternate pairs with sometimes an odd terminal leaflet, crowded especially distad, diverging at narrow angles both proximad and distad, especially one or two distal pairs. In the middle part of the leaf the angle of divergence ranges from 45 to 60°. Rachis relatively very stout. Texture coriaceous. Leaflets linear oblong or slightly spatulate, with a slightly narrowed, broadly sessile base and a rounded apex, slightly inequilateral. Margins entire. Midribs thin and immersed. Length, ranging from 1 to 2.5 mm. Maximum width one-half to one-fourth the length.

This species is not uncommon at Potosi. *Porlieria* is a small genus of shrubby plants, with three or four existing xerophytic species, found from Texas and Mexico southward to the Chilean Andes and the Argentina steppes. The fossil species greatly resembles the existing *Porlieria hygrometrica* Ruiz and Pavon of the arid country between southern Peru and northern Chile and *Porlieria lorentzii*

Engler of the Argentina steppes and eastern Bolivia plains (Santa Cruz, Cochabamba). It is one of the few fossil species found at Potosi that is clearly indicative of arid conditions, and this may be due to its having grown on a porous slope where insolation was great—i. e., it may reflect edaphic rather than climatic conditions.

The fragmentary specimens described by Engelhardt as *Mimosites*, species [1] and *Mimosa montanoides* [2] may, and probably do, represent this species.

Plesiotypes.—Cat. No. 35109, 35110, U.S.N.M.

Family EUPHORBIACEAE.

Genus EUPHORBIA Linnaeus.

EUPHORBIA (?), species, Britton.

Euphorbia (?), BRITTON, Trans. Amer. Inst. Min. Eng., vol. 21, 1903, p. 256, figs. 59, 60.

Description.—This record was based on an obscure specimen preserved in a coarser grained rock than the balance of the Potosi flora and considered by Britton to possibly represent a nodulose stem of some fleshy *Euphorbia* such as still characterize the existing flora in parts of South America. Nothing like it is contained in the collection studied by me.

Order PARIETALES.

Family PASSIFLORACEAE.

Genus PASSIFLORA Linnaeus.

PASSIFLORA CANFIELDI Britton.

Plate 18, figs. 4, 5.

Passiflora (?) *canfieldi* BRITTON, Trans. Amer. Inst. Min. Eng., vol. 21, 1893, p. 256, figs. 12, 13.

Description.—Leaves small, sessile, palmately trilobate. Margins crenulate. Texture coriaceous. Length about 1.5 cm. Maximum width, from tip to tip of the lateral lobes, about 1.4 cm. Sinuses rectangular, extending about halfway to the base. Central lobe broadly rounded distad with subparallel sides, much longer than the lateral lobes, its dimensions about 9 mm by about 5 mm, hence nearly twice as long as wide. Lateral lobes short, tending to be more narrowly rounded than the median lobe, their upper margins straighter than their lateral margins, which are full and curved to the broadly rounded base. The basal half of the leaf forms an almost exact semicircle and the crenulations of the margin become obsolete in the basal region.

[1] Engelhardt, H., Isis in Dresden, 1894, Abh. 1, p. 11, pl. 1, figs. 48, 49.

[2] Idem, p. 10, pl. 1, fig. 64.

Primaries three, stout, diverging from the extreme base at angles of about 40°, the central nearly straight and the laterals slightly curving outward, each terminating at the summit of the obtuse lobes. Tertiaries obsolete by immersion, from the character of the margin, presumably camptodrome as in the recent species.

This species is not represented in the present collection and the accompanying illustrations are reproduced from Britton's report. The latter author is doubtful of the reference of these leaves to Passiflora, but I see nothing to criticise in this determination. The marginal character and the peculiar aspect of the leaves, with their broadly rounded base, obtuse lobes, and extended oblong central lobe, and with the basal primaries stamp them clearly as referable to the Passiforiaceae, a family abundantly represented in the existing flora of South America. A number of fossil species of *Passifloria* are known, but none of these is especially close to the present species. The existing species number upward of 300 climbing shrubs or rank annuals, mostly American and tropical in their distribution, but found also in Madagascar (one species), Asia, and Australia. The present species appears to be referable to the section *Granadilla* De Candalle, which has over 80 existing species, more than half of which are Brazilian. I do not know whether or not *Passiflora* occurs at the present time in Bolivia to the west of the front range of the Andes, but it is not uncommon in eastern Bolivia, and according to Herzog [1] a species occurs in the Andean outliers of Santa Cruz and Cochabamba up to elevations of 2,600 meters.

Order MYRTALES.

Family MYRTACEAE.

Genus MYRTEOLA Berg.

MYRTEOLA POTOSIANA, new species.

Plate 18, fig. 6.

Description.—Leaves small, ovate in outline, petiolate, with entire margins and coriaceous texture. Apex acute. Base about equally acute. Length, about 13 mm. Maximum width, midway between the apex and the base, about 5 mm. Petiole stout, about 2.25 mm. in length. Midrib stout. Secondaries thin, about 1 mm. apart, diverging from the midrib at angles of between 40° and 50°, generally straightly ascending and subparallel, occasionally slightly curved, their tips joined close to the margin by a slightly arched acrodrome vein forming a marginal hem along each margin. Tertiaries indistinct, occasional fine percurrent tertiaries and acutely diverging branches from the secondaries can be discerned.

[1] Herzog, Th., Pflanzenformationen Ost Bolivias, 1910.

This little leaf is essentially myrtaceous in character and may be compared with various existing species of *Myrtus* and *Myrcia*. It shows more similarity, however to the leaves of the genus *Myrteola*, a genus of 9 or 10 species of shrubs and undershrubs closely related to *Myrtus* and now found in the existing flora in the Andean region from Ecuador to the Straits of Magellan; one species of the last region, *Myrteola nummularia* (Poiret) Berg, being also found on the Falkland Islands.

Holotype.—Cat. No. 35111, U.S.N.M.

Family COMBRETACEAE.

Genus TERMINALIA Linnaeus.

TERMINALIA ANTIQUA Britton.

Plate 18, figs. 8, 9.

Terminalia antiqua BRITTON, Trans. Amer. Inst. Min. Eng., vol. 21, 1893, p. 254, figs. 16, 28, 68–70.

Description.—Samaras bialate, elliptical in outline, wider than high, emarginate at the summit, cordate, truncate or decurrent to the stout peduncle. Length ranging from 1 to 2 cm. Width ranging from 1.1 to 2.5 cm. Peduncle ranging from 5 to 10 mm. in length, curved or straight. Essential part of fruit narrowly fusiform, extending upward four-fifths or all the way to the apical sinus. Wings thin, scarious. Veins numerous, thin, said by Britton to be simple but abundantly forked and anastomosing in my material.

These characteristic fruits are not uncommon at Potosi and Britton has figured a number to illustrate their variations. My material is smaller but otherwise indistinguishable, and undoubtedly belongs to the same species. On the other hand a *Terminalia* fruit collected at Corocoro, while it is bialate, is considerably larger and more coriaceous, with a large turbinate seed cavity and this I have described as a distinct species. While these Potosi fruits are suggestive of some of the Sapindaceae and average smaller than most modern winged *Terminalia* fruits, I have no hesitation in referring them to the latter genus. According to Britton [1] the present species is closely comparable to fruits of the existing *Terminalia oblonga* Persoon collected in Guatemala.

Terminalia is a large genus in the existing flora of the tropics of both hemispheres, with over 100 species about equally divided between America, Asia, Africa, and Australia. It is an old type and the modern species are segregated into four sections, based primarily on the characters of the fruit which may be fleshy, ligneous, or variously winged. So far as I know *Terminalia* is not now endemic

[1] Trans. Amer. Inst. Min. Eng., vol. 21, 1893, p. 254.

in the Andean region of Bolivia, but several species are recorded by Herzog [1] in the region of Santiago and San Jose and in the broken forests along the Rio Pirai and Rio Yapacani in eastern Bolivia.

The fossil record of *Terminalia* while very incomplete embraces about a dozen species found in both Europe and southeastern North America from the lower Eocene onward. The bulk of these, particularly those of the Mississippi embayment region, appear to have been littoral species like the modern *Terminalia catappa* and *Terminalia littoralis*.

Plesiotypes.—Cat. No. 35112, 35113, U.S.N.M.

TERMINALIA SINGEWALDI, new species.

Plate 18, fig. 7.

Description.—Samaras bialate, reniform in outline, wider than high, deeply emarginate or cordate at both the apex and the base. Peduncle stout, about as long as the vertical axis of the fruit. Length of the latter, 1.25 cm. Wings thin with entire margins. Veins thin, numerous, somewhat flexuous, frequently forking and less frequently anastomosing. Height of wings, between 2.25 and 2.5 cm. Width, about 1.25 cm. Width from margin to margin of the opposite wings, about 3.15 cm. Essential part of fruit turbinate, rounded distad, and tapering downward proximad to join the peduncle; turgid, the veins of the wings crossing its surface diagonally.

This species apparently belongs to the section Diptera of the genus. It is somewhat similar to *Terminalia antiqua* Britton, which is so common at Potosi, but differs from the latter in its larger size, in its turgid and turbinate, distally rounded seed cavity, and in its more equilateral wings with less frequently anastomosing veins. It is comparable to various two-winged modern species of Asia, Africa, and of the South American Tropics east of the Andes.

Holotype.—Cat. No. 35114, U.S.N.M.

Family LYTHRACEAE.

Genus CUPHEA P. Browne.

CUPHEA ANTIQUA Britton.

Plate 18, figs. 10–12.

Cuphea antiqua Britton, Trans. Amer. Inst. Min. Eng., vol. 21, 1893, p. 256, figs. 49–51.

Description.—Leaves small, ovate in general outline, with an acutely pointed apex, and a rounded, truncate, or cordate, inequilateral base. Margins entire. Length, 1.25 to 1.5 cm. Maximum width, in the middle part of the leaf, 6 to 9 mm. Petiole wanting.

[1] Herzog, Th., Pflanzenformationen Ost Bolivias, Englers Bot. Jahrb., vol. 44, 1910.

Midrib thin, generally somewhat curved. Normally there is a basilar or subbasilar acrodrome primary on either side diverging from the midrib at varying angles and merging with the secondary venation at or above the middle of the leaf. Sometimes a primary is developed on only one side and even when there is one on each side they are somewhat unlike in their courses since they tend to be parallel with the lateral margins of the leaf which are somewhat unsymmetric as compared with one another. There are two or three pairs of arched camptodrome secondaries above the primary or four pairs in case a primary is not developed on one side.

This species is known only from materials in the collection from Potosi studied by Britton and may therefore have been less common than the bulk of the fossil flora where the general representation runs remarkably uniform for the three collections studied.

Cuphea is a large modern genus with about 160 existing species of herbs and shrubs, otherwise unknown in the fossil state. With the exception of *Cuphea balsamona* of the Galapagos and Sandwich Islands it is confined to America and there chiefly in the equatorial and subtropical regions. *Cuphea viscosissima* Jacquin is the only North American species that extends northward beyond the Gulf States. There are over 50 species in Mexico and many extend southward along the Andes. There are 77 species in extratropical Brazil. These are several species in the moister parts of the Peruvian eastern Andes; thus *Cuphea cordata* is an under shrub which extends upward in the less arid parts of this region to elevations of 7,500 feet. The distribution of *Cuphea* in the existing flora of Bolivia is unknown, but the genus is represented in the Santa Cruz and Cochabamba regions of eastern Bolivia.

GAMOPETALAE.

Order ERICALES.

Family VACCINIACEAE.

Genus GAYLUSSACIA Humboldt, Bonpland, and Kunth.

GAYLUSSACIA TERTIARIA Engelhardt.

Gaylussacia tertiaria Engelhardt, Sitz. Naturw. Gesell. Isis in Dresden, 1894, Abh. 1, p. 6, pl. 1, figs. 8, 9.

Description.—Leaves spatulate or oblong lanceolate in outline, with an acuminate apex and a more gradually narrowed acute base. Margins entire. Texture coriaceous. Length ranging from 2.5 to 3 cm. Maximum width, in the middle part of the leaf, about 5.5 mm. Petiole missing, or absent. Midrib stout and prominent. Secondaries numerous, thin, and camptodrome.

This species was described by Engelhardt and has not been recognized in the collections from Potosi studied by me. It was compared with the existing *Gaylussacia ledifolia* Martius, a Brazilian species. *Gaylussacia* has many existing species of shrubs and undershrubs widely distributed in the Western Hemisphere from the equator well into both the North and the South Temperate Zones. The maximum of species occur in Brazil. On the other hand, the allied genera *Gaultheria* and *Vaccinium* have numerous Andean species from Central America to Chile, and the fossil species may possibly be more closely related to some of the existing species in the last two genera

Order GENTIANALES.

Family APOCYNACEAE.

Genus APOCYNOPHYLLUM Unger.

APOCYNOPHYLLUM POTOSIANUM, new species.

Plate 18, fig. 13.

Undetermined leaf, BRITTON, Trans. Amer. Inst. Min. Eng., vol. 21, 1893, p. 259, figs. 64, 67.

Description.—Leaves narrowly linear lanceolate, more or less falcate, with a gradually narrowed acuminate apex and base, presumably sessile. Margins entire. Texture coriaceous. Midrib stout and prominent, curved, expanded proximad. Secondaries remote, diverging from the midrib at wide angles, straight to near the margin where their ends are joined by flat arches. Thin percurrent veins subparallel with the arches usually present half way between them and the midrib. Length ranging from 5 to 6 cm. Maximum width, in the middle part of the leaf, ranging from 3 to 6 mm.

Leaves of this character have been referred to the genus *Callistemon* of the Myrtaceae and to the genus *Grevillea* of the Proteaceae as well as to the form genera *Acerates* and *Apocynophyllum*. The last, established for fossil forms of the Apocynaceae of uncertain generic identity, seems to be the proper reference for these Potosi forms which are not uncommon although usually broken. The form and venation are very characteristic. Lack of sufficient recent material renders comparisons difficult. The form and particularly the venation warrant the reference of this form to the Apocynaceae which has a large number of shrubs, trees, and leaves in tropical South America. A number of genera prominent in the South American flora such as *Skytanthus*, *Aspidosperma*, *Tabernaemontana*, *Vallesia*, *Thevetia*, *Prestonia*, *Forsteronia*, *Robbia*, etc., have some species with leaves that are very similar to the fossil.

Cotypes.—Cat. No. 35115, *a*, *b*, *c*, U.S.N.M.

Order POLEMONIALES.

Family BIGNONIACEAE.

Genus JACARANDA Jussieu.

JACARANDA POTOSINA, new species.

Plate 18, fig. 14.

Description.—Leaflets small and thin, subsessile, lanceolate in outline, with a bluntly pointed apex and a narrowly cuneate base. Margins entire. Length, about 1.5 cm. Maximum width, midway between the apex and the base, about 3 mm. Petiolule very broad, short, 1 mm. or less in length, truncate. Midrib attenuated distad, broad in the lower half of the leaflet, expanding rapidly proximad to its junction with the petiolule with which it is continuous. Secondaries thin, numerous, ascending; they diverge from the midrib at acute angles subparallel with one another and the lateral margins and are connected by straight oblique tertiaries.

This well marked new form is referred with some hesitation to the genus *Jacaranda*, agreeing with the leaflets of several of the existing pinnate leafed species with tiny leaflets, as for example, *Jacaranda caroliniana* Pohl or *Jacaranda cuspidifolia* Martius.

The genus *Jacaranda* comprises about two score existing species of shrubs of the campos and trees. It is confined to tropical America and ranges from Bermuda to Brazil, and is abundant in the Amazon basin. The only other known fossil species is one based upon both leaflets and seeds described by Ettingshausen [1] which Schenk [2] thinks is of doubtful identity. There are poorly preserved specimens of several varieties of winged seeds present in the Potosi collections, but none of these can be conclusively referred to the Bignoniaceae.

According to Herzog [3] *Jacaranda cuspidifolia* occurs in the vicinity of Santiago and San Jose and in the hill country of Velasco and a second species is found in the broken woods along Rio Piraï and Rio Yapacani, all localities in eastern Bolivia.

Holotype.—Cat. No. 35116, U.S.N.M.

[1] Ettingshausen, C. von. Die tertiäre Flora von Häring in Tirol, 1855, p. 59, pl. 20, figs. 12–20.

[2] Schenk, A., Palaeophytologie, 1890, p. 779.

[3] Herzog, Th., Pflanzenformationen Ost Bolivias, vol. 44, 1910.

Order RUBIALES.

Family RUBIACEAE.

Genus RUBIACITES Weber.

RUBIACITES NUMMULARIOIDES, new species.

Plate 18, fig. 15.

Description.—Leaves small, ovate, or broadly elliptical in outline, relatively long petiolate, widest in the middle, with a somewhat narrowed rounded tip and a broadly cuneate base. Margins entire. Texture coriaceous. Length, about 4 mm. Maximum width, about 3 mm. Petiole stout, curved, about 1.5 mm. in length. Midrib stout. Secondaries thin, about three subparallel, openly camptodrome pairs. Tertiaries obsolete.

These small leaves are somewhat suggestive of some species of Celastraceae, but upon the whole their closest affinities appear to be with several existing genera of Rubiaceae, and they are consequently referred to the form genus *Rubiacites* proposed by Weber for Rubiaceous leaves of uncertain generic affinity. Ignoring the exclusively herbaceous genera comparisons may be made with various existing species of *Anisomeris* Presl, *Palicourea* Aublet, and *Coprosma* Forster. None of these genera are recorded as fossils. *Anisomeris* comprises about 25 species of shrubs ranging from Venezuela to Paraguay, but chiefly Brazilian. *Coprosma* comprises about 40 species of shrubs and small trees mostly oriental and extending from Java to New Zealand and in Oceanica to Hawaii but found also on Juan Fernandez and in Chile. *Palicourea* comprises over 100 species of shrubs confined to tropical America and ranging from Mexico and the Antilles to southern Brazil.

Holotype.—Cat. No. 35117, U.S.N.M.

Order CAMPANULALES.

Family COMPOSITAE.

Genus CYPSELITES Heer.

CYPSELITES POTOSIANUS, new species.

Plate 18, fig. 16.

Description.—A linear, cylindrical achene with a corona of pappus distad. Surface with about 10 longitudinal ribs. Length, about 3 mm. Diameter, 1.5 mm. This undoubtedly represents the fruit of some species of Compositae of uncertain generic relationship. It is represented in the collections by two good specimens and fragments of others and is referred to the form-genus *Cypselites* to which Heer has referred a variety of similar remains from the Miocene of Switzerland.

Holotype.—Cat. No. 35118, U.S.N.M.

INCERTAE SEDIS.

CARPOLITHUS ENGELHARDTI, new name.

Plate 18, fig. 17.

Carpolites ovoideus ENGELHARDT, Sitz, Naturw. Gesell. Isis in Dresden, 1894, Abh. 1, p. 13, pl. 1, fig. 58 (not Corda or Goeppert).

Description.—An elliptical lenticular seed about 9 mm. in diameter and with a smooth surface, probably representing the seed of some leguminous tree, but of uncertain generic affinity. There is a single characteristic specimen in the present collection. Engelhardt's name was used by Corda in 1841 for a Paleozoic fruit and again by Goeppert in 1845 for another Paleozoic fruit, and both have been taken up by later authors, so that the name of the Potosi form has been changed as a slight token to M. Engelhardt, its original describer.

Holotype.—Cat. No. 35119, U.S.N.M.

CARPOLITHUS, species No. 1.

Plate 18, fig. 19.

A compressed seed or fruit about 7 mm. long and 5 mm. wide with the hilum at one side and surrounded by a narrow marginal wing. Possibly referable to the Aceraceae.

Cat. No. 35121, U.S.N.M.

CARPOLITHUS, species No. 2.

Plate 18, fig. 20.

A fruit consisting of five spherical nutlets, each about 4 mm. in diameter.

Cat. No. 35122, U.S.N.M.

CARPOLITHUS, species No. 3.

Plate 18, fig. 21.

A small, obovate, somewhat compressed seed with three longitudinal oblique ridges on each face, rounded distad and pointed proximad, one margin nearly straight and the other full and rounded. About 5 mm. long and 3 mm. wide. Probably corresponds to the unnamed seed figured from Potosi by Britton in his figure 78.

Cat. No. 35138, U.S.N.M.

CARPOLITHUS, species No. 4.

Plate 18, fig. 22.

A small, somewhat compressed obovate seed longitudinally lined proximad, about 2 mm. long and 1 mm. in maximum width.

Cat. No. 35123, U.S.N.M.

CARPOLITHUS, species No. 5.

Plate 18, fig. 23.

A fruit subglobular above, with a long stout peduncle, suggestive of the Lauraceae. Length, about 7 mm. Maximum width, about 2.5 mm.

Cat. No. 35124, U.S.N.M.

ANTHOLITHUS QUINQUEPARTITA Engelhardt.

Antholithus quinquepartita Engelhardt, Sitz. Naturw. Gesell. Isis in Dresden, 1894, Abh. 1, p. 13, pl. 1, fig. 57.

A small five parted calyx was described under the above name by Engelhardt without any suggestion as to its botanical affinity. No specimens are present in the collections studied by me. In appearance it suggests the Anacardiaceae or Celastraceae.

SPINED STEM.

Plate 18, fig. 18.

There are such a variety of unrelated plants in the modern flora of the tropics, including ferns, various monocotyledons and numerous dicotyledons, that possess slender spined stems like the small fragment figured that it is a hopeless task to even pass them in review. As an additional element in the Potosi flora this specimen deserves to be placed on record.

Cat. No. 35120, U.S.N.M.

EXPLANATION OF PLATES.

Plate 15.

Fig. 1. *Polystichum bolivianum* Berry.
2. *Podocarpus fossilis* Engelhardt.
3, 4. *Festuca*, species.
5. *Phragmites*, species.
6, 7. *Myrica banksioides* Engelhardt.
8. *Ruprechtia braunii* Engelhardt.
9. *Carpolithus viornaformis* Berry.
10. *Capparis multinervis* Engelhardt.
11. *Escallonia wendtii* Britton.
12. *Weinmannia brittoni* Engelhardt.
13. *Weinmannia potosina* (Britton).
14, 15. *Acacia uninervifolia* Engelhardt.
16, 17, 18. *Acacia dimidiato-cordata* Engelhardt.
19. *Inga ochseniusi* Engelhardt.
20. *Pithecolobium brittonianum* Berry.
21. *Mimosa arcuatifolia* Engelhardt.
22. *Mimosites engelhardti* Berry.
23–29. *Calliandra obliqua* Engelhardt.
30. *Enterolobium grandifolium* Engelhardt.
31. *Enterolobium parvifolium* Engelhardt.
32–34. *Cassia singewaldi* Berry.

PLATE 16.

FIG. 1. *Cassia rigidulifolia* Engelhardt.
2, 3, 4. *Cassia wendtii* Britton.
5, 6. *Cassia membranacea* Engelhardt.
7, 8. *Cassia ligustrinaformis* Berry.
9. *Cassia cultrifoliaformis* Berry.
10, 11. *Cassia cristoides* Engelhardt.
12, 13. *Cassia chrysocarpoides* Engelhardt.
14. *Caesalpinia gmehlingi* Engelhardt.
15. *Caesalpinia sessilifolioides* Berry.
16. *Caesalpinites potosianus* Berry.
17. *Copaifera potosiana* Berry.
18. *Copaifera corocoriana* Berry.

PLATE 17.

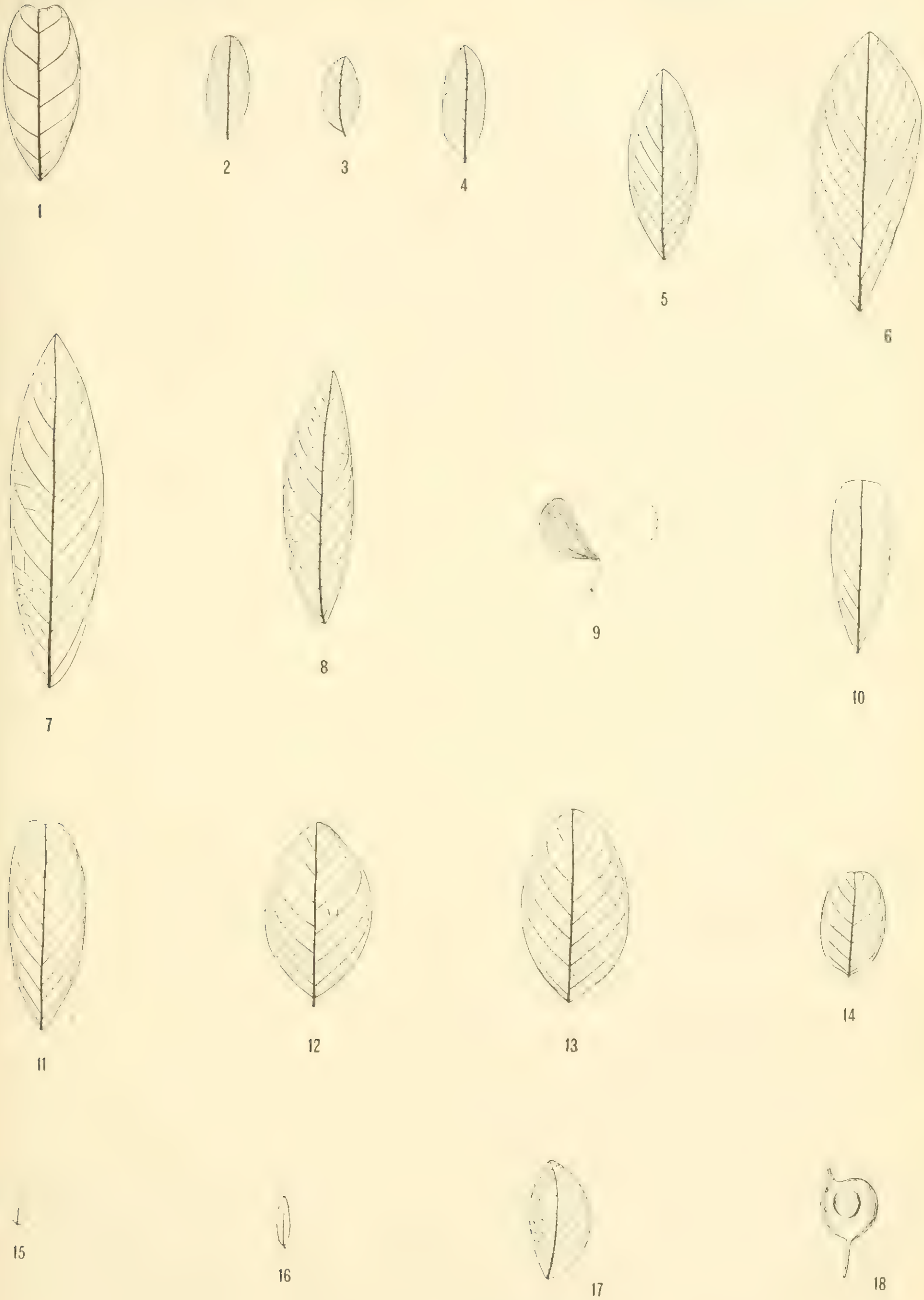
FIGS. 1, 2. *Bauhinia potosiana* Berry.
3. *Peltophorum membranaceum* Engelhardt.
4, 5. *Amicia antiqua* Britton.
6. *Machaerium eriocarpoides* Engelhardt.
7. *Machaerium milleri* Berry.
8. *Dalbergia potosiana* Berry.
9. *Dalbergia* (?) *antiqua* Engelhardt.
10, 11. *Drepanocarpus franckei* Engelhardt.
12. *Aeschynomene bolivianum* (Engelhardt).
13. *Sweetia tertiaria* Engelhardt.
14. *Lonchocarpus obtusifolius* Engelhardt.
15, 16, 17. *Platypodium potosianum* Engelhardt.

PLATE 18.

FIG. 1. *Leguminosites*, species.
2, 3. *Porlieria tertiaria* Britton.
4, 5. *Passiflora canfieldi* Britton.
6. *Myrteola potosiana* Berry.
7. *Terminalia singewaldi* Berry.
8, 9. *Terminalia antiqua* Britton.
10, 11, 12. *Cuphea antiqua* Britton.
13. *Apocynophyllum potosianum* Berry.
14. *Jacaranda potosina* Berry.
15. *Rubiacites nummularioides* Berry.
16. *Cypselites potosianus* Berry.
17. *Carpolithus engelhardti* Berry.
18. *Spined stem.*
19. *Carpolithus*, species No. 1.
20. *Carpolithus*, species No. 2.
21. *Carpolithus*, species No. 3.
22. *Carpolithus*, species No. 4.
23. *Carpolithus*, species No. 5.

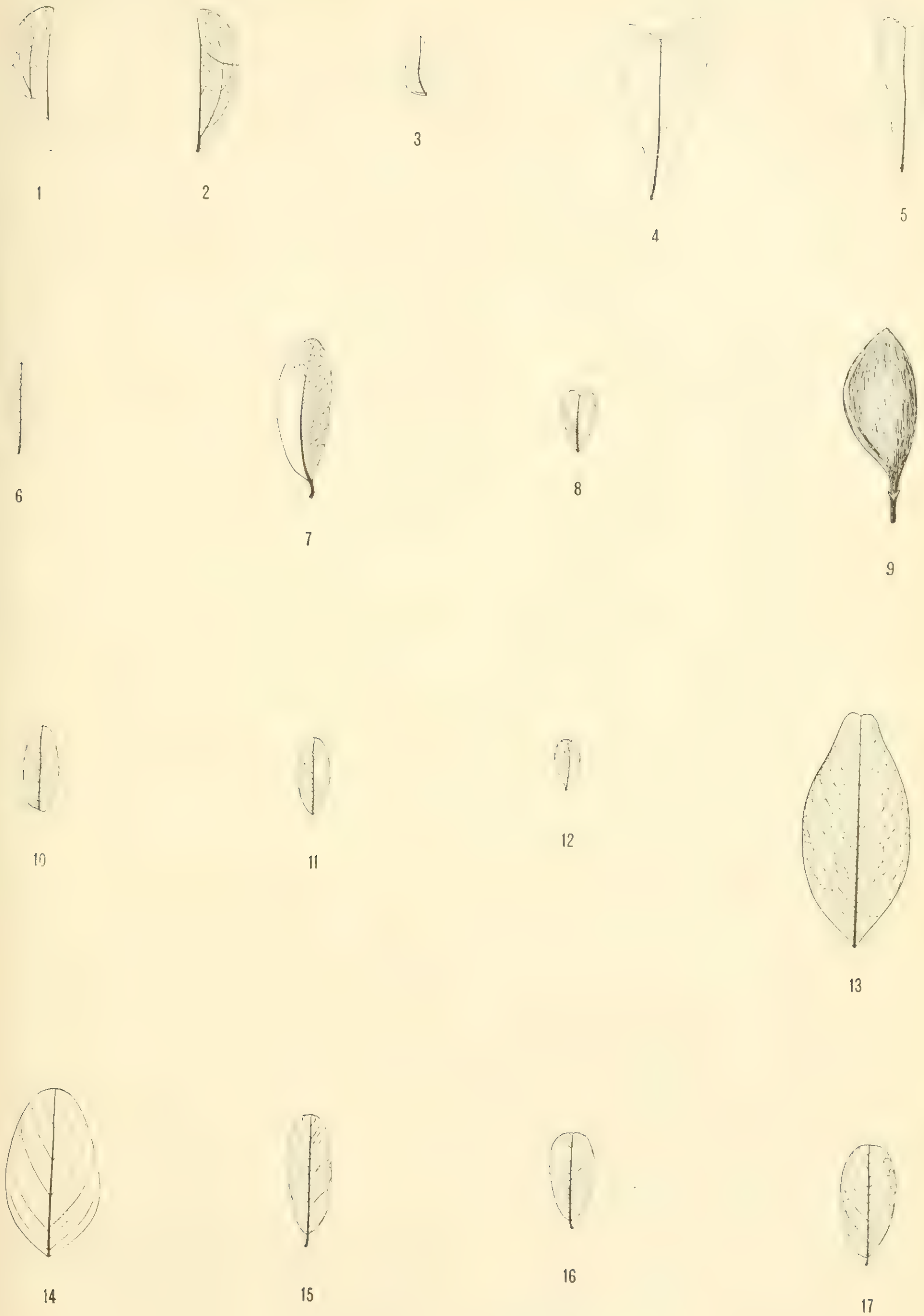
FOSSIL PLANTS FROM BOLIVIA

FOR EXPLANATION OF PLATE SEE PAGE 163



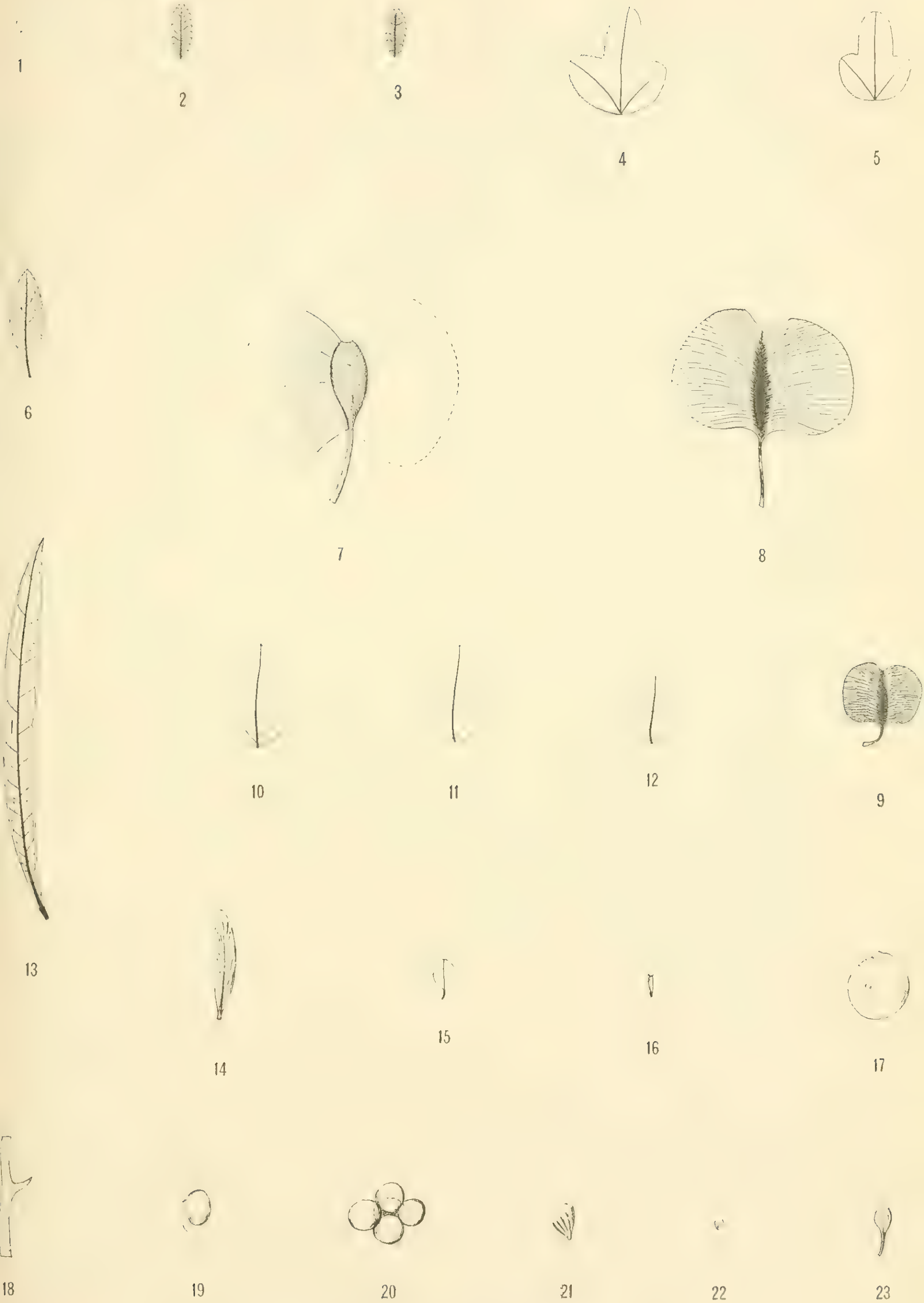
FOSSIL PLANTS FROM BOLIVIA

FOR EXPLANATION OF PLATE SEE PAGE 164



FOSSIL PLANTS FROM BOLIVIA

For explanation of plate see page 164



FOSSIL PLANTS FROM BOLIVIA

FOR EXPLANATION OF PLATE SEE PAGE 164

A REVIEW OF THE SUBSPECIES OF THE LEACH PETREL, OCEANODROMA LEUCORHOA (VIEILLOT).

By Harry C. Oberholser,

Of the Biological Survey, United States Department of Agriculture.

Notwithstanding the considerable attention that has been paid to the petrels of the *Oceanodroma leucorhoa* group, the last word has evidently not yet been said on the subject. Nor do we consider that all points in this difficult case are settled by the present investigation, which we undertook in connection with the identification of the specimens of this species in the Biological Survey collection; but the following notes on the status of the different forms of *Oceanodroma leucorhoa* seem worthy of presentation in print while we are waiting for more material to clear up the remaining uncertainty concerning their geographic distribution.

The latest author to discuss the relationships of these birds[1] recognized two forms—*Oceanodroma leucorhoa leucorhoa* from the Atlantic Ocean, Bering Sea, and the Aleutian Islands, and *Oceanodroma leucorhoa kaedingi* from the Pacific coast of North America from southern Alaska southward. This conclusion, however, was arrived at apparently without examination of the type series of *Oceanodroma leucorhoa kaedingi*.

For the present comparisons we have had available the collections of the United States National Museum, including that of the Biological Survey of the Department of Agriculture, and also that of the Carnegie Museum, for which last the writer's thanks are due Mr. W. E. C. Todd. This material comprises altogether 158 specimens, representing nearly all parts of the North American range of the species, and includes the type series of *Oceanodroma kaedingi* Anthony, with, of course, the type, and also the types of *Oceanodroma beali* Emerson and *Oceanodroma beldingi* Emerson. All measurements have been taken in millimeters, and otherwise as in the writer's paper on *Butorides virescens*.[2]

We are able to recognize three forms of *Oceanodroma leucorhoa*, as set forth below:

OCEANODROMA LEUCORHOA LEUCORHOA (Vieillot).

Procellaria leucorhoa Vieillot, Nouv. Dict. d'Hist. Nat., vol. 25, 1817, p. 422 (maritime parts of Picardy, France).

Procellaria leachii Temminck, Man. d'Ornith., ed. 2, vol. 2, 1820, p. 812 (St. Kilda Island, Scotland).

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[1] Willett, Auk, vol. 32, July, 1915, p. 301.

[2] See Proc. U. S. Nat. Mus., vol. 42, Aug. 29, 1912, p. 533.

P[rocellaria]. Bullockii FLEMING, Hist. Brit. Anim., 1828, p. 136 (St. Kilda Island, Scotland; based on the same specimen as *Procellaria leachii* Temminck).

Th[alassidroma]. scapulata KITTLITZ, Denkwürd. Reise Russ. Amer. Micrones. und Kamts., vol. 2, 1858, p. 191 (Pacific Ocean off the coast of Japan, in latitude 37° N.; longitude 148° 30′ E.).

Subspecific characters.—Size large; plumage sooty brown, lighter below; head slightly plumbeous; rump white; and tail much forked.

Measurements.—Male:[1] Wing, 145–157 (average, 152.9) mm.; tail, 77.5–88 (84.8); exposed culmen, 16–17 (16.4); height of bill at base, 5.8–6.8 (6.2); tarsus, 22–25 (23.8); middle toe without claw, 19.5–22 (20.6); fork of tail, 15.5–23 (19.3). Female:[2] Wing, 148–163 (average, 155.6) mm.; tail, 80–90 (85.8); exposed culmen, 15–17.1 (16.1); height of bill at base, 6–6.8 (6.3); tarsus, 23–25.8 (24.1); middle toe without claw, 18.8–22 (20.6); fork of tail, 15.5–26.5 (19.7).

Type-locality.—Maritime parts of Picardy, France.

Geographic distribution.—North Atlantic Ocean and North Pacific Ocean: breeds from southern Greenland and Iceland south to Maine and Ireland, and from the Aleutian and Commander Islands to the Kuril Islands. Migrates east to Sicily, south in the Atlantic Ocean to Virginia, the Bermuda Islands, the Equator, and casually even to South Africa; in the Pacific Ocean to Japan and Midway Island.

Remarks.—Petrels of this species from the Aleutian Islands and the middle and western portions of the North Pacific Ocean, including the Commander and Kuril Islands, appear to be slightly darker than birds from the North Atlantic Ocean, but this is probably due to the age of the specimens rather than to any subspecific difference; and since our series does not show them to be satisfactorily different, they must bear the name *Oceanodroma leucorhoa leucorhoa*. A specimen from the Ugashik River on the mainland of Alaska, west of the Alaska Peninsula, taken, December 3, 1881, is apparently also referable to this form.

Average measurements of specimens from the different parts of the range of this subspecies are as follows:

Locality.	Wing.	Tail.	Exposed culmen.	Height of bill at base.	Tarsus.	Middle toe without claw.	Fork of tail.
	mm.	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*
Ten males from northeastern North America..	152.9	84.8	16.4	6.2	23.8	20.6	19.3
Five males from the North Pacific Ocean.....	153.4	84.8	16.0	6.1	24.8	19.5	21.0
Eight females from northeastern North America....................................	155.6	85.8	16.1	6.3	24.1	20.6	19.7
Two females from the North Pacific Ocean...	153.8	84.8	15.7	5.9	25.0	20.3	17.5

Birds of this species evidently become much more brownish and sometimes paler after lying in the cabinet for a long term of years,

[1] Ten specimens, from northeastern North America.
[2] Eight specimens, from northeastern North America.

since fresh birds are usually darker. The more or less plumbeous cast of the plumage is entirely an individual variation, and the complete lack of it is often due to the age of the skin, like the brownish cast above mentioned. The whitish edgings on the secondaries and tertials, used sometimes by authors as a subspecific or specific distinction, are an indication of fresh plumage, for these apparently soon either partially or completely wear away by abrasion of the feathers. The measurements given above bring out the fact that the female of this subspecies, as in all the other forms of the species, averages slightly larger than the male.

The writer has examined 34 specimens of *Oceanodroma leucorhoa leucorhoa*, including, in addition to those from the localities mentioned in the subjoined table of measurements, birds from the Potomac River and from the State of New York, both without date of capture.

Measurements of specimens of Oceanodroma leucorhoa leucorhoa.

U.S.N.M. No.	Sex.	Locality.	Date.	Collector.	Wing.	Tail.	Exposed culmen.	Height of bill at base.	Tarsus.	Middle toe without claw.	Fork of tail.
					mm.	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*
62387 [1]	Male	Grand Menan Island, N. B.	....	H. Herrick	148.5	84	16	6.8	24.1	20.8	15.5
62386 [1]	do	do	....	do	157	84.5	16.5	6.2	22	20	20
93003 [1]	do	Off Nantucket Shoals, Mass.	July 28, 1883	J. E. Benedict.	152	88	16	6	24.5	19.5	21
93007 [1]	do	do	July 27, 1883	do	155	87	17	6	24	22	18
75238 [1]	do	Bank Quereau, North Atlantic Ocean.	Sept. 13, 1878	R. L. Newcomb.	156	87	17	6.5	23	20	23
75242 [1]	do	Sable Island Bank, Nova Scotia.	Sept. 3, 1878	U. S. Fish Commission.	154.5	87	16.2	6	25	21	22.5
75243 [1]	do	do	do	do	145	77.5	16.5	6.1	24	20.2	16
25278 [1]	do	Washington, D. C.	Aug. —, 1842	....	151	85	16.5	6.5	23.3	21	18
1194 [1]	do	do	do	....	155	84.5	16	6	24.8	21	21
94554 [1]	do	Fort Chimo, Ungava, Quebec.	July 12, 1882	L. M. Turner	155	83	16	5.8	23.5	20.5	17.5
65428	do	Attu Island, Alaska.	June 20, 1873	W. H. Dall	151	84	16.5	5.9	25.5	19.2	19.5
192387	Male?	Kiska Island, Alaska.	Sept. 17, 1904	J. H. Egbert	153	87	15.1	5.3	24	19	25.1
211226	Male	Near Midway Island, Pacific Ocean, Lat. 27° N.; Long. 179° E.	Nov. 9, 1907	P. Bartsch	155.5	83	16.5	6.2	25.5	20.1	16.5
211225	do	Near Midway Island, Pacific Ocean, Lat. 27° 20′ N.; Long. 172° 45′ W.	Nov. 5, 19	do	158.5	86	16.2	6.1	24.5	21	22
201457	do	Simushir Island, Kuril Islands, Japan.	June 23, 1904	A. H. Clark.	149	84	15.5	6.8	24.5	18	22
93004 [1]	Female.	Off Nantucket Shoals, Mass.	July 28, 1883	J. E. Benedict.	148	87	17.1	6	25.8	20.5	16
111719 [1]	do	Bird Rocks, Gulf of St. Lawrence, Quebec.	July 9, 1887	W. Palmer	152	80	15	6.7	23.5	19.2	15.5
111718 [1]	do	do	do	do	156	84	16.5	6	23.5	20	17.5
75239 [1]	do	Bank Quereau, North Atlantic Ocean.	Sept. 13, 1878	R. L. Newcomb.	163	90	16	6	24.8	20.3	26.5
12648 [1]	do	Potomac River	—— —, 185–	J. Varden	151.5	87.5	15	6.8	23.5	18.8	20
111858 [1]	do	Off Cape Sable, Nova Scotia.	Aug. 30, 1887	W. Palmer	155	86	17	6.5	23	22	23.5
111765 [1]	do	Penguin Island, Newfoundland.	July 24, 1887	do	158	84	15.5	6	24.5	21.8	17.7

[1] Used in measurement averages on p. 166.

Measurements of specimens of Oceanodroma leucorhoa leucorhoa—Continued.

U.S.N.M. No.	Sex.	Locality.	Date.	Collector.	Wing.	Tail.	Exposed culmen.	Height of bill at base.	Tarsus.	Middle toe without claw.	Fork of tail.
					mm.	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*
108426 [1]	Female.	Fox Islands, Maine	June 19, 1880	M. Hardy	161	88	16.8	6	24	22	20.5
211228	...do...	Near Midway Island Pacific Ocean, Lat. 26° N.; Long. 174° 16′ E.	Nov. 11, 1907	P. Bartsch	150	86	15.4	5.6	24.5	21	17.5
201458	...do...	About 100 miles east of Miedni Island, Commander Islands, Kamchatka.	June 12, 1906	A. H. Clark.	157.5	83.5	16	6.2	25.5	19.5	17.5
93006		Off Nantucket Shoals, Mass.	July 27, 1883	J. E. Benedict.	153	82	16	6.2	24.5	21	15
12857		Bay of Fundy, New Brunswick.		J. R. Willis.	156.5	91	15.8	6.4	24.2	19.1	25
211227		Near Midway Island, Pacific Ocean, Lat. 26° N.; Long. 174° 16′ E.	Nov. 11, 1907	P. Bartsch	154	84	16	5.9	25.7	18.5	16

[1] Used in measurement averages on p. 166.

OCEANODROMA LEUCORHOA BEALI Emerson.

Oceanodroma beali EMERSON, Condor, vol. 8, March 20, 1906, p. 54 (Sitka Bay, Alaska).

Oceanodroma beldingi EMERSON, Condor, vol. 8, March 20, 1906, p. 54 (Netarts Bay, coast of Oregon).

Subspecific characters.—Similar to *Oceanodroma leucorhoa leucorhoa*, but decidedly smaller, particularly the wing, tail, exposed culmen, and middle toe.

Measurements.—Male:[2] Wing, 138–151 (average, 144.8) mm.; tail, 75–84 (80.1); exposed culmen, 14.5–15.2 (14.8); height of bill at base, 5.5–6.5 (5.8); tarsus, 22.5–24 (23.2); middle toe without claw, 17.2–19.8 (18.3); fork of tail, 13–22 (18.2). Female:[3] Wing, 143.5–152 (average, 147.6) mm.; tail, 78.5–84.5 (81.6); exposed culmen, 14.5–15.1 (14.9); height of bill at base, 5.5–6 (5.7); tarsus, 22.1–24.2 (23.1); middle toe without claw, 18–19.5 (18.7); fork of tail, 15–18.8 (17.4).

Type-locality.—Sitka Bay, Alaska.

Geographic distribution.—Coast region of northwestern North America: breeds from southeastern Alaska south to the coast of Oregon; migrates south to the coast of California.

Remarks.—There is apparently no color difference between this race and *Oceanodroma leucorhoa leucorhoa*, nor any appreciable difference in the depth of the fork of the tail, but the present form is sufficiently smaller to warrant subspecific separation; in fact, birds from Washington and Oregon have been commonly referred to *Ocea-*

[2] Eleven specimens, from the coast of Oregon and Washington.

[3] Nine specimens, from the coast of Oregon and Washington.

nodroma leucorhoa kaedingi, but, as shown below, they are certainly not the same as that bird. Specimens from the coast region of Washington and Oregon are most different from *Oceanodroma leucorhoa leucorhoa*, and in present comparisons these have therefore been used as typical. Those from the latter locality form the basis of *Oceanodroma beldingi* Emerson.[1] The birds from the vicinity of Sitka, described by Emerson as *Oceanodroma beali*,[1] do not, however, as supposed by him, differ in color from the birds of Oregon, such difference as was noted by the describer [1] being due to individual variation. Although the birds from Sitka (*Oceanodroma beali*) are, it is true, slightly larger than those from Oregon, the difference is altogether too slight to warrant recognition in nomenclature, and the two supposed races must therefore be united under the name *Oceanodroma beali*, which name has anteriority.

Average measurements of birds from the different parts of the range of this subspecies are added below:

Locality.	Wing.	Tail.	Exposed culmen.	Height of bill at base.	Tarsus.	Middle toe without claw.	Fork of tail.
	mm.	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*
Eleven males from the coast of Washington and Oregon	144.8	80.1	14.8	5.8	23.2	18.3	18.2
Ten males from the vicinity of Sitka, Alaska.	146.7	81.1	15.3	6.0	23.2	18.5	19.2
Nine females from the coast of Washington and Oregon	147.6	81.6	14.9	5.7	23.1	18.7	17.4
Ten females from the vicinity of Sitka, Alaska.	149.0	81.3	15.3	5.9	23.3	18.9	18.7

A nestling taken by Mr. G. Willett (No. 239960, U.S.N.M.) on St. Lazaria Island, Alaska, August 11, 1912, has the body barely covered with down, and is so young that the feathers apparently have just begun to grow. In color it is, above, plain grayish brown, between mouse gray and hair brown; and below, of the same color but darker. The date of this specimen indicates the breeding season of the species, which is further corroborated by a nestling taken on Carroll Island, Washington, on August 10, 1915.

Altogether, 99 specimens of this race have been available. In addition to the localities already mentioned and those included in the table of measurements below, the following localities are represented by specimens:

Neah Bay, Washington; Destruction Island, Washington (July 11, 1915); Chemoluro Island, Alaska (May 24 and 28, 1884; June 21, 1884); Belkofski Island, Alaska (September 10, 1893); and Forrester Island, Alaska (June 23, 1887, July, 1913, June 23 and 29, 1914).

[1] Condor, vol. 8, Mar. 20, 1906, p. 54.

Measurements of specimens of Oceanodroma leucorhoa beali.

Museum and number.	Sex.	Locality.	Date.	Collector.	Total length.[1]	Wing.	Tail.	Exposed culmen.	Height of bill at base.	Tarsus.	Middle toe without claw.	Fork of tail.
					mm.	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*
J. Grinnell 1440	Male	Sitka, Alaska[2]	Aug. 5, 1896	J. Grinnell	203	149.5	81	15.8	....	22.5	18.7	....
U.S.N.M. 240790	do	St. Lazaria Island, Sitka Sound, Alaska.	July 27, 1913	G. Willett	....	146.5	81	15.4	5.5	23.5	18	19
U.S.N.M. 239614	do	do	July 31, 1912	do	194	149.5	80.5	15	6	23.5	18.8	20.2
U.S.N.M. 239595	do	do	do	do	203	141	77.5	16	6.2	24.2	19	18.7
U.S.N.M. 239590	do	do	do	do	208	152	86	15.5	6	23.6	18.8	21.5
U.S.N.M. 239609	do	do	Aug. 1, 1912	do	201	148	85	15	6.8	22.5	18.5	22.8
U.S.N.M. 239599	do	do	do	do	203	148.5	83	14.8	5.8	23.5	18	18.5
U.S.N.M. 239605	do	do	Aug. 2, 1912	do	199	142	78.5	15.1	6	23.8	19	17
U.S.N.M. 239606	do	do	do	do	203	144	81	15	6.3	23	18.5	19.2
U.S.N.M. 239611	do	do	Aug. 11, 1912	do	193	145.5	77	15	5.8	22.2	18	16
H. T. Bohlman 53[3]	do	Netarts, Netarts Bay, Oregon[4]	June 6, 1901	H. T. Bohlman	....	147	82	14.5	6.2	23	19	20
H. T. Bohlman 54[3]	do	Three Arch Rocks, Netarts, Oregon	June 7, 1901	do	....	143	82	15	6.5	22.5	17.5	19
Game Dept. Oreg. 1225[3]	do	do	July 2, 1914	S. G. Jewett	....	145	77	15	5.6	23.7	17.9	13
Game Dept. Oreg. 1261[3]	do	do	July 4, 1914	do	....	147	79.5	14.5	5.9	23.8	18	15.2
U.S.N.M. 157751[3]	do	La Push, Washington	June 19, 1897	R. T. Young	....	147	81	14.8	5.6	23.6	19.8	21
U.S.N.M. 157757[3]	do	do	June 20, 1897	do	....	149	79.5	15	5.5	24	18.5	19
U.S.N.M. 157756[3]	do	do	do	do	....	138	75	15.2	6	23	17.2	17
U.S.N.M. 157753[3]	do	do	do	do	....	139	83	15	6	23	18	18
U.S.N.M. 157760[3]	do	do	June 21, 1897	do	....	144.5	77	14.5	5.5	22.5	19	15
U.S.N.M. 157518[3]	do	Granville, Washington	July 8, 1897	do	....	151	84	14.5	6	23.3	18	21.5
U.S.N.M. 157517[3]	do	do	do	do	....	142	81.5	15	5.5	22.8	18.5	22
U.S.N.M. 239591	Female	St. Lazaria Island, Sitka Sound, Alaska.	July 31, 1912	G. Willett	193	148	78.5	15.1	5.8	24.3	20.3	19
U.S.N.M. 239592	do	do	do	do	194	148.5	82	15.5	6	23.5	18	18
U.S.N.M. 239598	do	do	Aug. 1, 1912	do	197	154	83.5	15.8	6	23	19.5	20
U.S.N.M. 239601	do	do	do	do	197	143	76.5	15	5.5	22.3	18.5	14.5
U.S.N.M. 239607	do	do	Aug. 2, 1912	do	194	147	79	15.5	5.5	23	19	18
U.S.N.M. 240791	do	do	Aug. 2, 1913	do	....	150	81	14.8	5.8	22.8	18.7	19.5
U.S.N.M. 239603	do	do	Aug. 2, 1912	do	197	141	79.5	14.5	6	22.6	18.5	16.2
U.S.N.M. 239608	do	do	Aug. 3, 1912	do	206	152	85	15	6	23.8	18.2	19.5
U.S.N.M. 239612	do	do	Aug. 11, 1912	do	210	155	84.5	16.5	6.5	24.5	18.8	22
U.S.N.M. 239613	do	do	do	do	202	151.5	83	15.3	6	23.5	19.5	19.8
H. T. Bohlman 13[3]	do	Puffin Rock, Three Arch Rocks, Netarts, Oregon.	June 6, 1901	H. T. Bohlman	....	148	80	15	5.5	22.1	18	17
Game Dept. Oreg. 1257[3]	do	Three Arch Rocks, Netarts, Oregon	July 2, 1914	S. G. Jewett	....	152	84.5	14.8	6	23.8	19.5	17.8
U.S.N.M. 157750[3]	do	La Push, Washington	June 19, 1897	R. T. Young	....	150.5	83	15	5.5	23.5	19	15.5
U.S.N.M. 157752[3]	do	do	June 20, 1897	do	....	146	78.5	15.1	5.5	23	19	17.5
U.S.N.M. 157758[3]	do	do	do	do	....	148	82	14.8	5.8	24.2	18	18.3
U.S.N.M. 157754[3]	do	do	do	do	....	145	82	14.9	6	22.3	18	15
U.S.N.M. 157757[3]	do	do	do	do	....	150	81	15	5.5	22.8	19	18.7
U.S.N.M. 157755[3]	do	do	do	do	....	145	80	14.5	5.8	23	19.5	18.8
U.S.N.M. 157761[3]	do	do	June 21, 1897	do	....	143.5	83	15.1	5.5	23.2	18.1	18

[1] Measured in the flesh by the collector. [2] Type of *Oceanodroma beali* Emerson. [3] Used in measurement averages on p. 168. [4] Type of *Oceanodroma beldingi* Emerson.

OCEANODROMA LEUCORHOA KAEDINGI Anthony.

Oceanodroma kaedingi ANTHONY, Auk, vol. 15, No. 1, January, 1898, p. 37 ("at sea near Guadalupe Island, Lower California").

Subspecific characters.—Similar to *Oceanodroma leucorhoa beali*, but decidedly smaller, especially the wing, tail, tarsus, and middle toe, the greatest difference appearing in the shortness of the tail; tail much less forked; and pileum more distinctly plumbeous.

Measurements.—Male:[1] Wing, 137–145 (average, 140.4) mm.; tail, 66.5–74.5 (71.1); exposed culmen, 12.8–15 (13.9); height of bill at base, 4.5–6 (5.4); tarsus, 20–21.5 (20.6); middle toe without claw, 15.3–17.2 (16.5); fork of tail, 9.8–17.5 (13.6). Female:[2] Wing, 138–145.5 (average, 142.6) mm.; tail, 67.5–77 (72.4); exposed culmen, 13.5–14 (13.9); height of bill at base, 5–6 (5.5); tarsus, 19.5–21.3 (20.7); middle toe without claw, 15–17.8 (16.4); fork of tail, 10–18.5 (12.6).

Type-locality.—Pacific Ocean off the coast of northern Lower California, in latitude 31° N.; longitude 117° W.

Geographic distribution.—The Pacific coast and islands of Lower California, south to Clarion and Socorro Islands in the Revillagigedo group, Mexico, and north probably also to southern California.

Remarks.—This race is similar to *Oceanodroma leucorhoa leucorhoa*, but in size differs decidedly more from the typical subspecies than it does from *Oceanodroma leucorhoa beali*. Although the depth of the forking of the tail varies somewhat, as may be seen in the appended table of measurements, it is much less in *Oceanodroma leucorhoa kaedingi* than in either of the two other subspecies, and is an excellent character for distinguishing the present race. Although *Oceanodroma leucorhoa beali* is of the same color as *Oceanodroma leucorhoa leucorhoa*, the present form seems to differ in the more distinctly plumbeous shade of the pileum, which the excellent series at our disposal shows to be fairly constant. As may be seen by the above-given characters, *Oceanodroma leucorhoa kaedingi* is much more different from either *Oceanodroma leucorhoa leucorhoa* or *Oceanodroma leucorhoa beali* than the two latter are from each other, but it is undoubtedly only a subspecies, since its characters intergrade individually with those of *Oceanodroma leucorhoa beali*.

All the specimens of *Oceanodroma leucorhoa kaedingi* at present known have been taken at sea near Guadalupe Island, Lower California, or off the coast of northern Lower California, or in the region southward to the Revillagigedo Islands. Its breeding ground is not definitely known, but may be assumed to be some of the islands within this area. However, it may be a breeding bird on the islands off central and southern California, as birds of this species from the

[1] Seventeen specimens, from the Pacific Ocean, off the coast of northern Lower California.
[2] Eight specimens, from the Pacific Ocean, off the coast of northern Lower California.

Farallon Islands, California, have not been available in the present connection.

Among the birds examined, not only of this form, but of the two other subspecies of *Oceanodroma leucorhoa* as well, are specimens in which the middle upper tail-coverts are more or less extensively, sometimes wholly, brown; and in the series of *Oceanodroma leucorhoa kaedingi* are four specimens, males and females, that have very little white on the upper tail-coverts, this being restricted to the outer vanes of the shortest lateral feathers. This variation is apparently individual, but it may be a lingering mark of the juvenal plumage.

Twenty-five specimens of this form have been examined, all of which are included in the following table of measurements:

Measurements of specimens of Oceanodroma leucorhoa kaedingi.

Carnegie Museum No.	Sex.	Locality.	Date.	Collector.	Wing.	Tail.	Exposed culmen.	Height of bill at base.	Tarsus.	Middle toe without claw.	Fork of tail.
			1897		mm.	mm.	mm.	mm.	mm.	mm.	mm.
22210[1]	Male...	Pacific Ocean, near Guadalupe Island, Lower California, Lat. 28° 35′ N.; Long. 118° 31′ W.	July 18	A. W. Anthony.	145	70	14.5	5.2	21	16	11.8
22219[1]	...do....	Pacific Ocean, off northern Lower California, Lat. 31° N.; Long. 117° W.[2]	July 25	.....do.......	144	74.5	14.5	4.5	20.5	15.5	16
22228[1]	...do....	.....do....................	...do.....	.....do.......	137.5	70	14.5	5.1	20	16.2	14
22226[1]	...do....	.....do....................	...do.....	.....do.......	139	72	13.8	5.8	20	17	15.2
22221[1]	...do....	.....do....................	...do.....	.....do.......	140	71	13.8	6	20.5	17.2	14
22232[1]	...do....	.....do....................	...do.....	.....do.......	143	70	14	5.5	21	15.8	13
22225[1]	...do....	.....do....................	...do.....	.....do.......	138	70	13	6	21	16	15
22237[1]	...do....	.....do....................	...do.....	.....do.......	140	71	....	5.2	20.5	17	12
22222[1]	...do....	.....do....................	...do.....	.....do.......	141	69	12.8	5.5	21	17	10.5
22216[1]	...do....	.....do....................	...do.....	.....do.......	139.5	66.5	14.3	5.1	20	17.2	9.8
22213[1]	...do....	.....do....................	...do.....	.....do.......	140.5	73	13.8	5.5	20.8	16	14.8
22238[1]	...do....	.....do....................	...do.....	.....do.......	137	71	14	5	20.2	17	16.3
22223[1]	...do....	.....do....................	...do.....	.....do.......	138	71.5	13.5	5.5	20.5	17	13
22236[1]	...do....	.....do....................	...do.....	.....do.......	142	72.5	14.5	5.2	21	16.8	14.7
22214[1]	...do....	.....do....................	...do.....	.....do.......	139.5	73	13	6	21.5	17	11.8
22231[1]	...do....	.....do....................	...do.....	.....do.......	143	74	15	5.8	21	17.2	17.5
22217[1]	...do....	.....do....................	...do.....	.....do.......	140	69	13.5	5.2	20	15.3	12.2
22211[1]	Female	Pacific Ocean, near Guadalupe Island, Lower California, Lat. 28° 35′ N.; Long. 118° 30′ W.	July 18	.....do.......	143	67.5	14	5.1	21	17.3	13
22229[1]	...do....	Pacific Ocean, off northern Lower California, Lat. 31° N.; Long. 117° W.	July 25	.....do.......	144	70	14	5.5	21.3	17.8	11.7
22227[1]	...do....	.....do....................	...do.....	.....do.......	140	73.5	14	6	21	17.2	11.5
22218[1]	...do....	.....do....................	...do.....	.....do.......	145	77	14	5.2	21	16	11
22234[1]	...do....	.....do....................	...do.....	.....do.......	145.5	75.5	13.7	5.8	19.8	15.8	18.5
22233[1]	...do....	.....do....................	...do.....	.....do.......	144	74	13.5	5.1	19.5	15	13
22224[1]	...do....	.....do....................	...do.....	.....do.......	138	69	13.8	5	21	16	10
22235[1]	...do....	.....do....................	...do.....	.....do.......	141	72.5	14	6	21	16	12.3

[1] Used in measurement averages on p. 171.
[2] Type of *Oceanodroma kaedingi* Anthony.

DESCRIPTION OF HYMENOCEPHALUS TENUIS, A NEW MACRUROID FISH FROM THE HAWAIIAN ISLANDS.

By Charles H. Gilbert and Carl L. Hubbs,
Of Stanford University, California.

During the course of their studies on the macruroid fishes of the Japanese and Philippine faunas, the authors have reexamined several of the Hawaiian species of this group, resulting in the discovery of an undescribed species of *Hymenocephalus*, widely different from any of the described forms. The description of this new species forms the basis of the present paper.

HYMENOCEPHALUS TENUIS, new species.

Hymenocephalus striatulus Gilbert, Bull. U. S. Fish Comm., 1903 (1905), sec. 2, p. 665 (in part, including only the specimen from Station 3920).

Type-specimen.—75 mm. long to end of tail, 20 mm. long to anus; dredged off the southern coast of Oahu, one of the Hawaiian Islands, at *Albatross* station 3920; depth, 265 to 280 fathoms; bottom temperature, 44.6 Fahr.; Cat. No. 78177, U.S.N.M.

In its form this species differs from all others, being the only one in which the head is not compressed. The width of the cylindrical head is half its length and is just equal to its greatest depth, which is also the greatest depth of the body. Preocular length of snout, 1.3 in orbit, 3.6 in length of head. The length of the orbit is a little greater than its vertical height, and is contained 1.15 times in the postorbital, or 2.65 times in the entire length of the head. The hinder margin of the pupil is equidistant from the tip of the snout and from the end of the opercle. The sides of the interorbital area are strongly concave; its least width is contained 6 times in the head; the least suborbital width is about 0.3 the orbital length. The barbel is not quite half the length of the orbit. The upper jaw extends from below the front of the nasal fossa backwards and slightly downwards almost to below the hinder margin of the orbit. Length of upper jaw 2.25 in that of head. The gillrakers are tubercular and are fewer in number than in any other species, there being only about 10 in the similar double series of the outer two arches. They are scarcely less rudimentary than in the species of the genera related to *Coryphaenoides* and *Lionurus*. The structure of the head is comparatively firm.

The distance between anus and base of ventral fins equals that between tip of snout and hinder margin of pupil, and is a little longer than the distance from base of ventral to fold of the gill-membranes where they cross the isthmus. Laterally the gill-membranes are free from the isthmus.

The lens-like structure before the anus is longitudinally elliptical in outline, and is a little longer than the similar but more nearly circular organ on the midventral line before the ventral fins.

The scales are largely lost, but several are retained along the sides and on the belly. They are all smooth and are marked with numerous concentric striae. About three rows of scales seem to separate the lateral line from the front of the first dorsal fin.

The distal portion of the second dorsal spine is weakly but distinctly denticulate, as in no other described species of the genus. The base of the first dorsal fin is contained 1.8 times in the interdorsal space, 1.3 times in the postocular length of the head. The rays of the paired fins are slender and weak; the outer ventral ray extends not quite to the anus and is contained 1.7 in the head; the inner ventral rays are shorter than the orbit and extend but halfway to the anus. The first anal rays are also shorter than the orbit. There are 8 rays in the ventral fin.

The ground color is yellowish brown, darkest about the base of the first dorsal fin; a median silvery streak is evident along the tail; the sides of the head and trunk to above the pectoral base are bright silvery in color, separated by an indistinct darker streak from the color of the back. The region before the ventral fins is blackish, with coppery luster near the isthmus. The head is marked by a dark streak along the front of the snout, one along the inner margin of the jaw next the teeth, and one along the crest forming the side of each mandibular ramus. The gular membrane is crossed regularly by fine parallel black lines, which are not separated by silvery streaks and are not to be confounded with the true striae of the abdominal region, which are of rather restricted development in this species. These fine striae extend forward from immediately above the ventral base, fading out along the sides of the isthmus. Behind the ventrals, they can barely be distinguished for a short distance. There are none immediately in front of the ventral base, and none immediately below the bases of the pectorals. The abdominal region is punctulate with very large chromatophores with pearly centers. The sides of the trunk above the silvery region are finely and densely punctulate. The chromatophores on the tail are coarser and sparser, occurring largely in oblique rows which follow the grooves between the myotomes A similar metameric arrangement is apparent in the squamation of the tail. The buccal and branchial cavities are wholly lined with silvery or white, with the exception of a few scattered spots on the inner surface of the opercles.

Only the one specimen is known. It is evidently immature but can not represent the young stage of any other species, as we have examined much smaller specimens of numerous other species and find that they do not in the least resemble this form.

BIRDS COLLECTED BY DR. W. L. ABBOTT ON VARIOUS ISLANDS IN THE JAVA SEA.

By Harry C. Oberholser,

Of the Biological Survey, United States Department of Agriculture.

The present paper contains the ornithological results of Dr. W. L. Abbott's visits to four islands in the Java Sea.

The writer has to thank Doctor Abbott for most of the physiographic facts concerning these islands; and Dr. Charles W. Richmond, assistant curator of birds in the United States National Museum, for other help.

The measurements used are all given in millimeters, and have been taken as in the author's article on *Butorides virescens*.[1] The names of colors are based on Mr. R. Ridgway's Color Standards and Color Nomenclature.

I. SOLOMBO BESAR ISLAND.

Solombo Besar Island, Solombo Island, or Masolombo Besar, as it is variously called, is situated in the eastern part of the Java Sea. It lies about 90 miles south of Borneo, about 145 miles north of the nearest point of the eastern end of Java, and some 120 miles east of Baweau Island. It is approximately 2 by 4 miles in extent, is of volcanic origin, though now surrounded by a coral reef, and has a low but rather uneven contour, which culminates in a hill some 250 feet in height. The soil is fertile and is extensively cultivated by the resident population. Nearly all the heavy forest has been cleared, and the chief remaining portion is to be found on and about the hill already mentioned. The principal native mammals are rats and flying foxes; and there are also many cattle running wild. Birds in 1907 were abundant and tame, though apparently of few species.

Dr. W. L. Abbott visited this island from December 3 to 6, 1907, and during this time collected 33 specimens of birds, which he sent to the United States National Museum. These represent 10 species, 8 of which are hereinafter described as new forms. One of these new birds belongs to an apparently undescribed endemic genus. Also a species of megapode was found on the island but not obtained.

[1] Proc. U. S. Nat. Mus., vol. 42, 1912, p. 533.

No birds have heretofore been reported from Solombo Besar, and Doctor Abbott's brief stay probably has not nearly exhausted its ornithological possibilities. Judging from the admittedly inadequate basis offered by the few species of birds catalogued below, this island appears to be faunally more closely related to Java and Timor than to Borneo.

Family FALCONIDAE.

CERCHNEIS MOLUCCENSIS MICROBALIA, new subspecies.

Subspecific characters.—Similar to *Cerchneis moluccensis occidentalis*, from Celebes, but with the blackish brown spots and bars of back, scapulars, and upper surface of wings decidedly smaller; blackish streaks on pileum somewhat narrower; and blackish markings of lower surface smaller.

Description.—Type, adult male, No. 181449, U.S.N.M.; Solombo Besar Island, Java Sea, March 12, 1907; Dr. W. L. Abbott. Upper surface auburn, rather lighter on rump and pileum, the latter narrowly streaked with black, the cervix, back, and rump with subtriangular spots or bars of black, these most numerous on cervix, largest on the back and smallest on the rump; upper tail-coverts neutral gray, the tips more or less washed with auburn; tail light neutral gray above, with a broad band of black near its end, and a rather wide tip of partly grayish, partly whitish, light-pinkish cinnamon; tail below similar, but paler; wing-quills fuscous black, the outer webs, excepting the outermost two primaries, conspicuously spotted basally with auburn, the inner webs barred with the same color, which, on the inner edge of the feathers, passes into white, the amount of auburn decreasing toward the outer quills until on the outermost the bars are nearly all white; primary coverts with alternating broad bars of fuscous black and auburn; remaining wing-coverts auburn, with subtriangular spots or narrow bars of black; subocular region pale grayish, finely streaked with black; lower parts cinnamon, rather duller anteriorly, the jugulum and sides of throat heavily streaked with fuscous black, the breast and upper abdomen thickly strewn with roundish or subtriangular spots of fuscous black, the thighs and crissum immaculate; lower wing-coverts white, barred, spotted, and streaked, but rather sparingly, with black and neutral gray; axillars white, but much tinged with auburn and heavily barred with fuscous black and neutral gray; "feet yellow." Total length,[1] 338 mm.; wing, 230; tail, 152; exposed culmen, 19.5; culmen from cere, 15; tarsus, 42.5; middle toe without claw, 29.5.

This bird represents an apparently well-characterized race, with which the birds from Flores and Timorlaut, mentioned by Meyer

[1] Measured in the flesh by the collector.

and Wiglesworth,[1] as well as those from other of the Sunda Islands, are probably identical. It differs from *Cerchneis moluccensis moluccensis* and *Cerchneis moluccensis orientalis* in paler under surface and cheeks, more purely whitish under wing-coverts, and additionally as from *Cerchneis moluccensis occidentalis*.[2] The specimen obtained by Doctor Abbott, taken on December 3, 1907, is molting a few of its contour feathers, but neither remiges nor rectrices.

With the present addition there are now four subspecies of *Cerchneis moluccensis moluccensis*, the names and geographic ranges of which are as follows:

Cerchneis moluccensis moluccensis (Jacquinot and Pucheran).—Moluccan islands of Goram, Ceram, Amboina, Buru, Peling, and doubtless other intervening and adjacent islands.

Cerchneis moluccensis orientalis (Meyer and Wiglesworth).—Moluccan islands of Gilolo (Halmahera), Morotai, Ternate, Tidore, Mareh, Batchian, and probably neighboring islands.

Cerchneis moluccensis occidentalis (Meyer and Wiglesworth).—Celebes and Borneo.

Cerchneis moluccensis microbalia Oberholser.—West to Java; south to Lombok, Sumba, Flores, Letti, and Timor; east to Timorlaut; and north to Solombo Besar Island.

Family MEGAPODIIDAE.

MEGAPODIUS DUPERRYII GOULDII Gray.

Megapodius gouldii GRAY, Proc. Zool. Soc. Lond., 1861, p. 290 (Lombok Island, East Indies).

Doctor Abbott obtained no specimens of this bird, but found unmistakable evidences of the occurrence of megapodes, doubtless this species, on the island. This record is interesting as marking the extreme western limit of the recorded range of this species.

Family CHARADRIIDAE.

PLUVIALIS DOMINICA FULVA (Gmelin).

[*Charadrius*] *fulvus* GMELIN, Syst. Nat., vol. 1, pt. 2, 1789, p. 687 (Tahiti Island, Society Islands).

One immature female, taken, December 5, 1907. Length (in flesh), 253 mm.

Family TRERONIDAE.

MUSCADIVORES ROSACEUS ZAMYDRUS, new subspecies.

Subspecific characters.—Similar to *Muscadivores rosaceus rosaceus*, from the island of Timor, but decidedly darker above, with the me-

[1] Birds Celebes, vol. 1, 1898, p. 80.
[2] See p. 178.

tallic sheen on interscapular region and posterior parts more evident (less overlaid with gray).

Description.—Type, adult male, No. 181434, U.S.N.M.; Solombo Besar Island, Java Sea, December 6, 1907; Dr. W. L. Abbott. Top and sides of head light grayish vinaceous, paling somewhat on lores and forehead; an incomplete orbital ring whitish; hind neck between light neutral gray and pale neutral gray; back and scapulars metallic dull Indian purple, in places rather dull metallic leaf green, both colors more or less overlaid and dulled by grayish, least so posteriorly; lower back and rump neutral gray, deepening on the shorter upper tail-coverts, and with a sheen of metallic dull Indian purple, this most conspicuous on the upper tail-coverts, where slightly mixed with dull metallic green; longest upper tail-coverts metallic leaf green, with a decided metallic purplish bronze tinge, particularly on the margins of the feathers; rectrices metallic dark dull yellow green, becoming more bronzy marginally, and more bluish medially, especially on terminal portion of some of the feathers; basal and outer portions of inner webs of wing-quills fuscous black, shading on inner margins of primaries and secondaries to fuscous; primaries and secondaries glaucous greenish slate gray on the outer webs, and greenish slate or greenish slate black on the inner and terminal portions of the inner webs, the outer vanes and tips of inner secondaries and tertials becoming more metallic leaf greenish, the tertials with also a tinge of dull Indian purple; primary coverts metallic dusky yellowish green; remaining upper wing-coverts dull metallic leaf green, mixed with dull Indian purple, greenish slate, and greenish slate gray; chin pale pinkish buff, shading into the pale brownish drab of middle of throat; sides of neck anteriorly between light and pale neutral gray, shading posteriorly into pale vinaceous drab; jugulum, breast, and abdomen, pale vinaceous drab; sides and flanks light neutral gray, the latter much washed with pale vinaceous drab; under tail-coverts kaiser brown; lining of wing pale neutral gray.

A fine series of 10 adults shows that this big pigeon from Solombo Besar Island is an easily recognizable subspecies, and apparently hitherto undescribed. The birds of this series exhibit some individual variations, but as a whole are fairly uniform in characters. They vary individually, for the most part, in the metallic color of the upper surface, which in some examples is decidedly purplish, in others green; in the depth of the gray color of nape, and in the color of the lower surface, which in some is much more pinkish than in others, this due, probably at least in part, to adventitious stain. The colors of the soft parts in life are given on the label of a male (No. 181435, U.S.N.M.) as follows: "Iris deep red; eyelids red; bill leaden; cere red purple; feet purple red." None of the specimens show any indications of molt in the wing-quills, and only one (No. 181432, U.S.N.M., December 4, 1907) in the rectrices. Four others (No. 181431, U.S.N.M., December 5, 1907; No. 181434, U.S.N.M., December 6, 1907; No. 181435, U.S.N.M., December 4, 1907; and No. 181436, U.S.N.M., December 3, 1907) have a few pin-feathers on the hind neck, and all but one bird also on the foreneck.

Detailed measurements of all these specimens are as follows:

Measurements of specimens of Muscadivores rosaceus zamydrus.

U.S.N.M. No.	Sex.	Locality.	Date.	Collector.	Total length.[1]	Wing.	Tail.	Exposed culmen.	Tarsus.	Middletoe without claw.
			1907.		*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*
181436	Male	Solombo Besar Island, Java Sea.	Dec. 3	Dr. W. L. Abbott.	420	233	150	20.5	30	36.5
181432	do	do	Dec. 4	do	420	238	154.5	22.5	32	37
181435	do	do	do	do	415	235	150	19	31	37
181437	do	do	do	do	410	239	155	19.5	30	33.5
181439	do	do	do	do	425	242	152.5	21	30.5	33.5
181431	do	do	Dec. 5	do	406	228	147.5	18.5	31	35
181433	do	do	do	do	396	230	144.5	20	31.5	37
181438	do	do	Dec. 6	do	......	230	152.5	19.5	32.5	34.5
181434	do	do.[2]	do	do	415	227	152.5	21.5	30	35
Average of 9 males					413.4	233.6	151	20.2	30.9	35.4
181440	Female	Solombo Besar Island, Java Sea.	Dec. 3	Dr. W. L. Abbott.	405	208	143	19	31	35

[1] Measured in the flesh by the collector. [2] Type.

Family KAKATOIDAE.

KAKATOE PARVULUS ABBOTTI, new subspecies.[3]

Subspecific characters.—In color like *Kakatoe parvulus parvulus*, from the island of Timor, but decidedly larger.

Description.—Type, adult male, No. 181453, U.S.N.M.; Solombo Besar Island, Java Sea, December 4, 1907; Dr. W. L. Abbott. Entire plumage cream white, excepting the long recurved feathers of crest, which are picric yellow; the basal portion of inner webs of wing-quills, and the greater part of the inner webs of the rectrices, which are martins yellow; and the auriculars, which are slightly tinged with the same yellow; "bill and cere black."

This new cockatoo is interesting as marking a new western limit for the genus. Doctor Abbott reported it in hundreds on Solombo Besar. He obtained eight specimens, all adults in full plumage, though somewhat soiled. The principal individual variation consists in the depth and extent of the yellow on the rectrices. Doctor Abbott records the color of the iris as red, and of the bare skin about the eyes as bluish white. Measurements of all the specimens follow.

[3] Named for Dr. W. L. Abbott.

Measurements of specimens of Kakatoe parvulus abbotti.

U.S.N.M. No.	Sex.	Locality.	Date.	Collector.	Total length.[1]	Wing.	Tail.	Exposed culmen.	Culmen from cere.	Tarsus.	Middle toe without claw.
			1907.		*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*
181453	Male	Solombo Besar Island, Java Sea.[2]	Dec. 4	Dr. W. L. Abbott.	420	264	134	37	35	25	34.5
181455	do	do	Dec. 5	do	415	265	137.5	39.5	38	25	37
181451	Male.?	do	Dec. 3	do	395	267	136	36.5	35	23	31
181454	do	do	Dec. 4	do	410	262	133	36	34	25.5	33.5
Average of 4 males					410	264.5	135.1	37.3	35.5	24.6	34.0
181456	Female	Solombo Besar Island, Java Sea.	Dec. 3	Dr. W. L. Abbott.	405	256	134	37	35	24	33
181457	do	do	Dec. 6	do	418	261	139	35	33	23	34.5
181452	"Male?" [= Female]	do	Dec. 4	do	412	256	126	36.5	35	26	34.5
181458	Female?	do	Dec. 6	do	421	253	146	34.8	33	26.5	33
Average of 4 females					414	256.5	136.2	35.8	34	24.9	33.8

[1] Measured in the flesh by the collector. [2] Type.

Family ALCEDINIDAE.

SAUROPATIS CHLORIS CYANESCENS Oberholser.

Sauropatis chloris cyanescens OBERHOLSER, Proc. U. S. Nat. Mus., vol. 52, February 8, 1917, p. 189 (Pulo Taya, off the southeastern coast of Sumatra).

One adult male, No. 181492, U.S.N.M., taken, December 4, 1907. This does not differ from Bawean Island birds. It is in worn plumage, and shows evidence of molt among the contour feathers and rectrices. It measures: Total length (in flesh), 263 mm.; wing, 110; tail, 71.5; exposed culmen, 48; tarsus, 16.

Family CAMPEPHAGIDAE.

PERISSOLALAGE, new genus.[3]

Generic characters.—Similar to *Lalage* Boie, but bill, in both vertical and horizontal aspects, longer and relatively more slender (more turdine); culmen less conspicuously curved, and more sharpely ridged; tail decidedly longer; lower tail-coverts much shorter, covering only about basal one-third of rectrices; spurious (first) primary relatively as well as actually much shorter and narrower; third and fourth (counting from outermost) primaries longest, the second shorter, equal to the fifth and very much longer than the sixth.

Type.—*Perissolalage chalepa*, new species.

PERISSOLALAGE CHALEPA, new species.

Specific characters.—Female similar to same sex of *Lalage nigra* (=*terat*), but the terminal portion of tail-feathers more extensively white; the lesser wing-coverts conspicuously edged with cinnamome-

[3] From περισσός, mirabilis; and Lalage (λαλαγή, loquacitas).

ous; all the other wing edgings more or less strongly tinged with buffy or cinnamomeous instead of being pure white; superciliary stripe narrower and shorter, posteriorly not reaching beyond the auriculars; entire upper surface strongly rufescent brown instead of grayish brown; and even wings and tail more rufescent.

Description.—Type, adult female, No. 181577, U.S.N.M.; Solombo Besar Island, Java Sea, December 4, 1907; Dr. W. L. Abbott. Forehead brussels brown; crown between brussels brown and clove brown; both forehead and crown with rather broad shaft streaks of fuscous black, the crown slightly streaked with buffy whitish, its ground color passing posteriorly into the light olive brown of the back; back and scapulars between olive brown and buffy brown, with narrow, barely discernible, dark clove brown shaft streaks; rump smoke gray with paler terminal bars; upper tail-coverts smoke gray with paler tips, the longest feathers darker, more brownish, with hair brown subterminal bars and grayish white tips; tail fuscous, the two middle feathers narrowly margined on both webs with brownish white, the remaining rectrices with large terminal white areas, these longest on the outer web, and increasing progressively to the outermost pair, which has about one-third of the inner web and two-thirds of the outer web white; wings fuscous, but the whole basal portion of the inner vanes of wing-quills white, this occupying two-thirds or more of the length of each feather on the inner primaries and outer secondaries; quills narrowly margined on exterior webs with creamy white or light buff, this broadest and most buffy on terminal portion of secondaries and tertials; primary coverts narrowly tipped with buffy white; greater wing-coverts narrowly edged and more broadly tipped with the same; median coverts very broadly margined on both sides with light pinkish cinnamon or whitish; lesser coverts also edged broadly on both vanes with whitish, pinkish cinnamon, and cinnamon, leaving, as on the median coverts, only a pointed central area of fuscous; lores olive brown, but much mixed with white; broad postocular stripe brown like the crown; superciliary stripe, sides of head and neck, and entire lower surface, including lining of wings, creamy white, more definitely tinged with cream color on the breast, sides of neck and of body; the flanks, sides of breast and of body somewhat obscurely and irregularly barred with pale mouse gray; thighs mixed light mouse gray, light drab, and dull white; bill (in skin) fuscous, the tip darker, the basal portion of mandible pale brownish. Total length (in flesh),[1] 192 mm.; wing, 90; tail, 81; exposed culmen, 15.5; tarsus, 23; middle toe without claw, 14.5.

Of this remarkably distinct bird Doctor Abbott obtained but a single example, an adult female. It is in process of molting some of the contour feathers, but wing-quills and rectrices seem to be intact. The characters it exhibits preclude its reference to any genus hitherto described.

[1] Measured by the collector.

The adult male will of course prove to be probably a bird of black, white, and gray plumage like the males of the species in the genus *Lalage*.

Family DICRURIDAE.

DICRUROPSIS PECTORALIS SOLOMBENSIS, new subspecies.

Subspecific characters.—Similar to *Dicruropsis pectoralis leucops* from Celebes, but smaller; iris light yellow (adult) or pale brownish gray (immature); hair-like plumes of forehead longer; back duller, less bluish or purplish black; hackles on sides of neck longer and somewhat less purplish (more greenish); posterior lower parts duller, more brownish (less velvety), black, with a less bluish (more greenish) sheen; metallic spots on feathers of throat and breast decidedly more greenish (less bluish).

Description.—Type, adult female, No. 181512, U.S.N.M.; Solombo Besar Island, Java Sea, December 4, 1907; Dr. W. L. Abbott. Upper surface velvety black, with a slight bluish green sheen, the feathers of pileum and some pointed feathers on cervix, shining metallic bluish slate black, and the upper tail-coverts shining metallic dusky yellowish green; tail black, more or less edged with shining metallic dusky yellowish green on exterior vanes of rectrices; wings black, becoming somewhat brownish on tips of primaries and inner margins of all the quills; the exposed portions of all the superior wing-coverts, the tertials, outer webs of secondaries, and outer webs of primaries except distal portion, shining metallic dusky yellowish green; sides of head and neck velvety black, the long pointed feathers of the latter shining metallic dull dusky bluish green; lower surface brownish black, the feathers of lower throat, jugulum, and upper breast with short lanceolate tips of shining metallic dusky dull green, giving to these parts a spotted appearance; lining of wing black, with a greenish or bluish metallic sheen, and a few of the under wing-coverts tipped with white; "iris pale straw yellow."

This race is apparently more nearly like *Dicruropsis pectoralis borneensis* (Sharpe) than like either *Dicruropsis pectoralis pectoralis* or *Dicruropsis pectoralis leucops*, but it differs in its duller, less velvety upper and lower parts, longer and more bluish neck hackles, and possibly also in the color of the iris.

Of the five examples obtained by Doctor Abbott, two, Nos. 181512 and 181515, U.S.N.M., are adults. The three others are somewhat immature, though fully grown, and differ from the adults in still more brownish black posterior surface and duller dorsum. None of the five seem to be in process of molt. The color of the bill and feet is given by the collector as black; of the iris in adult birds as pale yellow or straw yellow, in immature individuals pale brownish gray.

Both *Dicruropsis borneensis* (Sharpe)[1] and *Dicruropsis leucops* (Wallace)[2] seem without doubt to be but subspecies of *Dicruropsis*

[1] *Chibia borneensis* Sharpe, Proc. Zool. Soc. Lond., 1879, p. 246 (Mount Kina Balu, Borneo).

[2] *Dicrurus leucops* Wallace, Proc. Zool Soc. Lond., 1865, p. 478 (Celebes).

pectoralis. Also, *Chibia hottentotta* appears to be generically distinct from the other members of the group, as contended by some recent authors. It has a relatively more slender bill, much longer hair-like frontal plumes, and different wing-formula, the second primary (counting from the outermost) being decidedly longer than the eighth, instead of equal or shorter. As *Chibia hottentotta* is the type of *Chibia* Hodgson, the remaining species will take the generic name *Dicruropsis* Salvadori.[1]

Measurements of the series of the present new subspecies are as follows:

Measurements of specimens of Dicruropsis pectoralis solombensis.

U.S.N.M. No.	Sex.	Locality.	Date.	Collector.	Total length.[2]	Wing.	Tail.	Exposed culmen.	Tarsus.	Middle toe without claw.
			1907.		*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*
181513	Male immature.	Solombo Besar Island, Java Sea.	Dec. 4	Dr. W. L. Abbott.	303	151	131	30	23.8	17.3
181514	...do	...do	Dec. 5	...do	306	150	131	30.5	25	17
181516	Female? [=Male immature.]	...do	...do	...do	304	152	133.5	30.5	25.2	17
Average of 3 males					304	151	131.8	30.3	24.7	17.1
181512	Female	Solombo Besar Island, Java Sea.[3]	Dec. 4	Dr. W. L. Abbott.	296	147.5	130	29	22	16.5
181515	...do	...do	Dec. 6	...do	292	149.5	126.5	28	24	16.5
Average of 2 females					294	148.5	128.3	28.5	23	16.5

Family ARTAMIDAE.

ARTAMUS LEUCORYN AMYDRUS, new subspecies.

Subspecific characters.—Much like *Artamus leucoryn leucoryn*,[4] but paler on upper parts and jugulum.

Description.—Type, adult male, No. 181532, U.S.N.M.; Solombo Besar Island, Java Sea, December 4, 1907; Dr. W. L. Abbott. Pileum and anterior hind-neck dark quaker drab; upper tail-coverts creamy white; remainder of upper surface dark grayish brown, the middle of the back dusky drab; wings and tail sooty black, the outer webs of the secondaries mostly glaucous slate gray, the inner margins of all the wing-quills more or less brownish, and some of the rectrices with very narrow pale brownish tips; lores and a narrow ill-

[1] *Dicruropsis* Salvadori, Proc. Zool. Soc. Lond., 1878, p. 88 (type by monotypy, *Dicrurus megalornis* Gray).

[2] Measured in the flesh by the collector.

[3] Type.

[4] *Lanius leucoryn*. Linnaeus, Mantissa Plantarum, 1771, p. 524 (Manila, Luzon I., Philippine Islands). While the original spelling of the specific name here given is evidently an abbreviation, it is practically impossible to determine how Linnaeus would have spelled the remaining portion of the word. In view of at least four such possibilities, it seems much better to use the specific term as he left it, and write now *Artamus leucoryn* (Linnaeus).

defined capistrum, black; sides of head dark quaker drab, somewhat blackish anteriorly; sides of neck dark grayish brown; throat and jugulum dark quaker drab; rest of under parts creamy white, sharply defined transversely against the gray of throat; edge of wing underneath sooty black, flecked with white; remainder of wing-lining creamy white.

The characters of this race have already been indicated by Mr. Stresemann,[1] but no name provided. The birds from Solombo Besar and those also in the United States National Museum from other localities bear out these differences, and indicate that the form is worthy of nomenclatural recognition. It may be distinguished from *Artamus leucoryn celebensis* by its smaller size and somewhat darker upper and lower parts. In addition to Solombo Besar, it inhabits the islands of Bali, Java, Banka, and Sumatra, with doubtless others adjacent.

Two specimens are in the present collection. Both exhibit indications of molt among the contour feathers, and one (No. 181533, U.S.N.M., December 3, 1907—not the type) is molting also some of the wing-quills. Measurements of both are as follows:

Measurements of specimens of Artamus leucoryn amydrus.

U.S.N.M. No.	Sex.	Locality.	Date.	Collector.	Total length.[2]	Wing.	Tail.	Exposed culmen.	Tarsus.	Middle toe without claw.
			1907.		*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*
181533	Male	Solombo Besar Island, Java Sea.	Dec. 3	Dr. W. L. Abbott.	188	132	59	20	17.3	15
181532	do	do.[3]	Dec. 4	do	194	133	61	20	17	14.8
Average of 2 males					191	132.5	60	20	17.2	14.9

Family ORIOLIDAE.

ORIOLUS MACULATUS LAMPROCHRYSEUS, new subspecies.

Subspecific characters.—Similar to *Oriolus maculatus maculatus*, from Java, but larger; upper parts brighter, more golden (less greenish) yellow; yellow tips on inner webs of inner secondaries and tertials narrower; these tips and the edgings of secondaries and tertials of a duller yellow; yellow wing speculum averaging smaller.

Description.—Type, adult male, No. 181523, U.S.N.M.; Solombo Besar Island, Java Sea, December 4, 1907; Dr. W. L. Abbott. Lores, superciliary, subocular, and broad postocular streaks continuous with a broad occipital band, black; rest of upper parts, including crown, forehead, scapulars, and upper tail-coverts, together with

[1] Novit. Zool., vol. 20, June 17, 1913, p. 291.
[2] Measured in the flesh by the collector.
[3] Type.

entire lower surface, yellow, between lemon chrome and light cadmium, the throat almost pure lemon chrome; tail black, basally edged on inner webs of the rectrices with lemon chrome, this color at the base occupying practically all of the web; the two middle rectrices with a narrow tip of lemon chrome, and each succeeding pair with an increasingly broad terminal band of the same color, this band measuring on the outermost pair about 45 mm. in width; wings black, the inner margins of the quills somewhat brownish; all the primaries excepting the outermost narrowly margined exteriorly with grayish white, this decreasing in length inwardly, the inner feathers tipped with buffy white; secondaries rather broadly edged on terminal portion of outer webs with wax yellow, the tertials broadly margined on same part of outer vanes and narrowly tipped on inner vanes with the same color; lesser and median wing-coverts deep yellow like the back; greater coverts, edge of wing, lining of wing, together with broad tips of the black primary coverts, lemon chrome; "iris deep red, feet leaden."

This new subspecies differs from *Oriolus maculatus richmondi* Oberholser [1] of the Pagi Islands, western Sumatra, in more golden yellow upper and lower parts, more brightly yellow spots on tertials and secondaries, and usually larger yellow wing-speculum.

Three specimens are in the collection, all adults in good plumage, though showing among the contour feathers slight indication of molt. The feet of one of the males, No. 181521, U.S.N.M., are described on the label as "leaden blue"; the bill of the same specimen as "pale purplish fleshy." Measurements are given below:

Measurements of specimens of Oriolus maculatus lamprochryseus.

U.S.N.M. No.	Sex.	Locality.	Date.	Collector.	Total length.[2]	Wing.	Tail.	Exposed culmen.	Tarsus.	Middle toe without claw.
			1907.		mm.	mm.	mm.	mm.	mm.	mm.
181523	Male	Solombo Besar Island, Java Sea.[3]	Dec. 4	Dr. W. L. Abbott.	281	150.5	101	32.5	27.8	21
181521	do	do	do	do	293	151	104.5	33.8	27.5	20
Average of 2 males					287	150.8	102.8	33.2	27.7	20.5
181522	Female	Solombo Besar Island, Java Sea.	Dec. 5	Dr. W. L. Abbott.	281	150	104	32	27	21

[1] *Oriolus maculatus richmondi* Oberholser, Smithsonian Misc. Coll., vol. 60, No. 7, Oct. 26, 1912, p. 16 (North Pagi Island, western coast of Sumatra). It may be worth while to mention here that through some inadvertence the original diagnosis of this form is not entirely correct, as printed, and therefore somewhat misleading. The proper characterization is as follows: Similar to *Oriolus maculatus maculatus*, from Java, but larger; yellow of upper and lower parts deeper and more tinged with orange; yellow tips on tertials and inner secondaries darker and duller, those on tertials larger on outer webs, but narrower, often practically absent on inner webs, and yellow wing speculum smaller.

[2] Measured in the flesh by the collector.

[3] Type.

Family ZOSTEROPIDAE.

ZOSTEROPS SOLOMBENSIS, new species.

Specific characters.—Similar to *Zosterops flava*, from Java, but much larger; upper parts much more greenish and more uniform, the forehead and rump being barely more yellowish than the back; yellow of lower parts duller, lighter, more greenish; sides and flanks strongly washed with olive green; lores and line under eye blackish.

Description.—Type, adult male, No. 181588, U.S.N.M.; Solombo Besar Island, Java Sea, December 5, 1907; Dr. W. L. Abbott. Upper surface warbler green, the pileum more yellowish; upper tail-coverts lighter, between pyrite yellow and warbler green; tail chaetura drab, the feathers margined basally on external webs with warbler green; wings chaetura drab, the inner margins of the remiges, except at tips, paler, almost whitish, the tertials hair brown, washed with warbler green; superior wing-coverts and outer margins of outer vanes of wing-quills, warbler green; broad orbital ring white; a small spot under the anterior part of the eye and continuous with the lores, black; supraloral stripe lemon chrome; remainder of sides of head and neck between pyrite yellow and warbler green, and passing superiorly into the green of the upper parts, inferiorly into the yellow of the lower surface; lower parts medially rather dull lemon chrome; sides of breast and body, together with the flanks, between pyrite yellow and warbler green; lining of wing naphthalene yellow. Wing, 58 mm.; tail, 41.5; exposed culmen, 9;[1] tarsus, 18; middle toe without claw, 10.7.

The sole specimen secured by Doctor Abbott is an adult in perfect plumage, and differs so much from the other described forms of the genus that it seems to represent a new species. It may be distinguished from *Zosterops richmondi* McGregor, from Cagayancillo Island, in the Philippine Archipelago, by its darker, more greenish (less yellowish) upper parts, the forehead not yellow; darker wing-quills and rectrices; duller, paler, and narrower yellow supraloral stripe; rather more golden yellow lower surface, and darker, more olive-washed sides and flanks.

II. ARENDS ISLAND.

Arends Island lies in the eastern part of the Java Sea, about 50 miles south of Cape Salatan, southeastern Borneo, and some 35 miles north of the island of Solombo Besar.

Doctor Abbott stopped here on November 23 and 24, 1908, and collected for the United States National Museum eight specimens of birds, representing three species. Since there is apparently no published account of any birds from Arends Island, and since all three of the species obtained by Doctor Abbott are of more than passing interest, it seems worth while to place them on record.

[1] Tip slightly broken.

Family MEGAPODIIDAE.

MEGAPODIUS DUPERRYII GOULDII Gray.

Megapodius gouldii GRAY, Proc. Zool. Soc. Lond., 1861 (meeting of June 25), p. 290 (Lombok Island, East Indies).

One adult female is in the collection. This was taken on November 24, 1908. "Feet brick red; toes blackish; soles orange." Total length (in flesh),[1] 398 mm.; wing, 212; tail, 84; exposed culmen, 21.5; tarsus, 64; middle toe without claw, 38.5.

The present example differs from *Megapodius duperryii duperryii* of New Guinea in its smaller size, paler upper and lower parts, and is apparently identical with *Megapodius duperryii gouldii* of the Lesser Sunda Islands, though we have no specimens of the latter for actual comparison. This Arends Island bird, together with Doctor Abbott's other record from Solombo Besar Island,[2] extend for some distance westward the known range of the species.

The following four forms of *Megapodius duperryii* are now recognizable, and further investigations may increase this number:

Megapodius duperryii duperryii Lesson and Garnot.—New Guinea.

Megapodius duperryii gouldii Gray.—Lesser Sunda Islands, south to Lombok and Flores; east to the Aru and Kei Islands; north to the Banda Islands and Arends Island; and west to Arends Island, Solombo Besar Island, and the Kangean Islands.

Megapodius duperryii tumulus Gould.—Northern territory of Australia.

Megapodius duperryii assimilis Masters.—Northern Queensland.

Family TRERONIDAE.

MUSCADIVORES ROSACEUS ZAMYDRUS Oberholser.

Muscadivores rosaceus zamydrus OBERHOLSER, Proc. U. S. Nat. Mus., vol. 54, 1917, p. 179 (Solombo Besar Island, Java Sea).

Six specimens appear to be indistinguishable from the series from Solombo Besar Island already described under the above name.[2] Two of the six (No. 181676, U.S.N.M., November 23, 1908, and No. 181680, November 24, 1908) are molting both wing-quills and rectrices. Measurements of all are given in the following table:

[1] Measured by the collector.
[2] See p. 179.

Measurements of specimens of Muscadivores rosaceus zamydrus.

U.S.N.M. No.	Sex.	Locality.	Date.	Collector.	Total length.[1]	Wing.	Tail.	Exposed culmen.	Tarsus.	Middle toe without claw.
			1908		*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*
181676	Male	Arends Island, Java Sea.	Nov. 23	Dr. W. L. Abbott.	410	227	140	21	30	3
181679	do	do	Nov. 24	do	417	241	153.5	20.5	33	36
181680	do	do	do	do	430	232	151.5	22	32.5	36.5
181678	do	do	do	do	427	232	153	23	33.5	36.5
Average of 4 males					421	233	149.5	21.6	32.3	36.0
181677	Female	Arends Island, Java Sea.	Nov. 23	Dr. W. L. Abbott.	400	207	140	20.5	31	34.5
181681	do	do	Nov. 24	do	....	238	152	22	33.5	36.5
Average of 2 females					400	222.5	146	21.3	32.3	35.5

[1] Measured in the flesh by the collector.

Family ORIOLIDAE.

ORIOLUS MACULATUS LAMPROCHRYSEUS Oberholser.

Oriolus maculatus lamprochryseus OBERHOLSER, Proc. U. S. Nat. Mus., vol. 54, 1917, p. 186 (Solombo Besar Island, Java Sea).

One specimen, No. 181700, U.S.N.M., was obtained by Doctor Abbott on November 24, 1908. It is a male in juvenal plumage, and is apparently not distinguishable from the bird of Solombo Besar Island, already described by the writer as *Oriolus maculatus lamprochryseus*.[2] It measures: total length (in flesh),[3] 277 mm.; wing, 145.5; tail, 98.5; exposed culmen, 32; tarsus, 28; middle toe without claw, 20.5.

III. PULO MATA SIRI.

Pulo Mata Siri is the largest of the Laurot, or Laut Kitchil, Islands. It is situated in the middle of this group, some 75 miles south of the southeastern corner of Borneo, 225 miles north-northeast of the eastern end of Java, and about 250 miles west of southeastern Celebes. It is about 7½ miles in length from northeast to southwest, and approximately 1½ miles in width. Its surface is rocky, rough, and hilly, culminating in a high ridge which traverses its length, and at the highest point reaches an altitude of 1,400 feet. The rocks are chiefly granite, and there is but little coral reef along the coast.

This island is uninhabited, and is entirely covered with dense forest or jungle. The commonest mammals are rats, squirrels, bats, and muntjacs. Birds, at the time of Doctor Abbott's explorations, seemed not to be numerous.

[2] See p. 186.

[3] Measured by the collector.

Doctor Abbott paid two visits to Pulo Mata Siri: the first from December 7 to 12, 1907; the second from November 25 to December 1, 1908. On these occasions he collected 13 specimens of birds of 8 species, 5 of these representing new subspecies hereinafter described. These specimens, which Doctor Abbott has presented to the United States National Museum, and a single other species reported but not secured, constitute, up to the present time, the only ornithological records from the island of Mata Siri. Other birds, of course, remain to be detected here, but the avifauna is probably not large.

If these few birds are a criterion, Pulo Mata Siri is, as would be expected, faunally most closely allied to Borneo, but possessed, nevertheless, of a decided Javan and Celebesian infusion.

Family ARDEIDAE.

NANNOCNUS EURHYTHMUS (Swinhoe).

Ardetta eurhythma Swinhoe, Ibis, ser. 3, vol. 3, No. 9, January, 1873, p. 74, pl. 2 (Amoy, China) (wrongly spelled *Ardetta eurythma* on the plate).

One specimen, an immature female, No. 181399, U.S.N.M., taken, December 9, 1907; "iris yellow; bill dark brown above, pale greenish yellow beneath; feet pale green." Length (in flesh), 372 mm.

This apparently is the southernmost record for the species.

The specific name of this species has been consistently misspelled by authors. It is correct as above written.

Family MEGAPODIIDAE.

MEGAPODIUS DUPERRYII GOULDII Gray.

Megapodius gouldii Gray, Proc. Zool. Soc. Lond., 1861 (meeting of June 25), p. 290 (Lombok Island, East Indies).

Megapodes were reported to Doctor Abbott, but no specimens were obtained by him.

Family TRERONIDAE.

HAEMATAENA MELANOCEPHALA MASSOPTERA, new subspecies.

Subspecific characters.—Similar to *Haemataena melanocephala melanocephala*, from Java, but much larger; gray of head and neck somewhat paler; yellow of throat with slightly more of a chrome tinge.

Description.—Type, adult male, No. 181420, U.S.N.M.; Pulo Mata Siri, Java Sea, December 8, 1907; Dr. W. L. Abbott. Head and throat all around pale gull gray, with a large black patch, about 22 mm. long by 15–17 mm. wide, on occiput, and with the chin and middle of upper throat chrome yellow; hind neck and sides of neck warbler green, shading toward olive green on the upper back and scapulars; lower back, rump, and upper tail-coverts mixed olive green, warbler green, and dark green; tail-feathers basally, and, excepting the middle pair, also on marginal portion of inner webs, fuscous, the remaining portions of the feathers somewhat metallic cerro green, in places tinged with dark green or with bronzy, and having on the two middle rectrices numerous narrow almost invisible bronzy bars; wings fuscous, the superior coverts and the exposed portions of the quills in the closed wing somewhat metallic olive green, cerro green, bronzy green, and dark green, all mingled together, the general effect being near olive green; jugulum and breast between cerro green and spinach green, and shading to between parrot green and grass green on abdomen, sides, and thighs; crissum, including anal region, chrome yellow to cadmium yellow, the longest lower tail-coverts mostly red, between carmine and acajou red; lining of wing neutral gray, the feathers edged and tinged with cerro green and olive yellowish; "iris yellow; eyelids greenish yellow; bill pale yellow-green; feet deep red." Total length (in flesh), 266 mm.; wing, 127; tail, 81; exposed culmen, 15; tarsus, 23.5; middle toe without claw, 24.

This new race is much larger than *Haemataena*[1] *melanocephala melanospila* of Celebes, and has the gray of head and neck paler, also the yellow of throat and crissum lighter and less orange-tinged. From *Haemataena melanocephala xanthorrhoa* of the Sanghi Islands, it differs in the darker gray of head and neck, darker yellow of throat, and lighter, less orange-shaded yellow of posterior lower parts. Compared with *Haemataena melanocephala bangueyensis*, from the Philippine Islands, it is much larger, with gray of head and neck paler, and yellow of throat deeper. The type is the only specimen obtained by Doctor Abbott.

The genus *Haemataena* Bonaparte[1] (type, *Columba melanocephala* Forster) is sufficiently different from *Ptilinopus* Swainson to make necessary its recognition in nomenclature. The long tail, unbifurcated pectoral feathers, and relatively broad terminal portion of the first primary are distinctive. It equals *Spilotreron* Salvadori.

The forms referable to this genus are apparently all subspecies of *Haemataena melanocephala*, and are as follows:

Haemataena melanocephala melanocephala (Forster).
Haemataena melanocephala melanospila (Salvadori).
Haemataena melanocephala massoptera Oberholser.
Haemataena melanocephala xanthorrhoa (Salvadori).
Haemataena melanocephala bangueyensis (Meyer).
Haemataena melanocephala pelingensis (Hartert).
Haemataena melanocephala chrysorrhoa (Salvadori).

BUTRERON CAPELLEI PASSORHINA, new subspecies.

Subspecific characters.—Similar to *Butreron capellei capellei*, from Java, but bill more robust.

[1] For this generic name, see Richmond, Proc. U. S. Nat. Mus., vol. 53, 1917, p. 593.

Description.—Type, adult male, No. 181430, U.S.N.M.; Pulo Mata Siri, Java Sea, December 10, 1907; Dr. W. L. Abbott. Forehead pale olive gray, the anterior portion palest; crown greenish gray, between gnaphalium green and hathi gray; hind neck vetiver green; upper back and scapulars darker, between vetiver green and andover green: lower back storm gray, slightly washed with the green color of the interscapular region; rump green like the upper back, but anteriorly shading insensibly into the gray of the lower back, and posteriorly into the dull mignonette green of the longest upper tail-coverts; broad tips of middle pair of rectrices between light yellowish olive and mignonette green, the remaining exposed portion of the same color but somewhat darker, and the basal concealed part deep gull gray, more or less washed with the same green: remaining rectrices dusky neutral gray, basally deep gull gray on the outer vanes, light neutral gray on the inner, and terminally, for some 23 mm., pale neutral gray, the two pairs next the middle pair washed with the green of the middle feathers, particularly on the outer webs, the outer rectrices also very slightly and narrowly tinged with the same on the outer margins of their gray tips; wings slate color, but the outer webs of tertials and most of the lesser wing-coverts (excepting only those along the bend of the wing) together with a few of the inner median coverts, between andover green and vetiver green like the scapulars; narrow edgings on the outer webs of the inner median coverts and some of the inner greater coverts, lemon yellow; and similar but much broader edgings on the two innermost greater coverts and on the outermost tertial and innermost secondary, lemon chrome; lores pale greenish olive gray; superciliary region, a narrow orbital ring, and the anterior malar region, greenish gray like the crown; remaining parts of the sides of the head, together with the sides of the neck, vetiver green, rather brighter on the subauricular region; anterior part of chin between yellowish glaucous and seafoam yellow; posterior portion of chin and medial uppermost part of throat between citron green and water green; middle of rest of throat lime green; these colors of chin and throat pass insensibly into each other and into those of sides of head and neck; a broad (27 mm.) band on jugulum yellow ocher, shading laterally to buckthorn brown; breast light lime green; sides of body and upper abdomen between tea green and water green; flanks and lower abdomen between slate olive and sage green; shorter lower tail-coverts of the same green color, but mixed with feathers of cartridge buff and pinkish buff, and some of the green feathers broadly tipped with the same buff; rest of lower tail-coverts Hay's brown; thighs partly dull green like the lower abdomen, partly cartridge buff; lining of wing partly slate gray, partly dark gull gray.

The five birds, all adult, obtained by Doctor Abbott are in good plumage, and show only slight individual variation. There seems to be no difference in size between male and female. Two of the females, No. 181426 U.S.N.M., December 12, 1907, and No. 181427 U.S.N.M., December 10, 1907, are each molting one or two of the wing-quills. The colors of unfeathered parts, taken from the fresh birds, and given as the same on the labels of both sexes, are as follows: "Eyelids and feet yellow; iris dark brown; bill greenish jade color, base and cere green." Measurements of all the specimens are added below.

Measurements of specimens of Butreron capellei passorhina.

U.S.N.M. number.	Sex.	Locality.	Date.	Collector.	Total length.[1]	Wing.	Tail.	Exposed culmen.	Height of bill at base.	Tarsus.	Middle toe without claw.
			1907.		mm.	mm.	mm.	mm.	mm.	mm.	mm.
181430	Male	Pulo Mata Siri, Java Sea.[2]	Dec. 10	Dr. W. L. Abbott	387	202	127	23	11.5	30.5	28.5
181429	do	do	Dec. 12	do	375	194	116	24	10.5	31	28.5
Average of 2 males					381	198	121.5	23.5	11	30.8	28.5
181428	Female	Pulo Mata Siri, Java Sea.	Dec. 8	Dr. W. L. Abbott	378	208	122	23	11	32	30.5
181427	do	do	Dec. 10	do	373	203	118	24	11.5	26.5	30
181426	do	do	Dec. 12	do	368	195	124	23	10	28	28.5
Average of 3 females					373	202	121.3	23.3	10.8	28.8	29.7

[1] Measured in the flesh by the collector. [2] Type.

Family ALCEDINIDAE.

SAUROPATIS CHLORIS CYANESCENS Oberholser.

Sauropatis chloris cyanescens OBERHOLSER, Proc. U. S. Nat. Mus., vol. 52, February 8, 1917, p. 189 (Pula Taya, off the southeastern coast of Sumatra).

One immature female, No. 181491, U.S.N.M., taken, December 12, 1907.

This is nearly adult, but still has the dull-colored upper surface and dusky scale-like markings on the lower surface. It is molting both remiges and contour feathers. It is subspecifically the same as the birds from Bawean Island. Its measurements are: Total length (in flesh [3]), 258 mm.; wing, 112; tail, 70; exposed culmen, 46; tarsus, 15.5.

Family PYCNONOTIDAE.

PYCNONOTUS BRUNNEUS ZAPHAEUS, new subspecies.

Subspecific characters.—Similar to *Pycnonotus brunneus brunneus* [4] from the Malay Peninsula, and of about the same size, but upper sur-

[3] Measured by the collector.

[4] For this use of *Pycnonotus brunneus* Blyth, see Oberholser, Bull. U. S. Nat. Mus., No. 98, June 30, 1917, pp. 44–45.

face darker and more brownish or rufescent (less olivaceous or grayish); lower parts brighter, more yellowish, not so uniformly dull brownish or ochraceous.

Description.—Type, adult male, No. 181543, U.S.N.M.; Pulo Mata Siri, Laurot Islands, Java Sea, December 11, 1907; Dr. W. L. Abbott. Upper parts brownish olive, becoming more rufescent on rump, and shading into dark dresden brown on upper tail-coverts; the feathers of pileum edged with paler, which imparts a somewhat scaly effect; tail between mummy brown and brownish olive, paler on tips and inner margins of feathers, and edged on outer webs with brownish olive; wings fuscous, all the quills and superior coverts margined with brownish olive or light brownish olive; sides of head, neck, and breast brownish olive; cheeks and sides of throat light brownish olive; chin and upper throat buff, between deep olive buff and deep colonial buff; jugulum and upper breast dull isabella color, somewhat mixed with cream buff; abdomen dull marguerite yellow; lower breast the same, but washed with isabella color; sides, flanks, and thighs, light brownish olive; crissum and lining of wing chamois, a little mixed with fuscous; "iris red." Total length (in flesh[1]), 194 mm.; wing, 84; tail, 75.5; exposed culmen, 13.5; height of bill at base, 6.0; tarsus, 20; middle toe without claw, 13.5.

The single specimen of this new race that Doctor Abbott obtained on Pulo Mata Siri is identical with a good series of the same species from Borneo; and the birds from both these islands together differ, as above set forth, noticeably in color from examples taken on the Malay Peninsula and its islands, though apparently not in size. From *Pycnonotus brunneus zapolius* Oberholser,[2] of the Anamba Islands, *Pycnonotus brunneus zaphaeus* may readily be distinguished by its more rufescent or brownish (less greenish) upper surface, and darker, more brownish and ochraceous (less grayish and yellowish) lower parts.

The geographic distribution of *Pycnonotus brunneus zaphaeus*, so far as known, is confined to Pulo Mata Siri and Borneo. Thus *Pycnonotus brunneus brunneus* becomes restricted to the Malay Peninsula and its islands and to southern Tenasserim.

Family TIMALIIDAE.

MALACOCINCLA ABBOTTI SIRENSIS, new subspecies.

Subspecific characters.—Similar to *Malacocincla abbotti olivacea* (Strickland), from the southern part of the Malay Peninsula, but upper surface decidedly darker; lower parts duller, the sides of neck, sides of breast, and sides of body less ochraceous (more grayish): and jugulum pale vinaceous buff instead of ochraceous buff.

[1] Measured by the collector.

[2] Bull. U. S. Nat. Mus., No. 98, June 30, 1917, p. 45 (Pulo Siantan, Anamba Islands).

Description.—Type, adult male, No. 181561, U.S.N.M.; Pulo Mata Siri, Java Sea, December 11, 1907; Dr. W. L. Abbott. Upper parts dark brown, between dresden brown and mummy brown, somewhat darker on the pileum, and inclining to cinnamon brown on the rump, the feathers of the forehead with broad buffy central areas, those of the fore part of crown with narrow shaft lines of the same color; upper tail-coverts reddish brown, between argus brown and Sanford's brown; tail basally of the same color, though somewhat darker, and terminally shading toward Prout's brown; primaries and secondaries dusky sepia, the outer webs of secondaries, with all of the tertials and superior wing-coverts, Prout's brown, and the outer webs of the primaries between cinnamon brown and dresden brown; sides of head brown like the back, but the lores mixed with pale grayish from the basal portion of the feathers, the superciliary region also slightly grayish and with narrow shaft lines of grayish or buffy white; auriculars like the back but somewhat lightened by rather broad buff shaft markings; sides of neck Saccardo's umber, shading inferiorly toward tawny olive; chin white; throat grayish white; jugulum vinaceous buff, slightly washed laterally with brownish; breast tilleul buff; abdomen dull pinkish buff; lower tail-coverts between ochraceous tawny and zinc orange; sides of breast and jugulum between tawny olive and Saccardo's umber; sides tawny olive; flanks clay color; thighs between wood brown and tawny olive; inner under wing-coverts between cinnamon buff and pinkish buff; the outer rows tilleul buff; inner margins of outer secondaries and inner primaries avellaneous. Total length (in flesh[1]), 160 mm.; wing, 73.5; tail, 47; exposed culmen, 17.5; tarsus, 28; middle toe without claw, 16.2.

This new subspecies is more rufescent on the upper parts and on sides of neck than *Malacocincla abbotti büttikoferi* from Borneo; also more extensively and brightly tinged with ochraceous and ochraceous buff below. It thus really more closely resembles *Malacocincla abbotti olivacea* from the Malay Peninsula. The Bornean bird, *Malacocincla abbotti büttikoferi*,[2] while it seems to be but subspecifically different from the Malay Peninsula race, *Malacocincla abbotti olivacea*, is yet a recognizable form, differing in less rufescent upper surface, and less extensively and brightly ochraceous under parts. The type of *Malacocincla abbotti sirensis* is the only specimen obtained by Doctor Abbott.

The present species, *Malacocincla abbotti* Blyth, is clearly so different structurally from *Turdinus macrodactylus*, the type of the genus *Turdinus*, that its generic separation is apparently necessary. The

[1] Measured by the collector.

[2] *Malacocincla büttikoferi* Finsch, Notes Leyden Mus., vol. 22, March, 1901, p. 218 (Borneo).

former has a tarsus that appears almost booted, so slight are usually the indications of scutellae, while in *Turdinus macrodactylus* the scutellations are very distinct. Also the tarsi are weaker; the feathers of throat not stiff and scale-like; and the lower tail-coverts reach much more than halfway to the ends of the rectrices, instead of much less than halfway in *Turdinus*. The name *Malacocincla* Blyth (type, *Malacocincla abbotti* Blyth)[1] is the proper generic term for this species and its allies.

The subspecies of *Malacocincla abbotti* now number five, the ranges of which are as follows:

Malacocincla abbotti abbotti Blyth.—Nepal and Assam to Tenasserim.

Malacocincla abbotti olivacea (Strickland).—Malay Peninsula.

Malacocincla abbotti büttikoferi Finsch.—Borneo.

Malacocincla abbotti baweana Oberholser.[2]—Bawean Island, Java Sea.

Malacocincla abbotti sirensis Oberholser.—Pulo Mata Siri, Java Sea.

Family TURDIDAE.

KITTACINCLA MELANURA NIGRICAUDA Vorderman.

Cittocincla nigricauda VORDERMAN, Natuurk. Tijdsch. Nederl.-Indie, vol. 52, 1893, p. 197 (Kangean Island, Java Sea).

A single immature male of this species, taken on November 26, 1908, is referred to this form from the Kangean Islands. We have no specimens from these islands, however, and the present bird may well not be identical; but from the published description of *Kittacincla nigricauda* it is not with certainty distinguishable. It is just molting from the juvenal plumage into that of the adult, and with wings, upper surface, throat, and breast still showing evidences of immaturity. From specimens of *Kittacincla melanura opisthochroa* Oberholser,[3] from Lasia Island, off the western coast of Sumatra, this Pulo Mata Siri bird differs in much larger size and much paler posterior lower parts.

The measurements of this specimen (No. 181704, U.S.N.M.) are as follows: Total length (in flesh [4]), 228 mm.; wing, 99 [5]; tail, 106[5]; exposed culmen, 18; tarsus, 27; middle toe without claw, 19.

If this bird is really identical with *Kittacincla nigricauda* Vorderman, the latter is certainly but a subspecies of *Kittacincla melanura*.

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[1] *Malacocincla* Blyth, Journ. Asiatic Soc. Bengal, vol. 14, pt. 2, No. 164, for August, 1864, p. 600 (type, by monotypy, *Malacocincla abbotti* Blyth).

[2] Proc. U. S. Nat. Mus., vol. 52, February 8, 1917, p. 194 (Bawean Island, Java Sea).

[3] Smithson. Misc. Coll., vol. 60, No. 7, October 26, 1912, p. 13 (Pulo Lasia).

[4] Measured by the collector.

[5] Not fully grown.

Family DICRURIDAE.

DICRUROPSIS PECTORALIS SIRENSIS, new subspecies.

Subspecific characters.—Resembling *Dicruropsis*[1] *pectoralis solombensis* Oberholser,[2] from Solombo Besar Island, but larger; frontal hairs shorter or absent; black of upper parts deeper, richer, more velvety, and more bluish (less brownish or greenish); hackles on sides of neck more bluish or purplish (less greenish); metallic spots on throat and breast more bluish (less greenish); posterior lower surface of a deeper and more velvety (less brownish) black, with more bluish (less greenish) sheen.

Description.—Type, adult female, No. 181510, U.S.N.M.; Pulo Mata Siri, Java Sea, December 8, 1907; Dr. W. L. Abbott. Upper parts velvety black, with a slight violet or bluish sheen, but pileum and a few pointed feathers on cervix, shining metallic bluish black, and the upper tail-coverts shining metallic dull blackish green; tail black, the external webs of rectrices more or less margined with shining metallic dull blackish green; wings black, becoming slightly brownish on tips of primaries and on inner margins of all the quills; the exposed portions of all the superior wing-coverts, the tertials, outer webs of secondaries, and outer webs of primaries, excepting distal portions, shining metallic dull blackish green; sides of head and neck velvety black with a slight violet sheen, the long pointed feathers on the sides of the neck shining metallic dark delft blue; lower parts velvety black with a slight violet or bluish sheen, the feathers of lower throat, jugulum, and upper breast with short lanceolate tips of shining metallic dusky dull bluish green, giving to these parts a spotted appearance; lining of wing black, with a bluish or bluish green sheen; "iris straw yellow."

From *Dicruropsis pectoralis leucops*, which this new race resembles more than it does *Dicruropsis pectoralis solombensis* Oberholser,[2] from Solombo Besar Island, it is separable by its rather duller upper surface, longer hackles on sides of neck, and duller, more brownish posterior lower parts. The two specimens in the collection are both adults in good plumage. Their measurements follow.

[1] For the use of this generic name, see p. 185

[2] See p. 184.

Measurements of specimens of Dicruropsis pectoralis sirensis.

U. S. N. M. No.	Sex.	Locality.	Date.	Collector.	Total length.[1]	Wing.	Tail.	Exposed culmen.	Tarsus.	Middle toe without claw.
			1907.		*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*
181510	Female	Pulo Mata Siri, Laurot Islands, Java Sea.[2]	Dec. 8	Dr. W. L. Abbott.	305	157	127	31.0	26	17.8
181511	do	do	Dec. 12	do	308	158	134	30.8	25.5	18.5
Average of 2 females					306.5	157.5	130.5	30.9	25.8	18.2

[1] Measured in the flesh by the collector. [2] Type.

IV. PULO KALAMBAU.

Pulo Kalambau is one of the largest three islands of the Laurot, or Laut Kitchil, Islands, in the eastern portion of the Java Sea. It lies in the southern part of this group, and about 90 miles south of the eastern end of southern Borneo.

Doctor Abbott landed here for a day on December 7, 1907, and collected two birds, which he as usual presented to the United States National Museum. These represent two species, and one is an undescribed subspecies. So far as we are aware no birds have ever been recorded from Pulo Kalambau. Those collected by Doctor Abbott are given below.

Family RALLIDAE.

GALLICREX CINEREA (Gmelin).

[*Fulica*] *cinerea* GMELIN, Syst. Nat., vol. 1, pt. 2, 1789, p. 702 (China).

Doctor Abbott obtained a single specimen, an adult female, No. 181400, U.S.N.M., December 7, 1907. Length (in flesh), 350 mm. This example is in perfect plumage, but appears to exhibit no significant differences in either size or color from Chinese or Philippine birds, though it is somewhat smaller than any of our limited series of specimens from the Philippine Islands.

Family ZOSTEROPIDAE.

ZOSTEROPS SOLOMBENSIS ZACHLORA, new subspecies.

Subspecific characters.—Similar to *Zosterops solombensis solombensis*,[3] from Solombo Besar Island, but somewhat larger, particularly the bill; upper tail-coverts, pileum, and cervix, duller, more greenish (less yellowish) olive green; back lighter; and lower surface duller less golden (more greenish) yellow, the flanks and sides paler.

[3] See p. 188.

Description.—Type, adult male, No. 181589, U.S.N.M.; Pulo Kalambau, Laurot Islands, Java Sea, December 7, 1907; Dr. W. L. Abbott. Upper surface warbler green, the upper tail-coverts lighter, between warbler green and pyrite yellow; tail chaetura drab, the feathers margined basally on external webs with warbler green; wings chaetura drab, the inner margins of the remiges, except at tips, paler, almost whitish, the tertials hair brown washed with warbler green; superior wing-coverts and outer margins of outer vanes of wing-quills warbler green; broad orbital ring white; a small black spot under the anterior part of the eye and continuous with the black lores; supraloral stripe lemon chrome; remainder of sides of head and neck between warbler green and pyrite yellow, and passing superiorly into the green of the upper parts, inferiorly into the yellow of the lower surface; lower parts medially rather dull yellow, between lemon yellow and wax yellow; flanks, with sides of breast and body, pyrite yellow; lining of wing naphthalene yellow. Total length,[1] 126 mm.; wing, 57.5; tail, 42.5; exposed culmen, 11.5; tarsus, 18.5; middle toe without claw, 10.5.

Although Doctor Abbott obtained but a single specimen, this differs in such a manner from *Zosterops solombensis solombensis* of Solombo Besar Island, that it seems to be without doubt subspecifically distinct. Its upper surface is more uniform, indeed, almost of the same shade throughout, due chiefly to the fact that there is much less contrast between the back and the upper tail-coverts.

[1] Measured in the flesh by the collector.

AN ACCOUNT OF SOME FISHES FROM OWENS RIVER, CALIFORNIA.

By John Otterbein Snyder,
Of Stanford University, California.

Owens River basin occupies a long, narrow valley in the most rugged part of the high Sierras of California. On the west the mountains rise in an enormous wall above which tower the peaks of Whitney, Tyndall, and Lyell. On the east are Inyo Range and the White Mountains, whose summits also reach a great elevation. Owens Valley may properly be included within the Great Basin, its western boundary being coincident with the recognized confines of the latter. It is without exterior drainage, Owens River and its tributaries receiving their water from the slopes of the neighboring mountains and discharging it into Owens Lake, from which it is carried off largely by evaporation. The water of the lake is strongly impregnated with mineral salts.

The catchment basin of Owens River is narrowly though sharply separated from that of the San Joaquin by the crest of the Sierras. On the north are Mono Lake and its tributaries, and also a few relatively small depressions which may at one time have been connected with the quaternary Lake Lahontan. Extending far to the east and south is a wide expanse of almost waterless desert.

The occurrence of fishes in Owens River has long been known, but no serious attempt has been made to establish their relationships, a matter of importance when considered in connection with the geographical position and the complete isolation of the valley. Considerable interest therefore attaches to a small collection made by Mr. Clarence Kennedy while acting as assistant to the California State Fish and Game Commission at Laws, a station on the main river. Here the current is not very rapid, and the shores are more or less marshy.

Four native species are represented in the collection, possibly not the entire fish fauna of the basin. They are a catostomid, two cyprinoids, and a poeciliid. The catostomid and cyprinoids are Lahontan species and do not appear to possess any local peculiarities. The former, *Catostomus arenarius*, is abundantly represented in Owens River, while on the contrary it seems to be very rare in the Lahontan system, where specimens are seldom caught. The cyprinoids, *Siphateles obesus* and *Agosia robusta*, are common and widely distributed Lahontan species. The poeciliid, *Cyprinodon macularius*, is a form which has an irregular distribution in desert springs and small streams of southern Nevada, California, and elsewhere. Native trout have not been reported from the Owens River basin, their absence calling to mind the similar case of Eagle Lake, which has been reached by Lahontan catostomids and cyprinoids but not by the trout. The trout of Eagle Lake is related to those of the western slopes of the mountains.

The fauna of Owens River has been largely derived from the Lahontan system. Two of its species, *C. arenarius* and *A. robusta*, may have reached the river by stream capture, but the presence of *Siphateles* offers some difficulty to the acceptance of a speculation which would thus account for the invasion of the basin by Lahontan species. The known species of *Siphateles* are lake and channel forms, and none has yet been observed at a great distance up stream from a lake, a deep spring pond, or a slough-like channel.

CATOSTOMUS ARENARIUS Snyder.

SAND-BAR SUCKER.

Representatives of but one species of *Catostomus* were secured, and these belong to a form *C. arenarius* lately described from the Lahontan system. Where first discovered, the species appears to be rare, for after considerable collecting only nine specimens were obtained, not enough to furnish very definite data regarding its characteristics and distribution. Since, however, examples were taken in high mountain streams, in the lower Truckee River, and in Pyramid and Tahoe Lakes, one may be permitted to infer that its distribution is rather general in the Lahontan system, and therefore equally so in Owens River. Of its occurrence here Mr. Kennedy observes:

Suckers are common everwhere in the main river, usually lying in schools on the inflow side of the pools, with heads upstream. Some are very handsome fish, dark olive brown, with the paler areas of the sides flecked with shining gold which fades into yellowish white on the fins and ventral surface. Some are not so dark, gray and white examples often being seen.

Differences of a measurable character appear when examples from Owens River and the Lahontan system are compared, the former having somewhat smaller scales and longer fins. The differences are slight, and they may perhaps disappear with the study of a larger series of specimens.

Scale counts on Catostomus arenarius, Owens River.

Scales lateral series	72	73	74	75	76	77	78	79	80
Number of specimens	1	5	4	5	6	9	5	4	3
Scales before dorsal fin	34	35	36	37	38	39	40	41	42
Number of specimens	1	5	8	5	10	3	9	2	1
Scales above lateral line	14	15	16	17	18	....	....	....	....
Number of specimens	1	16	17	8	1	....	....	....	....
Scales below lateral line	11	12	13	14	....	....	....	....	....
Number of specimens	10	14	16	14	....	....	....	....	....

Measurements of Catostomus arenarius, Owens River.

Length of body......mm	155	179	170	154	169	153	160	143	128	134
Length head	.25	.25	.25	.255	.26	.24	.245	.255	.26	.25
Depth body	.21	.22	.23	.21	.20	.22	.21	.20	.24	.20
Depth caudal peduncle	.095	.10	.10	.09	.09	.10	.09	.10	.10	.09
Length caudal peduncle	.17	.155	.14	.16	.17	.17	.155	.18	.18	.17
Length snout	.12	.13	.12	.135	.13	.12	.115	.11	.12	.12
Diameter eye	.04	.04	.037	.04	.04	.036	.037	.038	.048	.04
Interorbital width	.11	.095	.11	.10	.10	.10	.095	.09	.11	.09
Depth head	.17	.16	.18	.165	.16	.17	.16	.17	.18	.16
Snout to occiput	.21	.22	.22	.24	.22	.21	.205	.21	.22	.21
Snout to dorsal	.48	.51	.52	.515	.52	.51	.49	.51	.52	.50
Snout to ventral	.57	.55	.56	.57	.57	.57	.57	.58	.59	.565
Length base of dorsal	.14	.15	.135	.14	.12	.13	.15	.13	.12	.15
Length base of anal	.08	.085	.08	.08	.078	.08	.085	.08	.075	.08
Height dorsal	.18	.18	.175	.16	.16	.17	.18	.185	.19	.18
Height anal	.195	.225	.20	.22	.19	.195	.22	.21	.21	.22
Length pectoral	.22	.23	.22	.24	.205	.215	.21	.21	.23	.23
Length ventral	.15	.18	.14	.17	.15	.15	.175	.15	.155	.17
Length caudal	.22	.23	.215	.21	.22	.22	.225	.23	.25	.23
Dorsal rays	10	10	11	11	9	10	11	10	10	10
Anal rays	7	7	7	7	7	8	7	7	7	7
Scales lateral line	77	76	73	81	76	75	74	77	78	75
Scales above lateral line	17	15	15	17	18	17	17	16	15	17
Scales below lateral line	12	12	13	14	13	13	13	13	14	13
Scales before dorsal	39	36	39	39	38	40	41	40	37	36

SIPHATELES OBESUS (Girard).

LAKE CHUB.

Specimens of this species appear to be like those found in the Lahontan system. The largest fishes secured at Laws measure 132 millimeters.

Scale counts of Siphateles obesus, Owens River.

Scales in lateral series	50	51	52	53	54	55	56	57	58	59	60
Number of specimens	2	4	4	6	9	8	6	6	5	5	1
Scales before dorsal fin	26	27	28	....	29	30	31	32	....	33	....
Number of specimens	1	2	9	....	18	12	7	6	....	1	....
Scales above lateral line	12	13	14	....	15	16	....	....	....	....	....
Number of specimens	6	16	21	....	12	1	....	....	....	....	....
Scales below lateral line	6	7	8	....	9	....	....	....	....	....	....
Number of specimens	1	15	22	....	5	....	....	....	....	....	....

Examples from the Lahontan system exhibit the following scale characters:

Scales in lateral series	50	51	52	53	54	55	56	57	58	59	60
Number of specimens	1	2	2	13	6	13	13	5	7	4	1
Scales before dorsal fin	27	28	29	30	31	32	33	....	....	....	....
Number of specimens	4	9	17	16	18	3	2	....	....	....	....
Scales above lateral line	12	13	14	15	16	....	....	....	....	....	....
Number of specimens	8	30	25	5	1	....	....	....	....	....	....

Measurements of Siphateles obesus, Owens River, Laws.

Length of body......mm	109	90	86	91	89	83	81	82	88	89
Length head	.275	.27	.29	.28	.28	.28	.27	.275	.27	.27
Depth body	.245	.25	.28	.26	.26	.26	.27	.28	.27	.27
Depth caudal peduncle	.11	.13	.135	.13	.12	.13	.13	.13	.135	.13
Length caudal peduncle	.20	.20	.22	.20	.21	.20	.20	.21	.19	.21
Length snout	.08	.075	.08	.08	.08	.09	.076	.08	.075	.08
Diameter eye	.05	.06	.06	.055	.065	.07	.065	.07	.06	.06
Interorbital width	.09	.10	.10	.095	.10	.10	.092	.10	.11	.11
Depth head	.20	.20	.20	.20	.20	.21	.20	.20	.20	.21
Snout to occiput	.21	.21	.21	.21	.22	.21	.22	.21	.20	.21
Snout to dorsal	.56	.57	.55	.53	.55	.57	.55	.55	.565	.55
Snout to ventral	.555	.55	.56	.55	.56	.56	.56	.56	.56	.55
Length base of dorsal	.11	.10	.11	.12	.125	.11	.12	.122	.12	.12
Length base of anal	.085	.09	.10	.08	.09	.082	.085	.09	.10	.08
Height dorsal	.19	.185	.18	.17	.20	.16	.20	.19	.19	.20
Height anal	.15	.15	.15	.13	.15	.14	.15	.15	.14	.16
Length pectoral	.175	.16	.18	.17	.17	.17	.16	.17	.18	.21
Length ventral	.155	.15	.15	.14	.16	.14	.15	.15	.15	.165
Length caudal	.235	.23	.23	.22	.26	.22	.25	.24	.27	.25
Dorsal rays	8	8	8	8	8	8	8	8	8	8
Anal rays	7	8	8	8	8	8	7	7	8	7
Scales lateral line	51	52	57	53	55	54	50	51	56	54
Scales above lateral line	14	14	13	14	15	14	13	14	14	15
Scales below lateral line	6	7	7	8	7	8	7	7	7	7
Scales before dorsal	32	32	29	29	32	33	29	31	29	31

AGOSIA ROBUSTA Rutter.

BLACK MINNOW.

Numerous specimens of this species fail to present any distinctive local characteristics when compared with a large series from the Lahontan system. The general shape is similar to Lahontan exemples. The barbels, usually present, are in some cases only seen on one side or the other, or are entirely absent. The laternal line may be entirely complete or variously interrupted, but usually extends to or beyond a point beneath the origin of the dorsal fin. There is a dark lateral stripe which is indistinct anteriorly, but very prominent posteriorly, ending in a black, round spot at the base of the caudal fin. Spots of dark pigment are scattered over the body. They are irregular in outline, their boundaries not coinciden with those of the included scales.

In 20 examples the scales in the lateral series number 60 to 67; between occiput and insertion of dorsal 37 to 42; above lateral line 12 to 14; below lateral line 9 or 10.

Mr. Kennedy remarks:

This species is not common. It varies much in color, often being olive brown above, occasionally more gray than olive; yellowish white below. The side stripe is in some cases very conspicuous, in others obscure. The small, yellowish eye distinguishes this fish among others.

CYPRINODON MACULARIUS Baird and Girard.

SPOTTED PURSY MINNOW.

This little fish occurs in the shallow pools along the river. It abounds in the bog pastures and tulle swamps, and enters the irrigation ditches in large numbers. When undisturbed it swims about after the manner of top-minnows, the mouth at the surface, the tail deeply submerged.

Mr. Kennedy reports that the swampy areas of Owens River are relatively free from mosquitoes, and suggests that their absence is probably due to the activities of this fish. The suggestion is well worth serious attention, and if investigation proves that the species aids in controlling the pest in this place, its introduction should be attempted in swampy and irrigated regions where mosquitoes abound, parts of the Sacramento Valley, and the lower Humboldt River, for example.

NOTES ON CHRYSODOMUS AND OTHER MOLLUSKS FROM THE NORTH PACIFIC OCEAN.

By William Healey Dall,

Honorary Curator of Mollusks, United States National Museum.

During the past year the writer received from Mr. Y. Hirasé, of Japan, a number of shells for identification, with a request that any new species be described. Having given special attention to the Chrysodomoid whelks, the opportunity was taken to revise the grouping of those mollusks as well as to prepare descriptions of a number of new species which occurred in Mr. Hirasé's collection.

The unique types were returned to him, but of several species cotypes were available for the National Collection. A few species of especial interest from the west coast of America are included in this paper.

A prodrome of the proposed classification of *Chrysodomus* and its allies was published[1] but, as this comprised merely a list of genera and subdivisions with designation of types, it was thought best to give herewith the complete discussion of the facts upon which the revision was based. A large number of boreal species from the Bering Sea region remain to be described at a later opportunity.

Genus CHRYSODOMUS Swainson.

The nuclei or larval shells of species belonging to *Chrysodomus* and its allies present several distinct types and numerous mutations.

In many cases, as in *Buccinum* and *Busycon*, it was shown many years ago by Lovèn and others that a single ovicapsule contains a number of ova fertile and unfertile. The unfertile eggs serve as food for the larvae developed from the fertile ones and there is a certain amount of competition between the larvae in the capsule which results in the most vigorous larvae getting more food and making a larger growth than the more weakly coinhabitants of the capsule. Thus at the time of leaving the capsule and coming into the outer world, it sometimes happens that there will be perceptible differences between the individuals issuing from a single capsule, not only

[1] Proc. Biol. Soc. Washington, vol. 29, pp. 7–8, January, 1916.

in actual size but in the length of the coil of whorls and the size and compactness of the larval apex.

The most common and typical nucleus comprises one or two whorls of a thin, smooth, more or less inflated character, while the normal sculpture of the adult shell usually commences abruptly at the termination of the nuclear coil. In some cases there are three or more nuclear whorls which are then usually coiled in a subcylindrical fashion.

The apex or initial whorl of the first fundamental type may present either of the following phases: (1) a bulbous appearance at times even larger in diameter than the next succeeding whorl; it may, however, be (2) small and coiled upon itself in a regular manner, gradually increasing in size. It may be (3) tilted obliquely to the axes of the succeeding whorls, or it may be (4) so compactly coiled that the initial cell forms with its first half whorl a little angle or point which forms the actual apex of the spire. Again the initial cell may be (5) quite small and regularly increase, with a low blunt spire recalling the appearance of a small *Turbo* viewed vertically from above. Most of these mutations are incidents of growth, and while the nucleus in a general way remains tolerably constant in form (though varying in size) within the species, I have found cases where from the same bunch of capsules one might select bulbous turbinoid, or laxly coiled nuclei.

These nuclear shells are thin, easily eroded, and it is frequently a matter of no little difficulty to find a single intact nucleus, even in a very large series of specimens of a single species. As the animal grows it either forms septa behind it as the viscera are withdrawn from the nuclear shell or fills the latter solidly up with shelly matter. This septum is often bulbous exactly as in nuclei of the type above mentioned (No. 1) and may later be solidly filled up internally with a shelly deposit. If the species had originally a nucleus of the type about to be described, and this thin shell be eroded away as is common, the septum-tip may remain, and so closely resemble the bulbous type as to deceive the very elect. One must therefore be on the alert for a wholly intact nucleus, and if possible secure it from a very young specimen. The best come from ovicapsules where the young shells are ready to emerge but have not yet been exposed to the erosive properties of seawater.

The third type above referred to[1] so nearly resembles the apex in the genus *Caricella* of the Volutidae, that one suspects the pres-

[1] For illustrations of the different types of nucleus which parallel one another in the Chrysodomiae and Volutidae see Friele in Norwegian North Atlantic expedition, Mollusca, pt. 1, pls. 1–3; and Dall, Trans. Wagner Inst., vol. 3, pt. 1, pls. 6 and 7, as follows: No. 1, Friele, pl. 1, fig. 12 *a–b*; No. 2, Dall, pl. 6, fig. 3*a*; No. 3, Dall, pl. 6, fig. 6; No. 5*a*; and Friele, pl. 1, fig. 11*b*; No. 4, Dall, pl. 6, fig. 6, and Friele, pl. 1, fig. 10*b*; No. 5, Dall, pl. 6, fig. 8.

ence in the larva of a cartilaginous primal cell, lost in the ovicapsule before emergence, and of which the shelly pointed apex is the secondary stage.

The first fundamental type may for brevity be termed the Chrysodomoid. The second, after its characteristic genus, the Siphonorbitoid. The latter may be described as follows: It has a turbinoid aspect when viewed from above and is always depressed or at least blunt; it is regularly coiled; it begins with a smooth minute apical cell which develops a whorl or sometimes a whorl and a half, then assumes a sculptured surface, composed of one or more sharp spirals crossed by rather distant thin sharp axial riblets for two or three regularly enlarging, moderately inflated whorls, usually ending abruptly but sometimes merging gradually into the adult sculpture; and is more or less invested with a distinct, sometimes villous, periostracum. This type of nucleus is common not only to the group, *Siphonorbis*, but also to *Mohnia*, *Kryptos*, and the aberrant *Troschelia*, which, by its dentition, is allied to *Fasciolaria* and *Fusinus*, perhaps indicating a closer relationship between these genera at an earlier period.

The *Siphonorbis* nucleus is figured by Friele on plate 2, figs. 19, 22, 30, and 34; and one with the original sculpture eroded, at fig. 25.

As far as sculpture is concerned the group of *Colus* divides itself naturally into those with spiral sculpture, but without axial riblets (*Colus sensu stricto*), in which the spiral sculpture may be strong or feeble, though in some of the latter it is almost obsolete, the shell without careful and even microscopic scrutiny appearing smooth; and those with axial plications, which are frequently confined to the early whorls and absent or obsolete on the later ones. There is also a small group (*Kryptos*) in which the axial sculpture may be developed only as nodules at the shoulder. The latter has not been examined anatomically and has been claimed as a member of another family.

In general form we have infinite gradations from the elongated type, simulating *Fusinus*, with narrow, nearly straight, and produced canal, to those species in which the canal is short and recurved, or wide and hardly differentiated from the aperture; or Buccinoid and scarcely to be differentiated from *Buccinum* except by the operculum. There is also a small group in which the shell is plicate and usually dark colored and, compared with the typical forms, quite minute in size.

The group of *Chrysodomus* proper has preponderately spiral sculpture sometimes varied by rude axial nodes or projecting lamellae, the shell substance tending to have a translucent outer layer and the periostracum extremely thin and usually absent except in the most protected places; the color tending in many cases to a purplish tint. In *Colus*, on the other hand, the periostracum is generally conspicuous, strongly adherent, usually smooth or even polished, though occasionally villous; the outer layer of the shell beneath it of an opaque chalky consistency and generally whitish. When the villosity of the periostracum is worn the basis may remain smooth and even acquire a polish. It is usually of a yellowish or greenish brown. The operculum is usually rounded-triangular with apical nucleus, the inner side with a thickened margin of a vitreous appearance. This, however, may be reduced to a thin, hardly perceptible varnish. The operculum may be shortened and the apex curved to the left, a tendency which in *Mohnia* is increased until the operculum assumes a subspiral form. In *Ancistrolepis* it becomes fan shaped, solid, with the apical part much prolonged beyond the attachment to the opercular gland, reminding one of the spurlike end of the operculum in *Strombus*. In *Beringius* it becomes short and rounded-quadrate, the nucleus at one side.

Whichever set of characters are selected to divide the genera into groups, it will be found that the other characters, each in its own group, will provide a parallel set of forms. Thus it becomes extremely puzzling to decide which characters shall carry most weight, and whatever decision is arrived at there will be a reasonable opportunity for differences of opinion among systematists.

The dentition among the species examined seems to show comparatively little variation, chiefly in the presence or absence of minor cusps.

It is somewhat surprising that some authors, even at this late day, will accept the prelinnean and frankly polynomial names in the work of Klein and oppose the adoption of the binomial and properly proposed names of the Museum Boltenianum. The probable explanation is that the latter until recently has been difficult of access and Klein's miserable Tentamen is comparatively common. At all events Klein's polynomials have fortunately no standing in zoological nomenclature. Mörch in 1852 adopted the name *Sipho* for *Murex islandicus* Gmelin, but it had previously been used by Fabricius and others and was not available. Moreover, the same species had been adopted by Beck as an example of his genus *Tritonofusus*. In my discussion of the history of the generic name *Fusus* in 1906, above cited, I showed that by adopting the name *Colus* Bolten, for the group typified by *M. islandicus*, the name *Fasciolaria* of Lamarck could be conserved. *Colus* being prior to Beck's genus, the name *Tritonofusus*, accepted by me in revising the family in 1902, must be relegated to synonymy.

In the magnificent volume on the mollusks of the expeditions in northern seas of the *Princess Alice* and *Hirondelle* by Dautzenberg and Fischer, published by the Prince of Monaco in 1912, the authors have utilized Mörch's name for this group of Chrysodominae and have divided it into several subgenera, chiefly on the basis of the relative lengths of the spire and canal. If the learned authors had been able to consult such a collection of boreal Buccinidae as the United States National Museum possesses, it is probable that they would have given less weight to characters of which every gradation may sometimes be observed between species of this group, and which often afford little opportunity of drawing valid distinctions of more than specific rank between them.

Their arrangement is as follows:

Genus SIPHO "Klein, 1753."

Subgenus *Siphonorbis* Mörch, 1869——Type, *S. ebur* Mörch.
Section *Turrisipho* Dautzenberg and Fischer, 1912——Type, *S. lachesis* Mörch.
Subgenus *Anomalosipho* Dautzenberg and Fischer, 1912——Type, *S. verkruzeni* "Kobelt."
Subgenus *Mohnia* Friele, 1879——Type, *S. mohni* Friele.
Subgenus *Parasipho* Dautzenberg and Fischer, 1912——Type, *S. kroyeri* Möller.

The arrangement adopted by M. Cossmann in his Essais de Paléoconchologie comparée, 1901, p. 96, is as follows:

Family CHRYSODOMIDAE.

Genus CHRYSODOMUS Swainson, 1840.

Subgenus *Chrysodomus* s. s.
Subgenus *Sipho* "Klein," Cossmann, 1901.[1]
Neotype, *S. gracilis* Da Costa.
Section *Siphonorbis* Mörch, 1869.
Type, *Neptunea ebur* Mörch.
Subgenus *Volutopsis* Mörch, 1857.
Type, *Neptunea norvegica* Chemnitz.
Section *Mohnia* Friele, 1879.
Type, *M. mohni* Friele.

[1] M. Cossmann in the "Essais," p. 101, writes: "Le nom Sipho, emprunté à Klein à été admis par le plupart des auteurs bien avant Mörch (v. Herrmannsen, 1845)." On turning to Herrmannsen's volume (of 1847) we find indeed that *Sipho* had been used by Fabricius and Brown before Mörch, but for totally different animals from those now designated *Colus*, while for Klein's *Sipho* Herrmannsen's comment is: "Genus Turbinum, Fusi, Mitrae, Buccini, et Pisaniae species confundens."

Genus PARVISIPHO Cossmann, 1889.

Subgenus *Parvisipho* s. s. 1889.
Type, *Fusus terebralis* Lamarck (Eocene).
Section *Columbellisipho* Cossmann, 1889.
Type, *Fusus hordeolus* Lamarck (Eocene).
Subgenus *Tortisipho* Cossmann, 1889.
Type, *Fusus jucundus* Deshayes (Eocene).
Subgenus *Andonia* Harris and Burrows, 1891.
Type, *Fusus bonellii* Géné (Pliocene).
Subgenus *Amplosipho* Cossmann, 1901.
Type, *Buccinum rottaei* Baudon (Eocene).
Subgenus *Varicosipho* Cossmann, 1901.
Type, *Sipho labrosus* Tate (Eocene).

In the case of the arrangement of Dautzenberg and Fischer, it has already been conclusively shown that *Sipho* can not be used in conformity with the International rules. *Turrisipho* differs from *Siphonorbis* only in the relative height of the spire to the length of the aperture. This character is subject to infinite gradations between related species and in my opinion is of not more than specific value, when the whole series is considered. Take the following series showing the relation between aperture (including the canal) and the whole shell in total length.

S. lachesis has a ratio of 1 to 2.36.
S. tortuosus has a ratio of 1 to 1.93, difference 0.43.
C. islandicus has a ratio of 1 to 1.90, difference 0.03.
C. hirsutus has a ratio of 1 to 1.90, difference 0.03.
C. jeffreysianus has a ratio of 1 to 1.82, difference 0.08.
C. pubescens has a ratio of 1 to 1.68, difference 0.14.
S. sabinii has a ratio of 1 to 1.44, difference 0.24.

Thus the difference between *sabinii* and *tortuosus* equals 0.49, or 0.06 more than between *lachesis* and the species nearest to it.

It is, however, true that the unusually long spire of *S. lachesis* gives it a rather peculiar aspect.

Anomalosipho presents a somewhat different case. The shell so beautifully figured by Messrs. Dautzenberg and Fischer under the name of *Sipho verkruzeni* Kobelt, is difficult to identify with the original figure of that species given by Kobelt in 1876, who says "feinen nur bei starkerer vergrösserung sichtbaren spiralstreifen." This agrees with specimens received from Verkruzen by me and named by Kobelt in 1876. It is possible that Verkruzen, who was not an expert, may have sent out more than one species under that name. At all events Dautzenberg's shell upon which the name

Anomalosipho is based, is very different in form and color from the original *S. verkruzeni*, which is not an *Anomalosipho* as defined. I would therefore propose the name of *Anomalosipho dautzenbergii* for the real type of that subgenus, which has perfectly obvious strong spiral sculpture and is closely related to "*Euthria*" *conulus*, Aurivillius, from the Arctic Ocean near Bering Strait, described and figured in the *Vega* report of 1885 (pl. 13, fig. 6).

Mohnia is generally accepted, and fairly well distinguished from the other groups, though some species of *Plicifusus* have a somewhat incurved nucleus of the operculum. It is notable that shells specifically very unlike agree in having a *Mohnia* operculum.

The subgenus *Parasipho* is founded on the same type as *Plicifusus* proposed 10 years earlier, and which will therefore take precedence.

M. Cossmann's arrangement is peculiar in making *Mohnia* a section of *Volutopsis*, but its principal feature is the combination of a number of small Eocene forms under the generic name of *Parvisipho*. In the absence of specimens of these species, it would be unwise to discuss their relations, especially as M. Cossmann's figures, phototyped from the fossils, are not as clearly defined in minor details as might be desired. One notes, however, the resemblance of *Columbellisipho* to *Aesopus* Gould, and of *Amplosipho* to certain forms which have by others been referred to *Daphnella*. It is also doubtful if any form with a strongly thickened varicose outer lip internally dentate, like *Varicosipho*, can be safely referred to this family. The difficulties of correctly referring fossil forms to their true position in the system without an intimate knowledge of their recent analogues are, however, very great, and the service rendered by M. Cossmann in bringing together scattered material for the use of those of more limited facilities is one deserving of appreciation.

Taking into account the preceding considerations, the following arrangement has been settled on.

Family CHRYSODOMIDAE.

Genus CHRYSODOMUS Swainson.

Murex, sp. LINNAEUS, Syst. Nat., ed. 10, 1758, p. 754.

Fusus, sp. BRUGUIÈRE, Encycl. Meth., vol. 1, 1789, p. xv, pl. 426. Not of Helbling, 1779.

Neptunea, sp. BOLTEN, Mus. Boltenianum, 1798, p. 115.—LINK, Beschr. Rost. Samml., vol. 3, 1807, p. 117.

Chrysodomus SWAINSON, Malacology, 1840, pp. 90, 308. Type, *Murex antiquus* Linnaeus. Not of G. O. Sars, Moll. Reg. Arct. Norv., 1878, p. 269 (= *Beringius* Dall).

Atractus AGASSIZ, Min. Conch., German ed., 1840, p. 44. Types, *Murex striatus* (= *antiquus* Linnaeus) and *M. contrarius* Gmelin. Not *Atractus* Wagler, 1828.

Neptunea MÖRCH, Cat. Yoldi, 1852, p. 104. (First species, *Murex antiquus* Linnaeus). Not of Renier, 1847.

Chrysodomus COSSMANN, Essais de Pal. Comp., livr. 4, 1901, p. 98. Type, *Murex despectus* Linnaeus.—DALL, Proc. U. S. Nat. Mus., No. 1264, p. 520, 1902.

Neptunea DAUTZENBERG AND FISCHER, Res. Camp. Scientifiques de Monaco, livr. 37, 1912, p. 68.—HARMER, Pliocene Moll. Gt. Brit., pt. 1, p. 156, 1915. Not *Neptunia* Renier, 1847 (Coelenterata).

The name *Neptunea* Bolten was given to a heterogeneous collection now divided into eight or more genera of several distinct families. Link in 1807 segregated *Nassa* without accepting Lamarck's name for it, which had already been used by Bolten for a different group. Bolten selected no type and gave no diagnosis. One by one the species included in his genus were used as types for new genera by later authors. The name generally accepted for the present group and including *Fusinus* Rafinesque, was *Fusus* Bruguière, 1789, but not of Helbling, 1779.

In 1840 Swainson instituted the genus *Chrysodomus* and mentioned as typical example (p. 90) the "beautiful orange mouth wilk of England" (*Fusus antiquus*). The first species of his list given on a later page is *C. dispectus* (sic), the second *C. argyrostomus* (= *C. antiquus*). Both are unquestionably congeneric, and the former, *Murex despectus* Linnaeus, has been taken as type by several authors who probably did not notice the selection of a type on the earlier page.

Shell large, short-fusiform, smooth or spirally sculptured, sometimes with rude axial ribbing or nodosities or varixlike sharp laminae; outer coat of the shell subtranslucent, the inner layers with a darker, usually purplish tint, the periostracum inconspicuous and dehiscent; last whorl longer than the spire, with a wide aperture, the outer lip in the adult flaring or subreflected, not thickened; pillar flexuous, smooth; labium without callosities or lirae; inner side of the outer lip without liration in the typical group; the canal rather long, wide, open and flexuous; animal short and broad; the penis large, usually sickleshaped and with a small elongate terminal papilla; operculum ovate with apical nucleus, nearly closing the aperture; ovicapsules massed, sessile either in a heap as in *Buccinum*, or in a cylindrical erect group; nucleus submammillary, of the Chrysodomoid type hereinbefore defined; the subsequent whorls rapidly increasing, not numerous. The dental formula 1. 1. 1, the teeth usually tricuspid, the central rhachidian cusp and outer lateral cusps usually larger; the minor cusps often irregular, multiple or obsolete. The habitat of the genus is in cold water of the North temperate or Arctic seas.

Section SULCOSIPHO Dall.

Shell like *Chrysodomus* but more slender and elongate and with the whorl in front of the suture conspicuously widely sulcate or tabulate, the nucleus inflated and slightly oblique, the color whitish.

Type.—Chrysodomus tabulatus Baird, Puget Sound. *C. adelphicus* Dall, of Japan, appears to belong to this group also.

Subgenus BARBITONIA Dall.

Shell short and stout, resembling *Chrysodomus*, smooth or axially ribbed, the outer wall of the aperture in the adult spirally lirate within. Habitat, Northeastern Asia and Japan.

Type.—Fusus arthriticus Valenciennes, 1858, Hakodate.

The closely related *Neptunea cumingi* Crosse, 1862, according to Aurivillius, has a radula differing from that of typical *Chrysodomus* in having two rather long cusps on the laterals, the rhachidian tooth bearing two curved cusps springing backward from the anterior edge of the basal plate, and between them on the posterior edge of the plate two short triangular cusps with no median denticle. The operculum is large, slightly arched with an apical nucleus. *Fusus bulbaceus* Bernardi, and *vinosus* Dall, have the dentition of *Chrysodomus*, lack axial ribbing and lirations, and, though otherwise similar, do not belong to this group.

Genus SEARLESIA Harmer.

Searlesia HARMER, Pliocene Moll. Gt. Britain, vol. 1, 1915, p. 135. Type, *Trophon costifer* S. Wood, Crag of Britain.
Chrysodomus COSSMANN, Essais, vol. 4, 1901, p. 101.

Nucleus (of *S. dirus*) smooth, of two laxly coiled smooth whorls changing abruptly into the adult sculpture of few strong axial ribs crossed by numerous spiral threads. The shell-structure subtranslucent, dark colored; the shell short-fusiform, periostracum inconspicuous; aperture shorter than the spire, the outer lip thickened and internally lirate; the body callous, with a narrow chink between the reflected enamel and the strong siphonal fasciole; canal short, open, slightly recurved. Radular formula $\frac{1}{2}:\frac{1}{3}:\frac{1}{2}$, the median rachidian cusp longer than the others.

The specimens of *T. costifer* at my disposal show the nucleus less perfectly than the recent species from which I have taken the description, but they appear to be essentially similar. The genus is convenient as it takes in several West American and Japanese species for which no satisfactory place had hitherto been found. The operculum is similar to that of *Colus*, long-ovate, arcuate, with apical nucleus and, on the proximal side, a marginal band of vitreous enamel.

Genus ECPHORA Conrad.

Ecphora Conrad, Proc. Acad. Nat. Sci., Phila., vol. 1, 1843, p. 310.—Dall, Trans. Wagner Inst., vol. 3, 1890, p. 124. Type, *Fusus quadricostatus* Say, Miocene, Maryland.

Shell vertically depressed, few whorled, the last much the largest; structure of shell Chrysodomoid; sculpture of few strong spiral ribs; canal short, very deep and narrow with a large, funicular umbilical pit.

Stenomphalus Sandberger, 1853, from the North European Miocene, appears to represent this form on the other side of the Atlantic, but I have not been able to examine a specimen.

Genus COLUS Bolten.

Colus Bolten, Mus. Boltenianum, 1798, p. 117, edition of 1819, p. 82. No type selected.

Neptunea B Link, Beschr. Rostock Samml., vol. 3, 1807, p. 117. No type selected.

Tritonofusus Beck, Amtl. Ber. d. 24 Vers. Deutsche Naturf., Kiel, 1847, p. 114. Type, *Fusus islandicus* Chemnitz.—Herrmannsen, Ind. Gen. Mal., vol. 2, 1849, p. 611.—Dall, Proc. U. S. Nat. Mus., vol. 24, No. 1264, 1902, p. 522. Not of Mörch, Fort. ov. Grönl. Blöddyr, 1857, p. 13.

Neptunella Verrill, Inv. An. Vineyard Sound, 1873, p. 637; Amer. Journ. Sci., ser. 3, vol. 6, 1873, p. 439. Type, *Fusus pygmaeus* Gould. Not *Neptunella* Meek, 1864.

Siphonella Verrill, Checkl. Mar. Inv. Atlantic Coast, 1879, p. 20 (New name for *Neptunella* preoccupied). Not *Siphonella* Hagen, 1851, Insecta.

Sipho Mörch, Cat. Yoldi, vol. 1, 1852, p. 104. Not *Sipho* of Fabricius, 1822, or of Brown, 1844, or *Sypho* of Brown, 1827.

Fusus of many Authors, but not of Helbling, 1779.

Colus Dall, Journ. Conch. (Leeds), vol. 11, No. 10, 1906, p. 294. Type, *Murex islandicus* Gmelin.

Sipho Dautzenberg and Fischer, Res. Camp. Scientifiques de Monaco, livr. 37, 1912, p. 81. Type, *Buccinum gracile* Da Costa.

Shell long-fusiform, slender, with numerous moderately rounded whorls, the nucleus Chrysodomoid, the shell structure usually white, often with a chalky external layer under a conspicuous, usually brownish, adherent periostracum; sculpture spiral, seldom very strong, sometimes nearly obsolete, never axially plicate or ribbed; aperture of moderate size, the outer lip simple, acute, not thickened or reflected, rarely slightly expanded; pillar smooth, the inside of the outer lip not lirate or denticulate; canal varying in length, usually somewhat tortuous or, when short, recurved; operculum filling the aperture, formed as in *Chrysodomus*. Radula like *Chrysodomus*, the minor cusps variable, the rhachidian tooth always cuspidate. Ovicapsules solitary, lentiform or hemispherical, attached by the whole of the flat side, usually with several enclosed young. Nepionic shells small, generally with the apical whorl inflated, the next succeeding somewhat constricted, and the rest regularly increasing; but the nucleus varies as previously described from inflated and irregular to blunt and regularly coiled, but always smooth.

Type.—Murex islandicus Gmelin.

It is questionable whether the small form named by Gould *Fusus pygmaeus* should be separated sectionally from *Colus* proper, or not. The characters of radula and periostracum upon which Verrill based his *Neptunella* are common to species of larger growth which one would not think of separating. The nucleus, however, is peculiar in being strongly spirally keeled clear up to the minute apical cell, thus tabulating the nuclear whorls. The summit, however, is not flat, and there are no such radial riblets as are found in *Siphonorbis*. *Sipho parvus* Verrill, a still smaller and similar species as far as adult characters go, has the nucleus Chrysodomoid, though on a smaller scale.

Another group of species, typified by *Fusus spitzbergensis* Reeve, has a special aspect due to the short canal and the prominence of the spiral ribs separated by chaneled interspaces. It may be called *Aulacofusus*.

Subgenus LATISIPHO Dall.

? *Parvisipho* COSSMANN, (part) Cat. Eocene bas. Paris, vol. 4, 1889, p. 147. Eocene of Paris basin. Type, *Fusus terebralis* Lamarck (not Gould).

Shell of moderate size, Buccinoid in form, with fine spiral striation or none; no axial sculpture; the periostracum persistent, smooth; the spire short, about equal to the aperture; the canal short, markedly recurved; the outer lip ample, simple, slightly reflected in the adult; the body and pillar callous, smooth; the siphonal fasciole strong with no chink between it and the columellar callus. Operculum as in *Colus* with apical nucleus. The nuclear whorls as in *Colus* but small.

Type.—Chrysodomus hypolispus Dall, 1891, U. S. Nat. Mus., No. 122606. Bering Sea.

The group of fossil species, included under *Parvisipho* by its author, from the present writer's point of view appears heterogeneous, including smooth, plicate, and varicose species, some with internal lirae in the aperture. *P. terebralis* Lamarck seems from the figure somewhat like the present group in outline, but, considering its geological remoteness, the boreal habit and buccinoid aspect of the group here assembled under *Latisipho*, it seems that a separation is not unreasonable. The features in *Parvisipho* upon which M. Cossmann lays special stress, such as the pillar without callus, the absence of a siphonal fasciole (bourrelet), etc., are quite the contrary of those which obtain in *Latisipho*, of which numerous species exist in the Bering Sea region, and which are contrasted with typical *Colus* by their buccinoid form and strongly recurved short canal.

This group is related to *Colus* much as *Latifusus* is to *Plicifusus*.

Curious zigzag ridges, not very prominent, appear behind the shoulder of the last whorl in some specimens of this species, but are absent in others. No explanation of them is obvious, but I suspect them to be pathologic.

Subgenus ANOMALOSIPHO Dautzenberg and Fischer.

Anomalosipho DAUTZENBERG AND FISCHER, Res. Camp. scientifiques de Monaco, livr. 37, 1912, p. 99.

Shell solid, of moderate size, the nucleus unknown, the sculpture exclusively spiral, the sutures not constricted, the aperture shorter than the spire, the canal very short, wide, hardly differentiated from the aperture.

Type.—*Sipho verkruzeni* Dautzenberg and Fischer (not Kobelt) = *Colus dautzenbergii* Dall. Atlantic Ocean; Grand Banks.

The *Sipho verkruzeni*, var. *plicata* figured by Brögger and cited in the work of Dautzenberg and Fischer, appears from the excellent figure to be probably a young specimen of *Plicifusus arcticus* Philippi. *Tritonofusus adonis* Dall, and *Euthria conulus* Aurivillius, are members of this subgenus, but all specimens yet seen have the apices of the shell eroded so that the nuclear characters are unknown. The radula appears to have normally three cusps on the rhachidian tooth and four on the laterals, but one or more cusps are sometimes deficient, according to Aurivillius.

Genus SIPHONORBIS Mörch.

Siphonorbis MÖRCH, Journ. de Conchyl., vol. 17, 1869, p. 397. No type cited. (First species, *Fusus lachesis* Mörch).—FISCHER, Manuel de Conchyl., 1884, p. 624. Type selected, *S. ebur* Mörch, Greenland seas.—DALL, Proc. U. S. Nat. Mus., vol. 24, No. 1264, p. 522.—DAUTZENBERG AND FISCHER, Res. Camp. Scientifiques de Monaco, livr. 37, 1912, pp. 82, 93 (*Fusus ebur* Mörch).

Turrisipho DAUTZENBERG AND FISCHER, Res. Camp. Scientifiques de Monaco, livr. 37, 1912, pp. 82, 97. Type, *S. lachesis* Mörch.

Nucleus siphonorbitoid as before herein described; shell generally like *Colus*, but variable; the canal usually short; the sculpture, if any, spiral; the spire varying in relative length compared with the aperture; the operculum as in *Colus;* the rhachidian tooth with a single cusp, the laterals with two cusps; otherwise as in *Colus*.

The peculiarly depressed, sharply reticulate, nepionic whorls starting from a smooth apical cell form such a contrast to the nucleus in *Colus* that it seems reasonable to separate them generically.

Genus KRYPTOS Jeffreys.

Kryptos (Jeffreys) DAUTZENBERG AND FISCHER, Mém. Soc. Zool. de France, vol. 9, 1896, p. 435. Type, *K. elegans* Jeffreys, Mém. Soc. Zool. de France, vol. 9, 1896, p. 435, pl. 15, fig. 20 (Separate copies, p. 41). Northeastern Atlantic in deep water.

Nucleus initially smooth, then depressed and reticulate as in *Siphonorbis;* shell as in *Siphonorbis* except that axial ribbing is developed over part or the whole of the shell, becoming reticulate or nodulous at intersection with the more prominent spiral sculpture. Operculum rounded-quadrate, short, as in *Beringius;* verge relatively enormous, cylindrical, with conical tip; eyes and radula apparently wanting in the typical species, *K. elegans.*

A manuscript note of Jeffreys states that the type is identical with *Boreofusus nodosus* Jeffreys of the *Porcupine* Expedition; but I have not found that *B. nodosus* has been published, though we have specimens so labeled in his collection.

The typical species of *Kryptos* has a plain, somewhat concave band in front of the suture and behind the nodosities at the shoulder of the whorl. Locard referred the species to *Pleurotomella*, but the nuclear characters are so obviously Siphonorbitoid that I can not accept this conclusion. *Fusus fenestratus* Turton, (+*fusiforme* Broderip, +*Broderipii* Jeffreys) probably belongs to this genus. Jeffreys' statement that the "top whorl" is smooth results from the fact that Broderip's type-specimen, now in the Jeffreys collection, had been cleaned with acid. Other species are *Fusus abyssorum* Fischer, 1884[1] (*profundicola* Verrill and Smith, April, 1884). *F. sarsi* Jeffreys is not a plicate species and probably=*ebur* Mörch.

This group is related to *Siphonorbis* somewhat as *Plicifusus* is to *Colus.*

Genus PLICIFUSUS Dall.

Plicifusus DALL, Proc. U. S. Nat. Mus., vol. 24, No. 1264, 1902, p. 523. Type, *Fusus kroyeri* Möller.

Parasipho DAUTZENBERG AND FISCHER, Res. Camp. Scientifiques de Monaco, livr. 37, 1912, pp. 82, 100. Type, *F. kroyeri* Möller.

Shell strongly plicate axially, smooth or spirally sculptured, usually with an inconspicuous periostracum; nucleus Chrysodomoid; aperture ample, the outer lip markedly flexuous behind, slightly expanded, simple, sharp; the pillar callous, the canal slightly twisted

[1] Fischer's separate copies of this leaflet were received July 26, 1884; the part of the Journal de Conchyliologie containing it, in November, 1884, at the Smithsonian Institution. I am unable to say when this number of the Journal was published. It is dated 1883 but did not appear until sometime in 1884.

and recurved, moderately long; the aperture (including the canal) about as long as the spire. Operculum as in *Colus*. Dentition (of *P. arcticus* Philippi) $\frac{1}{3}:\frac{1}{3}:\frac{1}{3}$, the cusps of the rhachidian subequal, the middle cusp of the laterals smaller and often variable or bifid. The type of the radular sac is chrysodomoid. Arctic seas.

The small size, livid coloration, and heavy shell of the North Atlantic species described by Möller, is so different from the large, whitish, thin form from the Arctic Ocean and Bering Sea named by Philippi in 1850 *Fusus arcticus*, that I think it best to regard the two as distinct species, though they have generally been regarded as synonymous.

Subgenus RETIFUSUS Dall.

Shell of small or moderate size, with a conspicuous dark usually vernicose periostracum; axially plicate, the surface reticulated by sharply incised spiral grooves; nucleus swollen, chrysodomoid; outer lip flexuous, slightly reflected, sharp, simple, without internal lirae; canal short, recurved, with the siphonal fasciole indistinct; operculum arcuate with apical nucleus. Bering Sea and north Pacific.

Type.—Tritonium jessoense Schrenck.

Chrysodomus virens Dall, and several new species belong to this group.

Subgenus LATIFUSUS Dall.

Shell short and broad, whitish, with a dull slightly villous periostracum; arcuately plicate with fine spiral threading; canal and aperture as long as the spire; outer lip strongly flexuous behind, slightly thickened and reflected; pillar short, smooth, with the body coated with callus in the adult; canal short, wide, recurved, with the siphonal fasciole feeble; operculum arcuate, the nucleus apical and in perfect specimens incurved; the apex of all the specimens is more or less eroded, but appears to have been acute and chrysodomoid.

Type.—Chrysodomus griseus Dall, Californian coast in deep water. U. S. Nat. Mus. No. 96531.

This is the buccinoid phase of *Plicifusus* as *Latisipho* is of *Colus*.

Subgenus MICROFUSUS Dall.

Shell small, with a somewhat villous, inconspicuous periostracum; nucleus smooth, swollen, obliquely tilted, chrysodomoid; subsequent whorls near the apex axially ribbed, the remainder without axial sculpture; spiral sculpture of fine close threading; suture appressed, spire acute; aperture shorter than the spire, with a wide, very short, recurved canal; outer lip simple, sharp; pillar without callous deposit, or marked siphonal fasciole.

Type.—Chrysodomus acutispiratus Sowerby. Japan, U. S. Nat. Mus., No. 274056.

It is possible that some of the species included under *Parvisipho* Cossmann might find a place here.

Section HELICOFUSUS Dall.

Shell small, short, inflated, with an external chalky layer covered with a dark rude periostracum, both usually eroded; the inner shell layer of an orange color; nucleus large for the shell, depressed, dome-like, smooth and of about one whorl; the succeeding whorl or two with short small axial ribs, the later whorls with only fine spiral sculpture, usually eroded; aperture as long as the spire; outer lip sharp, flexuous behind, not reflected; body and pillar with a thin callus; pillar short, twisted, abruptly bent to the left with the wide short canal, no siphonal fasciole present; operculum as in *Plicifusus*.

Type.—*Chrysodomus laticaudatus* Dall. Alaska U. S. Nat. Mus., Nos. 210801 and (nucleus) 213357.

The remarkable way in which the canal is diverted from its normal direction, seems to place this species in a group apart. The large number of specimens collected, though showing some variation, are constant enough to indicate that the deflected canal is a permanent feature. The tendency to superficial erosion is also characteristic.

Genus EXILIA Conrad.

Exilia CONRAD, Journ. Acad. Nat. Sci. Phila., n. ser., vol. 4, p. 291, 1860. Type, *E. pergracilis* Conrad, Journ. Acad. Nat. Sci. Phila., vol. 4, 1860, pl. 47, fig. 34. Eocene of Texas.

Shell elongate, very slender, with numerous whorls, chrysodomoid nucleus, and a straight canal; periostracum conspicuous, polished; sculpture of numerous fine flexuous axial ribs and spiral striation; aperture small, simple, not lirate within, outer lip thin, sharp, not reflected; inner lip and pillar smooth, without plications or denticles of any sort; operculum long, slightly arcuate, with apical nucleus.

This shell has the nucleus and periostracum of *Plicifusus* but much the form of *Fusinus*, of which Gabb's *Exilifusus* is a synonym. A curious error appears in Cossmann's Essais de Paléoconchologie comparée, (livr. 4, 1901, p. 26,) in which *Exilia* is described as having two oblique plaits on the pillar. There are none of any kind whatever. M. Cossmann's specimen was probably wrongly identified with *Exilia*, and may have been a *Fusimitra*.

Chrysodomus rectirostris Carpenter, and *C. kelseyi* Dall, appear to belong to this genus, which is also represented in the Pliocene of California.

Genus VOLUTOPSIUS Mörch.

Volutopsius MÖRCH, Fort. ov. Grönl. Blöddyr., April, 1857, p. 13; Article Manual, 1875, p. 129. Type, *Fusus largillierti* Petit. Greenland.

Strombella GRAY, Guide Moll. Brit. Mus., Jan. 1857, p. 13. Type, *Strombus norvegicus* Gmelin. Not *Strombella* Schlüter, Syst. Conch. Samml., 1838, p. 22.

Volutopsis DALL, Proc. Cal. Acad. Sci., vol. 5, 1873, p. 57.—G. O. SARS, Moll. Reg. Arct. Norv., 1878, p. 268.—DAUTZENBERG AND FISCHER, Res. Camp. Scientifiques de Monaco, 1912, p. 64.

Shell large, frequently rude or irregular, with the last whorl largest, covered with a thin, inconspicuous more or less dehiscent periostracum; spire short, blunt, beginning with a relatively large smooth bulbous nucleus; sculpture variable, smooth, spirally striate, or with indistinct wavelike axially directed prominences or even with feeble axial ribs; the aperture ample, the canal short, wide, hardly differentiated. Operculum short-ovate or rounded-quadrate, the nucleus at the right anterior corner; dentition: the rhachidian tooth with two to five small cusps, the laterals with two large arcuate cusps. In *V. castanea* Mörch the formula is $\frac{1}{2}:\frac{1}{3}:\frac{1}{2}$; in *V. norvegica* $\frac{1}{2}:\frac{1}{4}:\frac{1}{2}$, in *V. fragilis* $\frac{1}{2}:\frac{1}{5}:\frac{1}{2}$ according to Sars and Hanna. Ovicapsules large, hemispherical, attached by the whole of the flat side, containing several embryos. The species are boreal and Arctic, especially numerous in the Bering Sea region.

Having compared the Newfoundland *V. largillierti* with a large series (35 specimens) of the *V. norvegica*, I am inclined to regard them as distinct though closely related species. Mörch's type was the former; in it the nucleus is large, flattish above and with about a whorl and a half. The shell is thin and of an orange tint. In *norvegica* the enfolding of the apical whorl is almost pointed, and the nepionic shell continues in a subcylindric fashion for three or four whorls. The test is white and heavy.

In accordance with the International rules for nomenclature, I have returned to the original spelling of the name.

A feature which is not confined to this genus and which is foreshadowed in *Ancistrolepis* is that, while the species like *V. castanea* which live in shallow water near shore retain the usual long retractile proboscis and well developed functional radula, other species living in deep water have the radula degenerate in size (*V. fragilis*), the proboscis much shortened and the esophagus enlarged. From dissections made by Mr. G. Dallas Hanna under my supervision, these facts have been demonstrated. It seems that these deep water dwellers live chiefly by swallowing quantities of mud containing minute organisms, with which the stomach and esophagus were found loaded. The radula being no longer required and a long proboscis being inconvenient for the purpose, both appear to have degenerated. Something of the sort was noted by me in connection with *Ancistrolepis* in 1902, and with an abyssal trochoid mollusk (*Turcicula bairdii* Dall), in 1889. These adaptations to suit the environment would probably be found on examination of a series of species to gradually merge into one another.

Mr. Hanna finds that in *Volutopsius* and *Pyrolofusus* the radula is contained in a long sac below the esophagus and separated from it by a thick muscular septum. It emerges by a small orifice near the end of the evertible proboscis, so that on splitting open the proboscis no radula is visible. In *Chrysodomus* and *Plicifusus* on the other hand, the radula lies on the lower side of the esophageal tube covered only with a thin, not muscular, membrane. In *Beringius* (*Kennicottii* Dall) the radular sac is of the Chrysodomoid type.

Genus PYRULOFUSUS Mörch.

Pyrulofusus (Beck Ms.) Mörch, Mem. Soc. Malac. de Belgique, vol. 4, 1869, p. 20. Sole example, *Fusus deformis* Reeve.

Pirulofusus Cossmann, Essais Pal. Comp., vol. 4, 1901, p. 98, as synonym of *Chrysodomus*.

Heliotropis Dall, Proc. Cal. Acad. Sci., vol. 5, April, 1873, p. 61. Type. *Neptunea harpa* Mörch.

Pyrulofusus Friele, Jahrb. Mal. Ges., vol. 6; 1879, p. 280; N. Atl. Exp. 1882, vol. 1, p. 8, pl. 1, fig. 8; pl. 4, figs. 11–13.—Fischer, Man. de Conchyl, 1884, p. 624.—Dautzenberg and Fischer, Res. Camp. Scientifiques de Monaco, 1912, p. 67.

Pyrolofusus Krause, Arch. f. Naturg., vol. 51, 1885, p. 282; Zool. Jahrb., vol. 6, 1892, p. 362.—Friele and Greig, N. Atl. Exp., vol. 3, 1901, p. 102.—Dall, Proc. U. S. Nat. Mus., vol. 24, No. 1264, 1902, p. 523.

Shell large, relatively thin, with a very short spire and large body whorl, usually sinistral but with rare dextral individuals; nucleus very large, smooth, flat-topped, infolded with an apical dimple, subsequently spirally sculptured, with obscure axial folds; periostracum thin, dehiscent; aperture ample, the outer lip expanded and thickened, the body and pillar enameled, often brightly colored; the canal very short, shallow and wide, hardly recurved and with no evident siphonal fasciole; operculum much smaller than the aperture, rounded-quadrate with apical nucleus: radula chrysodomoid but rather irregular, the rhachidian tooth in the typical species tricuspid; the laterals with two large terminal cusps, the median cusp of the central tooth variable. Ovicapsules as in *Volutopsius*, large, solitary, and hemispherical, with few embryos. I have dextral specimens of both the sinistral species; an Arctic Pliocene form is dextral. *P. harpa* Mörch, has two strong cusps on the rhachidian tooth and two on each lateral. According to Friele the middle cusp of the rhachidian tooth in *P. deformis* is quite irregular. The *Fusus contrarius* is not a member of this genus, but merely a reversed species of *Chrysodomus*.

Genus BERINGIUS Dall.

Beringius Dall, Sci. Expl. Alaska, 1879, pl. 2, figs. 1, 1*a–c*. Sole example. *Chrysodomus crebricostatus* Dall, Proc. U. S. Nat. Mus., vol. 9, 1886, p. 304; vol. 7, 1894, p. 710; vol. 24, No. 1264, 1902, p. 529, pl. 35, fig. 1.

Jumala Friele, N. Ttl. Exp., vol. 1, 1882, p. 6. Type, *Fusus turtoni* Bean, Ann. Mag. Nat. Hist., Nov. 1893, *olim*.—Dautzenberg and Fischer, Res Camp. Scientifiques de Monaco, livr. 37, 1912, p. 62.

Ukko Friele, in Norman, Ann. Mag. Nat. Hist., ser. 6, vol. 2, 1893, p. 352.—Friele, Moll. Nordseefahrt *Michael Sars*, 1902, p. 6.

Shell dextral, large, solid, the spire usually longer than the aperture, the sculpture very variable but usually strong; the periostracum thin, dehiscent; the nucleus swollen, with several hardly increasing whorls forming a subcylindrical tip to the spire in most cases; aperture of moderate size, the outer lip slightly expanded and hardly thickened; pillar smooth, short, callous; canal short, wide, hardly recurved; operculum smaller than the aperture, subovate with apical nucleus; radula peculiar, with an edentate rhachidian plate, the laterals formed by single strong cusps with the tip incurved and two or more small blunt denticles on the inner edge near the middle. The ovicapsules are pouch-shaped, pedunculate, attached by the edge of the disk and opening at the upper edge, with few embryos.

None of the other groups here designated, except *Mohnia*, show such variation as this one in types of sculpture among the species; ranging from smooth to strongly axially ribbed, strongly spirally ridged, or finely striated.

The name *Ukko* was substituted for *Jumala* by the author, because it was found that the latter is the name by which the Christian Lapps signify the Deity. Both names are antedated by *Beringius*.

Genus LIOMESUS Stimpson.

Liomesus Stimpson, Canadian Naturalist, new ser., Oct. 1865, p. 34. Type, *Buccinum dalei* J. Sowerby.

Buccinopsis Jeffreys, British Conch., vol. 4, 1867, p. 297 (*B. dalei* J. Sowerby); Brit. Assoc. Adv. Sci. Rep. for 1868, p. 244; (not of Conrad, Emory's Rep. Mexican Boundary, vol. 1, p. 158, pl. 13, figs. 4*a*–4*b*. 1857).—Kobelt, Conch. Cab., ed. 2; *Buccinum*, p. 99, 1883.

Liomesus Harmer, Brit. Pliocene Moll., p. 115, 1914.

Shell of moderate size, bucciniform, the nucleus minute, with a very short twisted pillar, the outer lip thickened but not reflected; pillar and body smooth; the periostracum conspicuous, often villous; the operculum with apical nucleus; the rhachidian plate edentulous, the lateral teeth thorn-shaped, simple, their apices incurved without accessory denticles; the ovicapsules like those of *Beringius* but smaller.

The typical species is a Crag fossil of England, but it has long been confused with a totally distinct recent form from the Doggerbank, the earliest specific name for which is *Buccinum ovum* Turton, 1825. A later name is *Tritonium eburneum* M. Sars, 1849. The recent species of Bering Sea, like the British Pliocene fossils, are solid heavy shells, while the recent European species is thin and delicate. The radula is very long.

Genus ANCISTROLEPIS Dall.

Ancistrolepis Dall, Proc. U. S. Nat. Mus., vol. 17, 1895, p. 709. Type, *Chrysodomus eucosmius* Dall, Bering Sea; Proc. U. S. Nat. Mus., vol. 24, No. 1264, 1902, p. 523; Smithsonian Misc. Coll., No. 1727, 1907, p. 157.

Shell buccinoid, with the pillar shorter than the aperture, twisted as is usually the canal; suture channelled; nucleus beginning with a small initial cell, a blunt apex and followed by regularly increasing inflated, smooth and polished whorls; the periostracum usually coarse and villous or laminate; operculum straight, concave, fan-shaped with apical nucleus and small area of attachment; penis on a stout stalk with pediform distal extremity without any curved or attenuated terminal papilla; radula degenerate and disproportionately small, rhachidian tooth with three long subequal cusps, the laterals with a larger outer and two smaller inner curved cusps.

All of the species have spiral sculpture, some very strong. None of them has any axial ribbing. In most of them the periostracum is dehiscent and the shell substance white.

Section JAPELION Dall.

Shell with a produced spire, a very wide and sharp-edged channel in front of the suture and the periostracum adherent, polished, conspicuous. Otherwise as in the typical section so far as known.

Type.—Buccinum hirasei Pilsbry, 1901. Japan.

It is a remarkable case of convergence which has brought the typical species of this section to a point where in its specific characters it almost reproduces those of *Tritonium pericochlion* Schrenck. A casual inspection would hardly distinguish between them, but *hirasei* has the short pillar of *Ancistrolepis* while *pericochlion* has a straight long pillar and hardly recurved perfectly distinct canal. It is probable that the latter bears a relation to *Colus* such as *Sulcosipho tabulatus* does to *Chrysodomus*. But until the soft parts and operculum are known, I refrain from further action.

There are a number of groups of fossils and a few recent forms which apparently belong to the Chrysodominae, or like *Troschelia* seem to bridge the gap between this subfamily and the Fusinae. In the absence of authentic specimens it has seemed best in this review to restrict myself to the consideration of the boreal and Arctic forms of which the United States National Museum possesses a quite unequaled series.

The position of *Sulcosinus* will remain undetermined until specimens are obtained containing the living animal. Its conspicuously thickened continuous peristome is not paralleled either in the Buccininae or Chrysodominae.

DESCRIPTIONS OF SPECIES.

TURRIS (CRASSISPIRA!) RUGITECTA, new species.

Shell solid, moderately large with ten whorls, exclusive of the (lost) nucleus, blackish brown with a broad pale peripheral band; axial sculpture of about (on the penultimate whorl 17) short oblique similar ribs, beginning at the shoulder and on the last whorl gradually becoming obsolete toward the canal, separated by subequal interspaces; spiral sculpture of in front of the suture a prominent blunt keel, in the anal fasciole two or three subequal cords; in front of the shoulder (on the penultimate whorl four, on the last whorl twelve or more) flattish equal cords overrunning the ribs, separated by narrower grooves which toward the canal become gradually wider; apex acute, last whorl more than half of the length of the shell, aperture rather narrow, smooth within, the enamel dark brown except where the pale band reaches the margin of the outer lip; anal sinus wide, not very deep, rounded proximally, canal wide, short, slightly curved to the right, with no siphonal fasciole. Length of shell 30; of last whorl 16; of aperture 12; maximum diameter of shell 10 mm.

Habitat.—Lower California, off San Bartolomé Bay, Dr. Paul Bartsch. U. S. Nat. Mus., Cat. No. 266911.

This is a remarkably fine species, less black than most of the species of *Crassispira.* Toward the upper part of the spire the spaces between the ribs remain brown, but on the later whorls they partake of the waxen pale band as well as the ribs.

PLICIFUSUS (RETIFUSUS) SCISSURATUS, new species.

Shell slender, elongate, acute, with grayish buff colored periostracum and about eight whorls without the (lost) nucleus; suture distinct, slightly appressed; whorls moderately convex; axial sculpture on the penultimate whorl of about thirteen narrow, rounded, retractively arcuate plications extending from suture to suture and on the last whorl over the periphery to become obsolete on the base; spiral sculpture of (on the penultimate whorl 10–11) straplike flattish bands separated by narrow deeply cut grooves, and divided by a shallower groove in the center of each spiral; these bands are practically uniform over the whole surface; aperture sublunate, the canal wide, recurved, half as long as the aperture; outer lip recurved, thin, white, the throat more or less livid; pillar white, erased, arcuate, obliquely truncate in front, the fasciole inconspicuous. Length of shell 55; of last whorl 35; of aperture and canal 25; maximum diameter of last whorl 19 mm.

Habitat.—Nemuro, Japan. Hirasé collection, U. S. Nat. Mus., Cat. No. 274071.

This species belongs to the group of *P. yessoënsis* Schrenck (*manchuricus* E. A. Smith) but is much larger than that species, the periostracum lighter and polished, the canal relatively longer, and the whole shell relatively more slender.

PLICIFUSUS (AULACOFUSUS) RHYSSOIDES, new species.

Shell slender, fusiform, with an olivaceous periostracum, and about seven whorls, nucleus more or less eroded but apparently globose and blunt; penultimate whorl with thirteen retractively arcuate rounded plications with about equal interspaces, extending from suture to suture and obsolete on the periphery of the last whorl; the suture distinct but not constricted; spiral sculpture of fine equal close-set rounded threads, about three to a millimeter, slightly sparser toward the canal; aperture semilunate, white within, the outer lip slightly expanded; canal short, wide, recurved; the pillar white, slightly arcuate, erased, obliquely truncate in front, the siphonal fasciole faint. Length of shell 49; of last whorl 30; of aperture 20; maximum diameter of last whorl 18 mm.

Habitat.—Rikuzen, Japan. Hirasé collection. Cotype, U. S. Nat. Mus., Cat. No. 274069.

The operculum is thin, pale yellowish-brown, the apex strongly incurved. This species is quite close to *P. rhyssus* Dall, from which it differs in its more fusiform shape, less inflated whorls, less constricted suture, and, in the specimens available, lighter colored periostracum. The incurvation of the apex of the operculum suggests an approach toward *Mohnia.*

PLICIFUSUS (LATIFUSUS) WAKASANUS, new species.

Shell of moderate size, thin and light, covered by a yellowish-brown smooth periostracum, with six moderately rounded whorls without the (lacking) nucleus; suture distinct, not appressed; whorls axially sculptured with (on the penultimate whorl 15–18) retractively arcuate plications, strongest near the suture, barely crossing the periphery, and becoming gradually obsolete on the last whorl; the plications are rounded, not sharply defined, and have about equal interspaces; spiral sculpture of numerous equal flattish threads with narrower interspaces, about three threads to a millimeter, this sculpture covering evenly the whole surface; aperture semilunate, interior and pillar white; outer lip slightly expanded, pillar straight, anteriorly obliquely truncate; canal short, recurved, with no marked siphonal fasciole. Length of shell 40; of last whorl 28; of aperture 18; maximum diameter of last whorl 17 mm.

Habitat.—Wakasa, Sea of Japan. Hirasé collection.

This belongs to the group represented on the American coast by *Plicifusus* (*Latifusus*) *griseus* Dall.

COLUS (LATISIPHO) LEPIDUS, new species.

Shell very thin, with a strong, smooth, yellowish-brown periostracum which in drying comes away from or cracks the thin calcareous portion of the shell; whorls six without the (deficient) nucleus, moderately inflated, with the appressed suture somewhat constricted; in front of the suture there are whitish radiating ill-defined patches which in some specimens might almost attain to something like a color pattern; the apical whorls of the best preserved specimen are decorticated and slightly eroded, but bear the remains of about seven oblique short plications which apparently did not reach the sutures; the later three whorls are smooth, except for a few very faint irregular indications of spiral threads; the aperture is short, roughly semilunate, with the outer lip slightly expanded and reflected; the pillar is straight, white and somewhat callous; the color within the aperture livid purplish; the canal short, slightly twisted, with no marked siphonal fasciole. Length of shell 40, of last whorl 25, of aperture 15; maximum diameter of last whorl 17 mm. Another specimen increases more rapidly in diameter, that of the last whorl measuring 20 mm.

Habitat.—Iterup Island of the Kuril group. Hirasé collection.

There is nothing on the American coast that resembles this species, and the color painting is unique among the species of the region. Unfortunately both the specimens are more or less broken and eroded.

COLUS (LIMATOFUSUS) TAHWITANUS, new species.

Shell small, buccinoid, with about six whorls; nucleus eroded, suture deep, not appressed; whorls well rounded; sculpture of fine even uniform grooves with wider flat interspaces over the whole shell; periostracum dull, olivaceous; interior white, outer lip reflected, arcuate; pillar and body erased, axis twisted, almost pervious, canal very short and strongly recurved. Height 33; max. diameter 17 mm.

Habitat.—Off Tahwit Head, Washington, in 178 fathoms, mud. U. S. Nat. Mus. Cat. No. 122632.

SEARLESIA CONSTRICTA, new species.

Shell dark purplish brown, strongly constricted and appressed at the suture, rude and with no visible periostracum, with about six prominently rounded whorls without the (decollate) nucleus; axial sculpture of (on the penultimate whorl 12) prominent nearly straight rounded riblets which become obsolete toward the sutures and on the last half of the last whorl; spiral sculpture on the earlier whorls of strong rounded threads overrunning the plications without nodosities. and alternated with one or two intercalary smaller threads all close-set; this alternation continues over the shell, but is less conspicuous on the last whorl; aperture semilunate, livid brown within, pinched to a notch by the sutural constriction; outer lip somewhat thickened, not reflected, lirate within (with about 15 lirae); inner lip with a thin coating of brownish enamel and three sharp subsutural lirae in the adult, close to the subsutural notch; pillar nearly straight, canal narrow, strongly recurved, short, with a very conspicuous flaring siphonal fasciole, with a chink between it and the reflected enamel of the inner lip; operculum small for the size of the aperture, brownish, with apical nucleus. Length of shell 44; of last whorl 29; of aperture and canal 19; of operculum 7.5; maximum diameter of last whorl 17.5 mm.

Habitat.—Fusan, Korea. Hirasé collection. Cotype, U. S. Nat. Mus., Cat. No. 247072.

This shell belongs to the group of *C. dirus* Reeve (*incisus* Gould), of the west coast of America, and which includes "*Euthria*" *viridula* Dunker (? *ferrea* Reeve) of Japan. The probabilities are against the identification of the northern group, which has received the name of *Searlesia* from Harmer, with the Magellanic *Euthria* typified by *E. plumbea;* so I have accepted Harmer's name for a group which appears to be largely represented by species in the North Atlantic Pliocene, and in regard to the generic affinities of which very diverse opinions have been expressed.

ANCISTROLEPIS LATUS, new species.

Shell large, solid, pale orange color under the (lost) periostracum, with two nuclear and five subsequent whorls rapidly enlarging; nuclear whorls beginning with a minute apex followed by two rounded, smooth, inflated, equal whorls with a deeply constricted suture forming a subcylindrical apex to the mature shell; later whorls with a wide and deep channel in front of the suture bounded in front by a sharp thin elevated keel; the remainder of the surface with numerous, obsolete flat spiral ridges which are larger and more perceptible on the base of the last whorl, where (in the type) six may be discerned, with narrower interspaces; axial sculpture of rather rude incremental lines; aperture wide, notched at the end of the keel; outer lip sharp, rounded; inner lip with a smooth continuous callus, its edge slightly raised; canal very short and wide; siphonal fasciole well marked; interior of the aperture orange and white, concentrically zoned. Length of shell 100; of last whorl 75; of aperture 57; maximum width of shell 70 mm.

Habitat.—Quelpart Island, south of Korea. Hirasé. Type in Hirasé collection.

This species is wider with a wider presutural channel and more elevated keel than *A. magnus* Dall, to which it is of described species most nearly allied. The latter has a smaller and shorter nucleus and white shell substance. It is also a lighter and thinner shell. It is possible, judging from some of the other species, that the spiral ridges which are obsolete in the type-specimen, may in other individuals be stronger and more elevated. The operculum is unknown.

ANCISTROLEPIS DAMON Dall.

Chrysodomus (*Ancistrolepis*) *damon* DALL, Smithsonian Misc. Coll., No. 1727, p. 157, 1907.

The original specimen of this species from which it was described had a single low keel at the shoulder and half a dozen nearly obsolete ridges on the base. Specimens from Nemuro, Yesso, sent by Mr. Hirasé have five prominent cords on the base with wider interspaces, and the spiral striation quite perceptible over the whole surface. There is also a cord in front of the suture, between it and the shoulder keel. Another specimen from the same locality has in addition two strong equidistant cords on the periphery in front of the keel. For these quite distinct looking forms. I propose the varietal name of *polygramma*.

SIPHONALIA LUBRICA, new species.

Shell slender, acute, with about seven whorls and a nucleus of somewhat less than two additional whorls; with brown flammulations and more or less interrupted spiral rows of brown dots on a yellowish-white ground; nucleus smooth, polished, flat-topped with the whorls inflated; subsequent whorls sculptured with (on the penultimate whorl 12) short rounded axial riblets at the shoulder of the whorl but more or less obsolete above and below, and varying in extent on the spire in different specimens; these are separated by narrower interspaces and may be obsolete on the last whorl and a half; spiral sculpture of close-set inconspicuous threads more or less flattened on the last whorl and rarely with occasional smaller intercalary threads; suture rather constricted and strongly appressed; aperture rounded, the outer lip thin and sharp; when mature (and not worn by hermit crabs) with eight or ten lirations a little within the margin of the outer lip; a small, prominent subsutural callus on the body and another at the margin of the canal on the concavely arcuate pillar-lip; throat and pillar white, the latter slightly erased; canal narrow, long, strongly recurved, the fasciole not prominent. Length of shell 59; of last whorl 40; of aperture 18; of the canal 17; maximum diameter of last whorl 22 mm.

Habitat.—Tosa and Nagasaki, Japan. Hirasé collection.

This species is rather exceptional in its slender form and polished surface. The operculum was not preserved. The prominent callus on the edge of the pillar at the inception of the canal gives it somewhat the aspect of a *Fasciolaria*.

BUCCINUM SIMULATUM Dall.

Buccinum simulatum Dall, Smithsonian Misc. Coll., No. 1727, p. 150, 1907. Petrel Bank, Bering Sea, in 54 fathoms.

Habitat.—Akkeshi, Yesso. Hirasé collection.

The Japanese specimen differs from that from Bering Sea, in having the sculpture a little more prominent and the axial plications smaller, more distinct, and numerous. These differences, however, are well within specific limits in this genus.

BUCCINUM GLACIALE, var. PARALLELUM Dall.

Tritonium carinatum Dunker, Novit. Conch. Moll. Marina, p. 1, pl. 2, figs. 3, 4, 1858. Not *Buccinum carinatum* Gmelin, 1792, or Turton, 1819.

Buccinum angulosum Mörch, in Dunker, Novit. Conch. Moll. Marina, pl. 2, figs. 3, 4, explanation on plate. Not *B. angulosum* Gray, 1839.

This variety of *B. glaciale* seems confined to the Bering Sea region and many specimens reach a length of 80–85 mm., while I have one 95 mm. in length from Atka Island, Aleutians. Mr. Hirasé, however, has reached the other extreme by sending a specimen quite mature and characteristic which is probably a male, and measures only 26 millimeters long. It is from Iterup Island of the Kuril group.

Both the names previously given to this variety were preoccupied for other species.

BUCCINUM STRIATISSIMUM Sowerby.

Buccinum striatissimum Sowerby, Ann. Mag. Nat. Hist., ser. 7, vol. 4, p. 370, fig. 1, 1899.

The typical form of this species is the fine large shell figured by Sowerby. In the northern dredgings there are numerous apparently adult shells of a stout and stumpy character, whose thickset appearance is increased by the fact that the apex is usually eroded. These on examination prove to be nearly all males, a few immature females forming the exceptions. I showed years ago that in certain species of *Buccinum* the males were usually very much smaller than the females, who have to carry the vast mass of material composing their heaps of agglutinated ovicapsules. This does not seem to be true of all the species of *Buccinum*, but is markedly so in *B. cyaneum* and *B. hydrophanum* Hancock, and appears to be so in the case of *B. striatissimum*. The variety of *B. undatum* which lives on the coast of New England has two races of males, one of nearly the size of the average female, and another conspicuously dwarfed.

This small thick male *B. striatissimum* has such a different aspect from that of the large thin females that it might easily be taken for a distinct form.

BOREOTROPHON XESTRA, new species.

Shell fusiform with about six moderately rounded whorls, white with a thin chalky external layer, and distinct suture; last whorl axially sculptured with sixteen sharp elevated laminae, continuous over the whorl but obsolete on the canal, and rising in a short triangular spine at the shoulder; there are also rather strong axial lines of growth irregularly distributed; there is no spiral sculpture; aperture rounded, outer lip sharp, slightly expanded, inner lip smooth, white, with a thin layer of enamel; pillar obliquely truncate at the proximal end of the canal; canal narrow, long, arcuate, slightly recurved. Length of shell 34; of last whorl 27; of canal and aperture 20; maximum diameter of last whorl 19 mm.

Habitat.—Station 4813 of U. S. S. *Albatross*, in 200 fathoms, mud and sand, off Sado Island, Japan, bottom temperature 33°.9 Fahrenheit. U. S. Nat. Mus. Cat. No. 205508. Also at Sagami, Japan, Hirasé collection.

This belongs to the group of *B. cepula* Sowerby, than which it is more delicate, with a longer spire and generally thinner shell. The Hirasé specimens were immature.

BOREOTROPHON ECHINUS, new species.

Shell thin, yellowish white, fusiform, with about six post-nuclear whorls; nucleus small, smooth, with about two laxly coiled whorls; subsequent whorls spirally sculptured with from one to three strong, rather distant cords, the posterior cord being at the shoulder of the whorl; on the last whorl there may be five to eight of these cords, those on the canal being more or less obscure; at their intersection with the varices these cords develop guttered spines, usually only the spine on the posterior cord at the shoulder is prominent and this in a well developed specimen may be long and deeply recurved, even sickle-shaped, while in less well developed specimens there may be only an ordinary triangular anteriorly grooved short spine; the slope between the shoulder and the suture behind it has no spiral sculpture; axial sculpture of thin sharp varices varying from ten to seven, less numerous on the later whorls and more or less spinose at the intersections with the cords; aperture sublunate, outer lip sharp, thin, slightly expanded; canal rather long, sometimes bifurcated by the end of the previously formed canal, rather tortuous, narrow, and recurved; inner lip concavely arcuate, smooth. Length of shell 36; of last whorl 30; of aperture and canal 22; maximum diameter (excluding spines) 13 mm. Another specimen is about one-third longer.

Habitat.—Sagami, Japan. Hirasé collection. Cotype, U. S. Nat. Mus. Cat. No. 274076.

This very elegant species belongs in the group of *B. stuarti* Edgar Smith, of the west American fauna, and is subject to the modifications of sculpture which I have elsewhere discussed in this genus.

ANACHIS BARTSCHII, new species.

Shell small, polished, white, with (on the upper whorls one, on the penultimate whorl two, and on the last whorl one near the suture, two at the periphery, and three to five on the base) narrow brown spiral lines; between the peripheral pair on the ribs is a series of squarish, nearly black spots, about eleven on the last whorl, but sometimes a rib is skipped; whorls seven, spire acute; nucleus white, small, smooth, blunt, of a whorl and a half; axial sculpture of eleven or twelve rounded, nearly vertical, equal and equally spaced ribs, with subequal interspaces, extending from the suture well beyond the periphery; spiral sculpture of a few faint striae near the end of the canal; behind the outer lip is a slight varicose swelling; aperture less than half the length of the shell; outer lip thickened, with a sharp edge, internally with four small denticulations; body erased, pillar smooth, canal short, rather deeply sinuous, the axis minutely pervious. Length of shell 8; of last whorl 4.7; of aperture 3; maximum diameter of shell 3.5 mm.

Habitat.—Mazatlan, Mexico. Dr. Paul Bartsch. Type in United States National Museum, Cat. No. 265463.

This is one of the prettiest species of the group from the Gulf region. The painting recalls that of *A. azora* Duclos, from the Mauritius, but the latter has strong denticulations on the pillar lip.

LEPETA (CRYPTOCTENIDIA) LIMA, new species.

Shell large for the genus, ovate, with a convexly arcuate back, the apex one-fourth the total length from the anterior edge, the anterior slope straight or slightly concave; sculpture of concentric close-set sharp slightly elevated lamellae over-running numerous narrow, elevated, clean-cut threads which radiate from the apex to the periphery with equal or wider interspaces, and scaly at the intersections; the sculpture is uniform over the whole surface and rasplike to the touch; shell white, usually discolored by a ferruginous coating externally, the interior bluish white, more or less translucent. Length of shell 37; width 30; height of apex above the base 10 mm.

Habitat.—Nemuro, Yesso, Japan. Hirasé collection. U. S. Nat. Mus. Cat. No. 274074.

This is sharply distinguished by its size and rasplike surface from any of the other species. The name *Cryptobranchia* having been used by Gray, thirty years before Middendorff's application of it to the present group, I substitute *Cryptoctenidia*.

VENERICARDIA (CYCLOCARDIA) MORSEI, new species.

Shell of moderate size, solid, moderately inflated, covered by a yellowish horny periostracum; the umbones rather acute, prosocoelous, over a short, rounded, deeply impressed lunule; sculpture of 17–18 radiating arcuate ribs, rendered slightly nodulous in places by rude, conspicuous, rather irregular lines of growth, and separated by subequal, almost channelled, interspaces; interior yellowish white, the muscular impressions rather deep, the hinge normal, the margin with squarish crenulations; the ligament as long as the posterior hinge-line. Height of shell 28; width 25; diameter 15 mm.

Habitat.—Sagami, Japan. Hirasé collection. Cotype, U. S. Nat. Mus. Cat. No. 274075.

This species has a remarkable superficial resemblance to *V. borealis* Conrad, of the North Atlantic, and, without careful comparison, would be unhesitatingly referred to that species. The number of rays is the same, the profile is very similar, and the color not very different. However, a close examination shows that in the Japanese species the periostracum is horny, not villous; the lunule is short, rounded and deep, not long, narrow and shallow; the valves are more inflated; the radiating sculpture is more prominent, the interspaces are more sharply defined, and the anterior cardinal tooth averages narrower. The present species is named in honor of Prof. Edward S. Morse, who has published on this genus. There is no closely related species on the Pacific coast of America.

VENERICARDIA HIRASEI, new species.

Shell solid, subquadrate, suffused with light brown and rose color, inflated, equivalve, inequilateral, the beaks high, strongly incurved, prosocoelous; umbones one-sixth the total length from the anterior end, overhanging a deeply impressed short-cordate unsculptured lunule; radial sculpture of 29–30 narrow prominent equal and equally distributed ribs with subequal channelled interspaces; these ribs are spinose with each spine issuing from the interior of its predecessor, the distal margin of the cup of each spine in the middle part of the disk being thickened into a conspicuous ring out of which the next spine issues, as in some Cardiums; in the middle of the shell there are about four spines to the length of five millimeters along the rib; interior white, the hinge normal, the lower valve-margin crenate by the sculpture. Length of shell 37; height 30; diameter 30 mm.

Habitat.—Kii, Japan. Hirasé collection.

This very handsome *Venericardia* has no very close relatives in the genus, perhaps the *V. spinosa* Lamarck of the Mediterranean being as near as any. There is nothing like it on the Pacific coast of America.

THE HOPI INDIAN COLLECTION IN THE UNITED STATES NATIONAL MUSEUM.

By WALTER HOUGH,
Curator of Ethnology, United States National Museum.

INTRODUCTION.

This publication aims to give an impression of the arts and industries of a tribe of Pueblo Indians at a period when they were little modified by outside influences. It may serve as a guide to the Hopi collection now exhibited in the Natural History building of the United States National Museum. Handbooks of this character which are made up virtually of extended labels of the collections are projected for other sections of the exhibit of Ethnology.

The following descriptive label for the family group case displayed in the west north hall of the Natural History Museum of the Smithsonian Institution in Washington gives a brief account of the Hopi:

> The Hopi Indians occupy stone-built villages in northeastern Arizona. They were first seen by white men in 1540 when Tobar and Padilla were dispatched by Coronado to visit them. On account of the isolation of their country, they have preserved to a greater degree than other tribes the arts and customs of the Pueblos. They are farmers and depend mainly upon corn for their subsistence. Among the arts in which they are skillful, are weaving, basket-making, and wood-carving, and in the minor art of cookery they are widely known among the Indians. The group represents the parching, grinding, and baking of maize which goes on in every household. A woman and little girl grind on the slanting millstones the corn prepared by the parcher. The baker spreads with her hand the batter on the heated stone slab and the result is the paperlike bread called piki. Another woman is weaving a basket of yucca leaves. The man brings in from the field a backload of corn ears and the boy exhibits triumphantly a rabbit which he has killed with the curved boomerang club peculiar to the Hopi.

AGRICULTURE AND REARING.

Agriculture is the principal occupation of the Hopi. They are industrious and resourceful tillers of the soil under conditions which would seem hopeless to a farmer. Their efforts are principally devoted to raising corn, but wheat, beans, squashes, and common vegetables are grown. They preserve an agriculture of native cotton, *Gossypium hopi*, which they use for ceremonial purposes.[1]

[1] Lewton, F. L., The Cotton of the Hopi Indians: a new species of Gossypium, Smithsonian Misc. Coll., vol. 60, No. 6, Oct. 23, 1912.

Corn is planted in the sandy soil along the washes, dependence for its ripening being placed on the winter snows and the summer thunderstorms. In spite of the conditions, large quantities of corn are produced. The fields are cleared of brush in February and leveled. Planting begins in April and the crop is gathered in September. Spring frosts and sandstorms are drawbacks to the success of the crops, and sometimes floods injure the low-lying fields. The tools used are a planting stick usually with wedge point (pl. 19, fig. 4), but sometimes having a blade (pl. 19, fig. 5). A hole is dug and from 6 to 12 or more grains placed therein and covered. The hills are about 6 feet apart. The plant is small and rarely 5 feet high, the ears shooting near the ground.

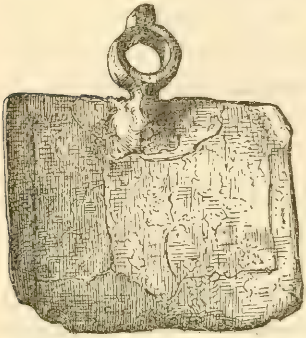


FIG. 1.—IRON BROAD HOE OF SPANISH PATTERN.

The field is kept clear of weeds by means of hoes, usually the heavy homemade blade of Spanish pattern, like those seen among the Rio Grande Pueblos (fig. 1), sometimes of wood (pl. 19, fig. 6), and anciently, according to tradition, of stone. These implements are smooth spatulate blades of fine stone (see Archeology, second floor, east side), found mostly in the northern cliff-house region, but never in ancient Hopi sites. The Hopi call them *wiki*, hoes, regard them as sacred objects, and place them on the altars of some of their ceremonies, but there is little evidence that the fine spatulate stones were actual hoes, though the Hopi may have anciently used stone hoes. The wooden hand trowel for tending plants appears to be a survival (fig. 2).

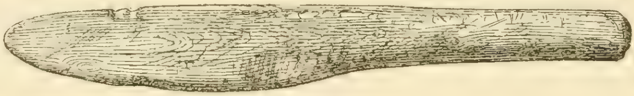


FIG. 2.—HAND DIBBLE OF WOOD.

Corn is gathered by removing the ears and transporting them to the pueblo in wicker carrying baskets on the back (see family group) or in blankets over the back or on the burro. The fodder is gathered by breaking off the stalks and tying them in bundles. It is usually almost valueless, as the leaves are frayed or whipped off by the wind. Much of it is used in the green state during the roasting-ear season, when a part of the crop is baked

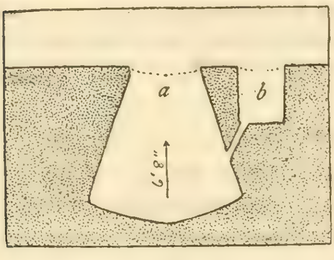


FIG. 3.—FIELD PIT OVEN FOR ROASTING GREEN CORN; *a*, FIRE PIT; *b*, FLUE.

in field pit ovens (fig. 3), and either eaten at feasts or strung on cord to be dried for winter provision. Husking pegs of bone or wood have been observed among the Hopi, but it is not known that this implement is ancient. Corn ears are stored in the house in a place reserved for the purpose, is often sorted by the colors, and is occasionally taken out, sunned, and brushed to free it from dust and insects (pl. 20). It is also stored by crops, one year's being held over in case of failure due to a bad season. This custom is said to have arisen on account of famines, which have often plagued the Hopi in former years. Hopi corn is a pure breed of ancient strain, 12 rowed, white, yellow, red, carmine, dark blue, black, and variegated. The cobs are slender, the ears 5–7 inches long, generally perfect, and the grains regular and not indented (pl. 21).

The Hopi have also pop corn and sweet or sugar corn, both probably introduced. Sweet corn is referred to as the particular possession of the Middle Mesa Pueblo Shemopavi, where it is raised in some amount.[1]

In the cornfields scarecrows consisting of sheep scapulae, tin cans, etc. (pl. 22, fig. 3), are set up.

For cleaning brush from the fields, a curious rake-fork is used (pl. 19, fig. 1, Cat. No. 128767, collected by Mrs. M. C. Stevenson). It consists of a three-tined branch of a juniper tree, peeled, and across the tines is secured by lashing a strengthening rod of wood.

For picking the fruit of the prickly pear, wooden tweezers, *natcha*, are used (pl. 19, figs. 2, 3). The fruit is picked with the tweezers and rolled in sand until the spines are removed. The Navaho, Zuñi, Pima, Papago, and other southwestern tribes use similar implements.

A great number of varieties of beans are grown by the Hopi and these form a substantial addition to their fare. They are named *pala mozhri*, red beans, *avatch mozhri*, speckled beans, etc., from their color or markings. Success also sometimes attends the planting of peas. Squashes, gourds, pumpkins, melons, and onions are raised. As in Mexico, the flowers of the squash are much appreciated as a dainty food.

Of cultivated fruits, the Hopi have only peaches which were introduced among the Pueblos several centuries ago by the Spaniards. The trees are planted on sand slopes below the pueblos and as there are no peach diseases or insect enemies in the region, they flourish to a considerable age. At this elevation, however (6,500 feet), frosts render the crop precarious. The Hopi are extravagantly fond of the fruit and a good yield is a matter of great rejoicing. The berries of the rhus and prickly pears furnish the only native fruits in the immediate environment of the Hopi.

[1] Collins, G. N., A drought-resisting adaptation in seedlings of Hopi maize, Journ. Agricultural research, Washington, D. C., vol. 1, No. 4, Jan. 10, 1914.

DOMESTICATION.

At the time of the arrival of the Spaniards the Hopi had two domestic animals, the dog and the turkey. The dog appears to have been a short-legged species,[1] resembling a dachshund. The name given this animal is *poko*, which also means pet or attendant animal of the world quarter beings. Bones of the dog are not infrequently dug up. The skull of a dog was excavated from a grave at Chavez Pass, Arizona,[2] the specimen being polished, as though from use as a fetish or object of special care.

The turkey is the only bird that was domesticated by the American Indians north of Mexico. In the latter country the turkey was a familiar domestic animal, and in the Pueblo region the same condition of affairs seems to have prevailed since early times. The turkey is mentioned in the Zuñi cosmogenic legend, and its tail-feather markings are said to be caused by the slime of the earlier wet world. It is a sacred bird, probably never eaten but preserved for its feathers, which were used both for ceremonial and practical purposes in *pahos* and in preparing the feather cord from which garments were constructed.[3]

The Hopi have received from the white man horses, burros, cattle, sheep, goats, pigs, chickens, and cats. It is difficult to say in what order the animals came into the possession of the Hopi, but in point of usefulness the smaller animals are first. (A bell of horns for grazing animals is shown in pl. 22, fig. 1.) The care of cattle necessitates the use of the horse, and it is probable that the Hopi acquired these animals late and never owned them in number. The burro, however, is an animal suited to meager environments, and has become inseparable from the Hopi economy. With the larger animals came rude harness, spurs, whip, hobbles, the lariat, and other articles connected with them (pl. 22, fig. 4).

In the humane treatment of animals the Hopi has much to learn. Horses are often overworked and starved, and the goad is sometimes cruelly used on the weak, jaded animals. Burros are "punished" for stealing, the penalty being the loss of an ear. Some old offenders have suffered the loss of both ears. The Hopi does not appear to be intentionally cruel; he is rather childishly careless of the rights of the dumb creatures under his charge. The equipments rendered necessary by the introduction of the horse are crude compared with those of the Navaho, and reflect the scanty resources of the Hopi and their incomplete utilization of the horse, again losing

[1] Lucas, F. A., A dog of the ancient Pueblos, Science, n. s., vol. 5, No. 118, April 2, 1897, p. 543–544.

[2] Fewkes, J. W., Two summers' work in Pueblo ruins, 22d Ann. Rept. Bur. Amer. Ethn., p. 27.

[3] Hough, Bull. 87, U. S. Nat. Mus., 1914, p. 71.

in comparison with the Navaho, who are the best horsemen in the Southwest.

The Hopi depend almost entirely upon their flocks of sheep and goats for the material for clothing and for animal food. The sheep apparently do not differ from those of the Navaho, whose flocks are mostly mongrel interbred animals whose fleece is coarse and full of chaffy useless fibers called kemp by wool graders. The fiber is very strong and serves well for the manufacture of coarse stuffs. Hopi sheep are herded with goats whose courage and aggressiveness serve to protect the weaker sheep. The flocks are constantly tended by herders while grazing. At nightfall they are driven into stone corrals, located on the wide ledges just below the pueblo. The herders are usually women and children, but the men also are charged with the responsibility when the numerous ceremonials do not require their attention. A crook is used in herding and the sheep are sheared with the iron shears of commerce. Sundry piles of stone set up in various places are said to be for the purpose of guiding the herders in driving their charges, probably with regard to the boundaries of communal or clan lands.

Chickens are kept in some number for eggs, which are sold to the white people when the latter can be induced to buy. Sometimes a coop is built on the house roof for the chickens, but usually they roost in the rooms. They do not thrive, principally on account of insect pests.

Dogs are plentiful in the Hopi villages, where they lie around sleeping in the shade all day. Their nocturnal habits appear in the excursions, yelping and fighting, in which they engage after sundown in the pueblos. They are mongrels of little use except as scavengers and for hunting rabbits. Cats are very scarce and die soon under the severe conditions as to food and water in the pueblos.

DOMESTIC ECONOMY.

The Pueblos are better provided with vessels for various domestic use than any other tribes, and this accords with their great advancement in domestic science. With apparently small advantages to be derived from an environment that seems to offer little for material needs, the Hopi present a striking example of resourcefulness. The chief necessity in this arid region is for containers adapted for water, salt, seeds, for cooking purposes, and other multifarious uses; and this need was supplied by pottery, which even at the earliest time at which the Hopi are known to investigators was greatly diversified in form, texture, and ornamentation. Plate 23 shows: Figure 1, a dipper; figure 2, a salt vessel; figure 3, a condiment bowl; figures 4 and 8, bottle forms for water; figure 6, spoon; figure 5, a water vase; and figure 7, a food bowl.

Vessels of wood.—Vessels of wood were uncommon and were usually procured only when natural shells or knots suggested the use as spoons or small bowls. The cottonwood, which may be termed the culture tree of the Hopi, decayed easily, forming hollow cylinders which were adapted with not much work to the shells of drums and gave this tribe their only idea of a boat, expressed in the snake legend. The roots of this tree being of even grain, soft and easily worked, were the favorite material for feather boxes and gaming cups. (See pls. 43, 48.) Feather boxes for holding the plumage necessary for *pahos* and the decoration of religious paraphernalia are by far the most common wooden vessels employed by these Indians. (See pl. 43, figs. 2, 3, 4; and fig. 4.)

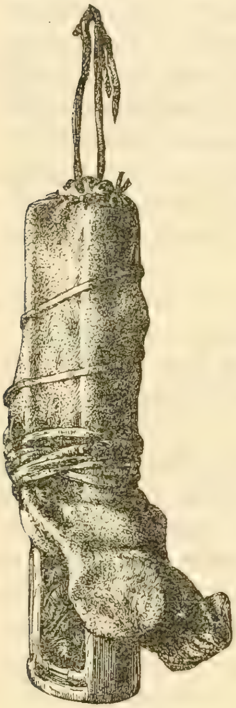


Fig. 4.—Box with buck skin cover for sacred feathers.

Vessels of skin, etc.—Vessels of skin, rawhide, or membrane were also of slight value in the Hopi domestic economy, and those now or recently found in the villages were of scrota of the domestic goat, made by distending the membrane with sand, leaving to dry, and fitting with a rim of bent branch of rhus over which the skin was turned and stitched with sinew. The Hopi, however, knew how to work rawhide into masks, decoys, etc.

Gourds.—The light, strong rind of the cultivated gourd marked this plant for a wide range of usefulness among the Hopi. Despite the discovery of pottery with its attendant economies, the gourd continued in favor, its lightness and strength being valuable qualities, while its use was not superseded by basketry, which brought in vessels that were lighter than pottery and nonbreakable.

The species of gourd cultivated by the Hopi are small, and the imposing gourd vessels such as are seen about the Pima houses are absent from the Hopi economics. The small gourds, however, are very useful for many purposes, and the shell, which is more available and more easily worked than wood, has numerous applications. In connection with water the gourd is used for dippers (pl. 24, fig. 3, pl. 22, fig. 2) spring bailers, sacred water vessels (pl. 24, fig. 2) and canteens; for household use, as spoons, cups, and dippers; as tools, for pottery smoothers, and cups for paint; for special use, as seed bottles and vessels (pl. 24, figs. 1, 4, 5), medicine holders, powder horns, etc.; in music, as horns, trumpets, flutes, bells, and rattles; in games, as pea shooters, etc.; in religious paraphernalia, as parts of masks such as noses, horns, flowers, etc., the mask head of the serpent effigy, also for containing sacred honey and water, and as *pahos;* in art, as gourds decorated with symbolic designs. The gourd has always been fertile in suggestion to the Hopi and to the tribes of man, as illustrated by the adaptations for masks mentioned above and for the forms it has impressed upon pottery and basketry.

Cradles.—The Hopi cradle is of two types, the one commonly used consisting of a yoke made by bending a sapling of green wood and weaving across it wicker work of rhus stems (pl. 25, fig. 2). A bow also of wicker is adjusted at the upper end of the cradle to protect the face of the infant. A carrying cord is attached to the limbs of the yoke about one-third of the length of the cradle below the head. An orifice is left in the wicker work of the cradle at the proper place for adjusting an absorbent mass of frayed cedar bark under the infant. The baby is folded in a blanket, laid on the cradle and secured to it by means of a woven belt or band of cloth wound continuously around the cradle and infant. The cradle described above is peculiar to the East Mesa and Oraibi. The other type of cradle consists of a thin board with rounded ends and has a collapsible bow made of three withes held in position by cords (pl. 25, fig. 1). The margin of the plank has holes burnt or bored through it in which cord loops are fastened. The band for securing the infant on the cradle is rove through these loops. This type of cradle is peculiar to the Middle Mesa. It is more difficult to make than the wicker cradle, since the working out of a board by primitive methods presents an almost insuperable obstacle. In recent years boards from packing boxes have been utilized for cradles. The old cradles have been preserved for generations and are worn thin and smooth from long use. Especially is the wear noticeable where the head of the infant comes in contact with the board. The cradle of the Hopi appears to be a survival from a former environment which entailed the use of a pack cradle whose necessity is apparent among tribes not having fixed habitations. The Hopi now use the cradle merely as a bed for the infant during its period of sleep, the secondary explanation being that lashing in the confines of the cradle will make the child grow straight, and with this object in view especial attention is given to a boy. The effect of the hard cradle in producing deformation of the skull has been noticeable and the flattened back of the cranium of the Hopi and most other Pueblos is very characteristic. This deformation is observed in the most ancient crania recovered from the graves in this region.

Fire-making tools.—Like many other tribes of the world, the Hopi have preserved their primitive wood friction fire-making implements for the purpose of religion. The abandonment of the fire sticks in practical use, however, is recent, and all Hopi men still know the method. The apparatus consists of a spindle and the tablet of wood upon which it is rotated, kindling of rubbed cedar bark and a roll of cedar bark used as a slow match (pl. 26, figs. 1-3). The drill and hearth are made of the root of the cottonwood, a material of peculiar excellence for the purpose. In the New Fire Ceremony the lower piece or hearth employed is made of sandstone, a custom unique in the history of fire-making.

COSTUME AND ADORNMENT.

Man's costume.—There is evidence that formerly when skins were more plentiful the Hopi men sometimes wore shirt coats of tanned

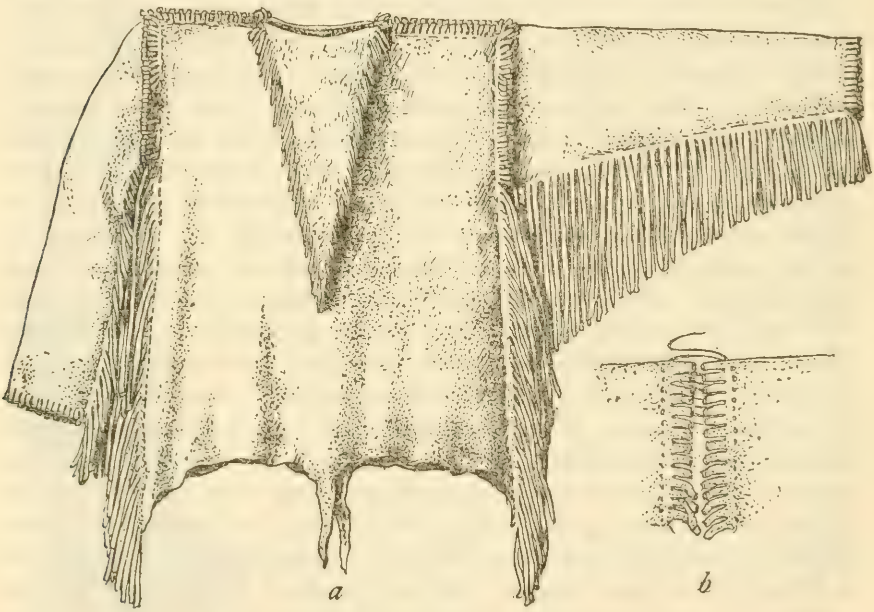


FIG. 5.—*a*, BUCKSKIN SHIRT OF ARCHAIC STYLE. *b*, DETAIL OF SEAMS.

deerskin of the general type prevailing in America (fig. 5). This is true also of the Zuñi and Rio Grande Pueblos and some specimens of this costume, which seems to have come in from the Plains, have survived. As a rule, however, the costume of the Pueblos is affiliated with that of Mexico and is thus characterized by the use of weaving to a greater extent than among any other North American tribes. Men formerly wore leggins of tanned skin, but these were also probably adopted from outside sources. The typical body garment of the Hopi man in historic times was a length of dark blue or black woolen cloth with an opening made in the middle for drawing over the head, equal lengths of the garment hanging over the back and front like the Mexican poncho (fig. 6). This early form with the addition of sleeves was sewed partly down either side, leaving openings under the armpits and slits in the skirts (fig. 7). The sleeves were loose and short. This shirt-coat, which is shown complete in figure 8, had little ornament, but modernly bits of ribbon and stitchings of red and green worsted have been affected. No undergarment except a loin cloth was worn (fig. 9). This feature of dress is well nigh universal and may be considered among the most primitive. The ceremonial costume gives a good indication of the archaic dress. This consists of a width of cloth finished on the edges, wrapped sarong fashion around the waist and held by a belt (fig. 10). The leather belt was probably not worn in ancient times and not generally in modern times, those found among the Hopi being adopted from the Navaho. These costly leather belts, heavily adorned with large pierced and chased silver plaques, are worn by young men who wish to be leaders of fashion. Woven belts and garters for holding the leggings are ancient (fig. 11).

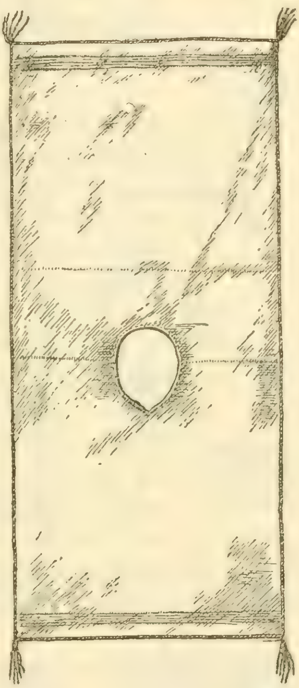


Fig. 6.—Archaic form of shirt of woven stuff.

It is difficult to ascertain whether the legging was anciently used. The presumption, however, is that it came into use at the time when the moccasin replaced the sandal. The legging was a square of tanned deerskin folded once around the calf of the leg and tied with a thong or woven garter (fig. 12 *a–b*). A more ornamental legging with pairs of tying cords and fringe (fig. 13) is a companion piece with the "old style" shirt (fig. 5). Another more pronounced in art, folded on the leg and tied with the garter, is shown in figure 14. Knit leggings are sometimes worn by old men and women.

Moccasins are worn by all Hopi men. Though their form is characteristic and not to be confounded with those made by any other tribe, it is a fact borne out by archaeological evidence that the Hopi and other Pueblo tribes anciently were sandal-wearing peoples and it must be concluded that the leather moccasin was acquired from the non-Pueblo tribes. Peculiarities in the manufacture of the Hopi moccasin, especially the sole bent up around the sides of the foot, seem to point to the Navaho and Apache as the tribes responsible for the change in footwear, and this change probably took place after

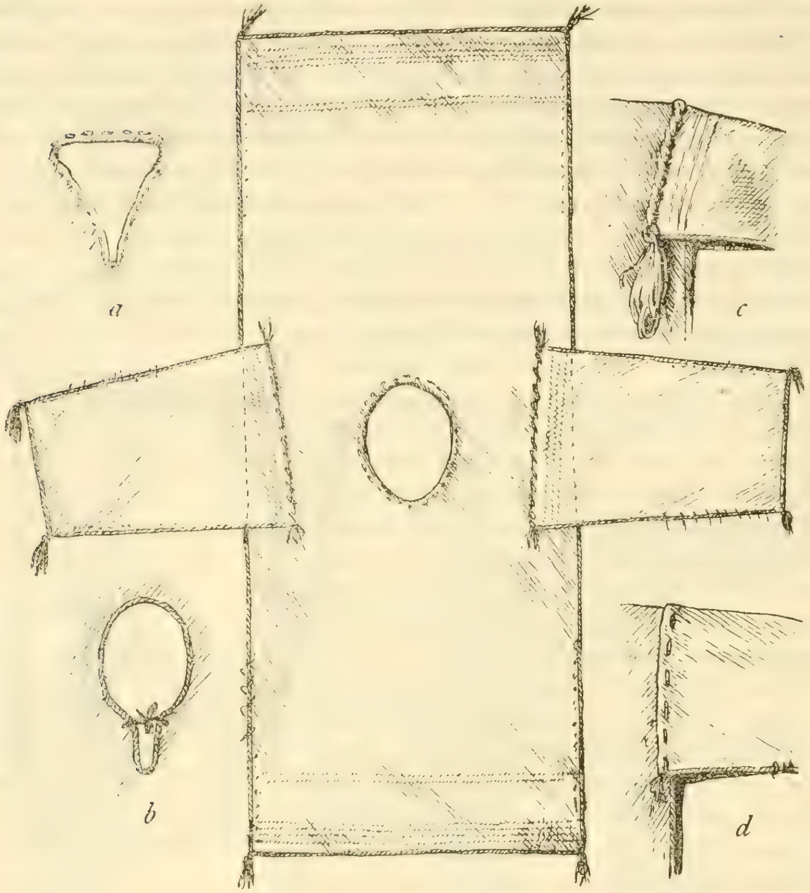


FIG. 7.—SHIRT FORMED BY ADDITION OF SLEEVES. *a*, *b*, FORMS OF NECK OPENINGS. *c*, *d*, METHOD OF APPLYING SLEEVE.

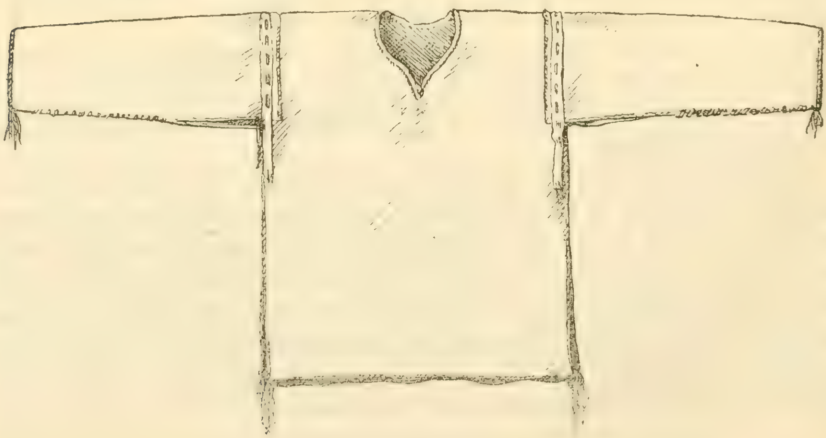


FIG. 8.—COMPLETED SHIRT.

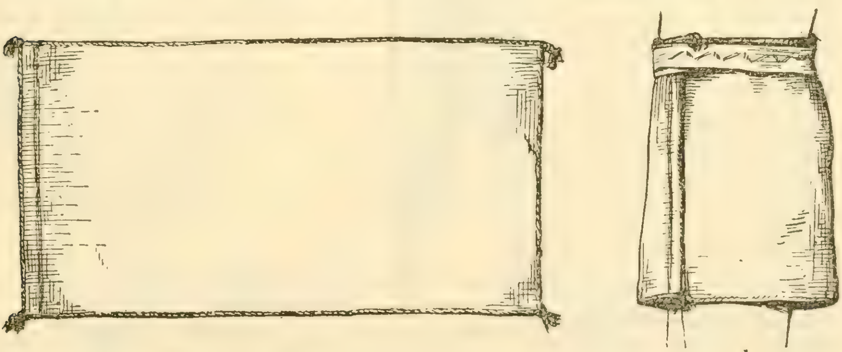
the introduction of cattle. The man's moccasin (fig. 15) is well made and serviceable. It is composed of (*a*) the sole made of rawhide from the back of the cowskin, (*b*) the vamp, and (*c*) the tongue. At present the Hopi use silver buttons for fastening the flap, like the Navaho, instead of tying thongs. The boys' moccasin (fig. 16) sometimes has an extended vamp in two parts sewed together, going around the foot as an anklet.

FIG. 9.—MAN'S LOIN CLOTH.

The blanket also enters somewhat into Hopi costume as an emergency or temporary wrap for a naked priest going through the wintry air to the Kiva, or by the softer men of modern days. The blanket is generally put to more practical use for carrying a canteen or supplies on the back or as bedding.

Smaller adjuncts of clothing, as pouches, etc., were rarely used by the Hopi, except in ceremonies for sacred meal (see fig. 46).

Among the Hopi men, not so frequently as among the other Pueblos, the hair is tied in a knot at the back of the head with a narrow woven tape. The Hopi have adopted this style exclusively since the "hair-cutting order" went into effect. Anciently the hair cord was probably of twisted or braided cotton or other fiber like the Navaho *tsos be tlotl* early adopted by this tribe from the Pueblos. Garters for securing the tops of the leggings are worn by Hopi men and this custom is common among all the Pueblos, but there is no evidence of its antiquity. Ornaments worn by men consist of beads of worked shell and stone made into a necklace. The beads, which are disks, are strung uniformly into a strand of a certain length or are spaced



a *b*

FIG. 10.—*a*. MAN'S CEREMONIAL KILT. *b*, METHOD OF WEARING.

at intervals with oval pieces of shell or turquoise (pl. 27, fig. 1). Several of these strands are bunched and bound together for a short space, forming a necklace which is put on over the head. The importance and value of these necklaces to the Hopi is very great, because of the religious significance of the beads and their pecuniary worth. The standard value is about two dollars a string, depending on the character of the beads and the amount of turquoise. The Hopi do not make beads, but obtain them in trade from the Zuñi or Rio Grande tribes. Beads are the most ancient recognizable feature of Pueblo costume and are found practically of the same form and materials in prehistoric ruins. Ornaments of metal, as earrings, finger rings, etc., are of modern introduction among the Hopi, who were unacquainted with metallic minerals before the arrival of the Spanish. Hopi men formerly wore on the left wrist a band of leather to take the rebound of the bowstring, but this part of costume has not survived for personal use, though it is still in ceremonial use.

FIG. 11.—WOVEN GARTER.

The parts of man's costume here described may be regarded as typical of a completely dressed Hopi, but only on rarest occasions has any one seen the complete assemblage. Usually the season, avocation, wealth, age, or whim of the individual fixes the matter whether he shall wear all, a part, or

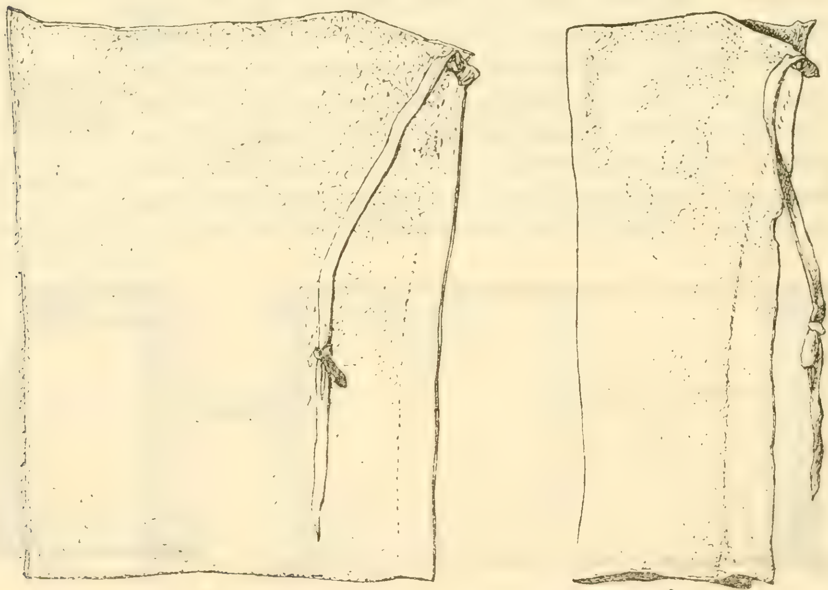


FIG. 12.—*a*, OUTLINE OF MAN'S LEGGING; *b*, LEGGING COMPLETE.

next to none of the tribal costume. As in civilization, the most lavishly dressed man has nothing else to do.

Married woman's costume.—The chief garment of the married woman is of dark brown and blue blanket stuff woven in one piece for her by the men weavers. It is wide enough to reach from the shoulder to the middle of the lower leg, though worn shorter when

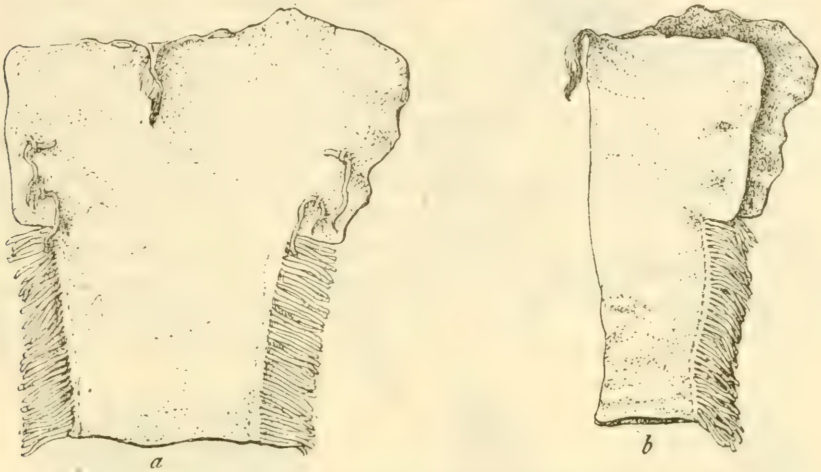
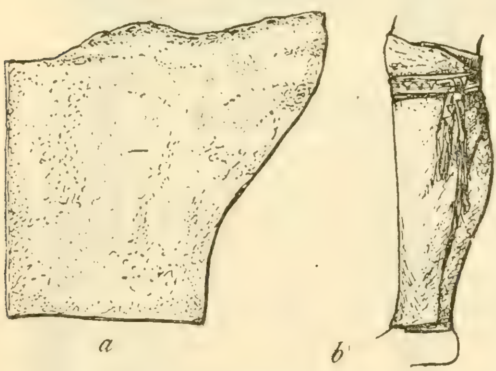


FIG. 13.—*a*, OUTLINE OF FRINGED LEGGING; *b*, LEGGING COMPLETE.

moccasins and wrap-leggins form a part of the costume. The making of one of these blankets into a dress is simplicity itself, only requiring the two ends to be brought together and sewed (fig. 17), the result being a bag open above and below, the seam on the left side. The upper edges are now stitched together for a short distance over the right shoulder, an opening being left there for the right arm. It is now ready to be drawn on over the head, and when it is in place it will be seen that the left arm and shoulder are free (fig. 18). The dress is sometimes ornamented with embroidery and stitching of colored yarns. The weaving of this dress is interesting and is described on page 254. Sometimes the blanket, *pusala*, is not made into a dress, but is used to enwrap the baby or for other household purposes. It is the completed fabric in demand among the Pueblos, with whom it was exchanged for beads and other commodities. The



14.—*a*. OUTLINE OF WRAP-LEGGING; *b*. LEGGING APPLIED AND SECURED WITH GARTER.

pusala is of standard size, measures 50 by 60 inches, and as all Pueblo wear the same style of dress, it is available for clothing in any part of the Pueblo region. The serviceable quality of the Hopi *pusala* is excellent and well known to the Pueblo Indians. A wide, long belt, woven by Hopi women or purchased from the Navaho, girds the dress at the waist (fig. 19). This belt is given many turns around the body, and the end tucked under,

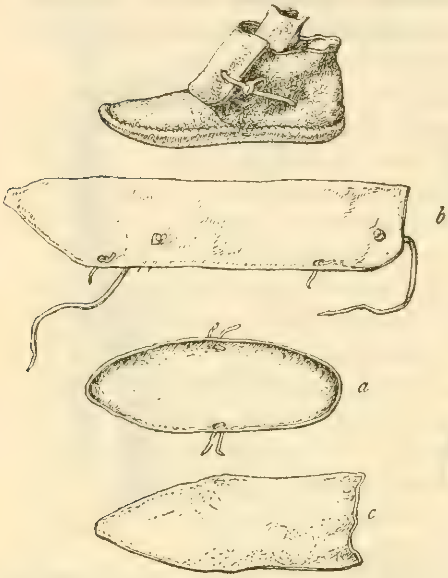


FIG. 15.—MAN'S MOCCASIN. *a*, SOLE; *b*, VAMP; *c*, TONGUE.

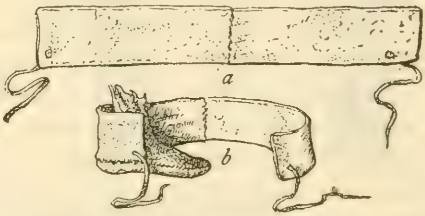


FIG. 16.—*a*, BOYS' MOCCASIN WITH *b*, ANKLET VAMP.

the long fringe hanging down on the left side (see fig. 18).

Unmarried woman.—The costume of the unmarried woman is like

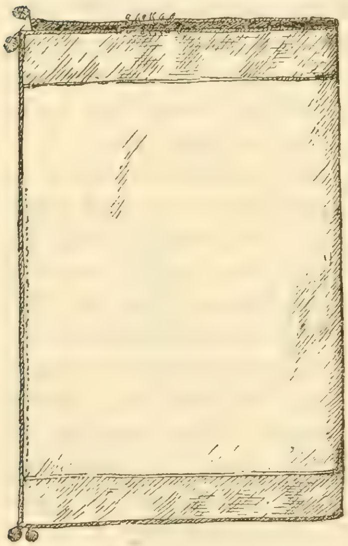


FIG. 17.—WOMAN'S BLANKET DRESS.

FIG. 18.—MODE OF WEARING WOMAN'S BLANKET DRESS.

FIG. 19.—WOMAN'S WOVEN BELT.

that of the married woman except that earrings consisting of little wooden tablets overlaid on one side with a mosaic of turquoise are worn (pl. 27, fig. 2). The dressing of the hair in whorls is characteristic of the maidens. The method of hair dressing is as follows: The hair is carefully brushed with a bundle of grass stems (pl. 28, fig. 1), parted in the middle and divided into two locks, each wound over a wooden bow (pl. 28, figs. 2, 3) of size determined by the length of the hair. The mass of hair on the bow is pressed together at the middle and wound with hair cord (pl. 28, fig. 4), which is passed at each turn also around the lock of hair next the head in figure eight winding. When the winding is completed, the bow is removed and the hair adjusted into a circular shape. Previously the hair whorls were held in shape with a light structure of corn husk covered with hair combings. These forms were six inches in diameter divided into two sections (fig. 20, *a*, *b*) the division facilitating the tieing of the hair (fig. 20 *c*). This coiffure is said to represent the squash flower and to be significant of fertility as well as to indicate that the girl is of marriageable age.

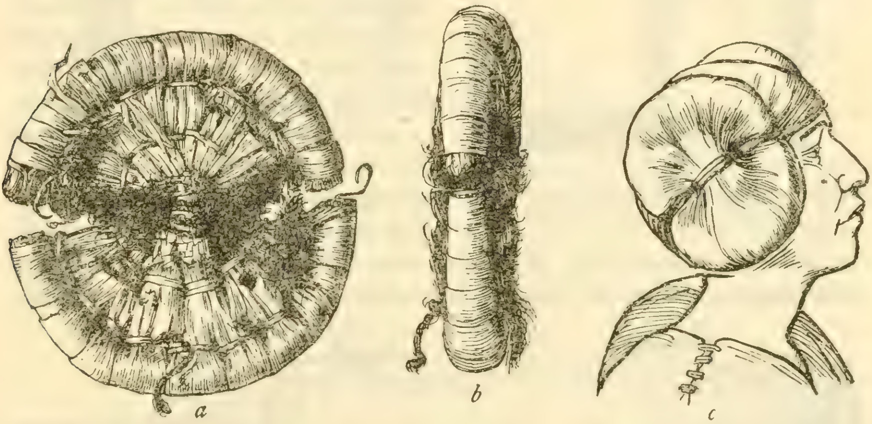


FIG. 20.—*a*, *b*. ARCHAIC HAIR FORMS OF CORN HUSK. *c*. MAIDEN'S HAIR WHORLS.

Children.—Little attention is given to the clothing of children, but such garments as they possess are modeled after those of their parents, being usually cut from cast-off apparel of adults.

Married women.—In full dress the Hopi women wear a camisa with sleeves. This garment is at present made of calico, resembles the Mexican *huipil*, but it is not possible to say that it is traceable from ancient times. The probability is that it was adopted not many years ago.

The shoulder blanket is the most striking article of Hopi women's dress. The colors are red, white, and blue, the body of the blanket being white with wide border of red and blue. The material is cotton and wool and the weaving is diversified and excellent. The blanket measures 36 by 48 inches and is worn over the shoulders somewhat like a shawl. It is not customarily found in ordinary use, but is worn in full dress and in ceremonies (fig. 21*a*, *b*, *c*). Unmarried girls, however, wear it when out walking, and matrons don it on gala occasions or during ceremonies. Within the last 15 years Hopi women have begun to wear a length of gay cotton print in the manner of the Mexican rebosa or the Spanish mantilla. It is like these also, a versatile garment as to the methods of wearing it, and adds a bit of style to the rather primly clad and demure maidens and young matrons. The blanket worn as part of the marriage ceremony, and which becomes the woman's choicest possession, is woven of white cotton. It is carefully woven, so as to be a perfect example of the weaver's skill (fig. 22*a*). It measures 48 by 58 inches, is quite heavy, the weaving being like canvas, and requires the tieing strings observed on the upper edge. The corners are sometimes reinforced with yellow yarn. It is rolled in a reed mat (fig. 22*b*). After the marriage ceremony the blanket is heavily embroidered with worsteds

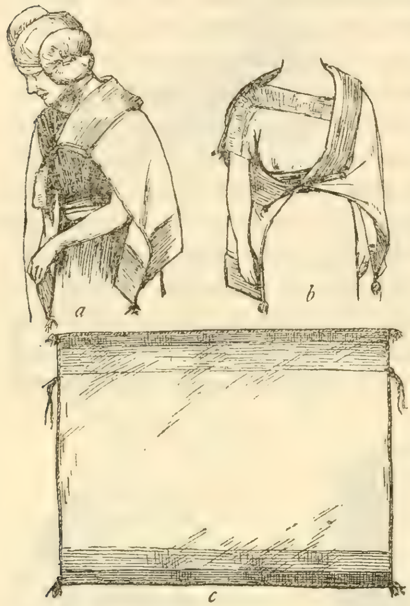


FIG. 21.—*a*, *b*, METHOD OF WEARING THE SHOULDER BLANKET. *c*, SHOULDER BLANKET.

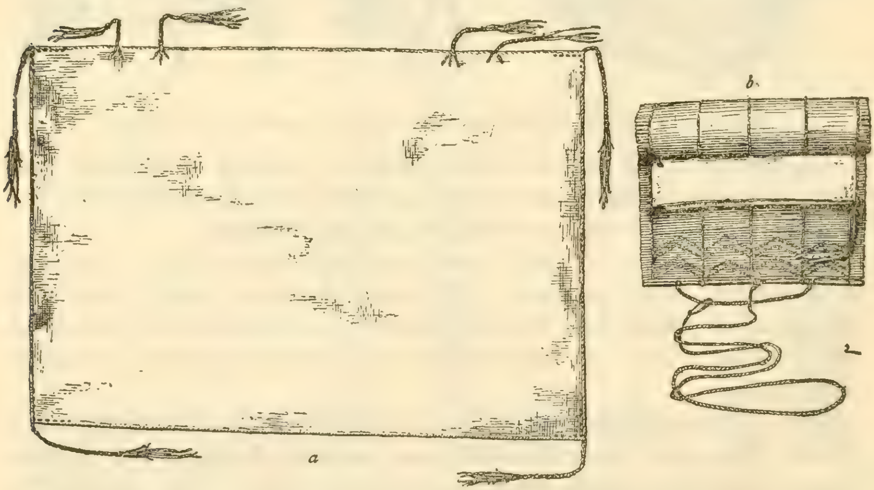


FIG. 22.—*a*. WHITE COTTON WEDDING BLANKET. *b*, WEDDING BLANKET ROLLED IN BED MAT.

in pleasing color and designs and heavy tassels are fastened to the corners. The Hopi married woman's hair is parted with a straight part and gathered into two locks over the ears. Each lock is wound over the first finger and the end drawn through as the finger is withdrawn (fig. 23). The end of the lock is looped up and caught in the winding (fig. 24). There is thus found a loose knot which is wound over and over with hair cord, the result being a spindle swelling at

FIG. 23.—METHOD OF TIEING WOMAN'S HAIR, FIRST STAGE.

FIG. 24.—METHOD OF TIEING WOMAN'S HAIR, SECOND STAGE.

FIG. 25.—METHOD OF TIEING WOMAN'S HAIR, COMPLETE.

the middle of the lock (fig. 25). In connection with care of the hair a device of thin slips of hardwood is used for crushing lice (fig. 26). Navaho silver bracelets are sometimes worn and rarely earrings. Necklaces like those of the men are worn. Formerly necklaces of juniper berries and other wild fruits and seeds were worn by women (pl. 27, fig. 3). Hopi women customarily go barefoot, but it is probable that the cumbrous moccasin with wrap-leggins was formerly more in use than at present, when deerskin is scarce and expensive, beyond the means of the poor and frugal Hopi. The woman's moccasin (fig. 27*a*, *b*, *c*, *d*, *e*) is small, stylish, and has the sole turned higher around the sides of the foot than the man's moccasin. To the edge of the upturned sole is sewed a whole white tanned deerskin, which is wrapped in folds around the calf of the leg and ties at the knee, giving the limbs a most elephantine appearance. Moccasins of this style are required in the trousseau of a bride, and it is probable that they will be made to last her lifetime, since she, like her sisters, will prefer to go barefoot. Baby's moccasins are made of fur (pl. 29, fig. 2) and small children wear a replica of their elder's moccasin (pl. 29, fig. 1, boy's moccasins; fig. 3, small girl's moccasin leggins).

FIG. 26.—SLIPS OF HARDWOOD FOR RIDDING HAIR OF INSECTS.

A curious and rare article of costume is an eye shade, which is made of a circular frame of rods (fig. 28*b*) to fit around the head and a bowed frame attached, covered with skin to form a visor (fig. 28*a*).

WEAVING.

The summer climate of the elevated region inhabited by the Hopi is that of Maine, but the winter temperature, while not so low is nevertheless cold enough to necessitate substantial woolen clothing. For centuries the Hopi have been famed as weavers of excellent blue cloth which was traded for by many tribes living far or near in the Pueblo region. The Hopi did not weave cloth in a commercial sense; the products of their looms were mostly finished "blankets" of estabtablished measurement (50 by 60 inches), which without cutting or alteration would make a woman's dress or smaller "blankets" for children (see Costume, p. 247). The true blanket or *serape*, like those for whose manufacture the Navaho are celebrated, was so rarely made by the Hopi that it can scarcely be considered in describing their textile industry. Narrower widths of woolen stuff than that of the woman's dress were made for men's garments. Special weavings of cotton, or of cotton and wool, as the wedding blanket and the girls' shoulder wrap, etc., were of ceremonial character and are treated under separate headings.

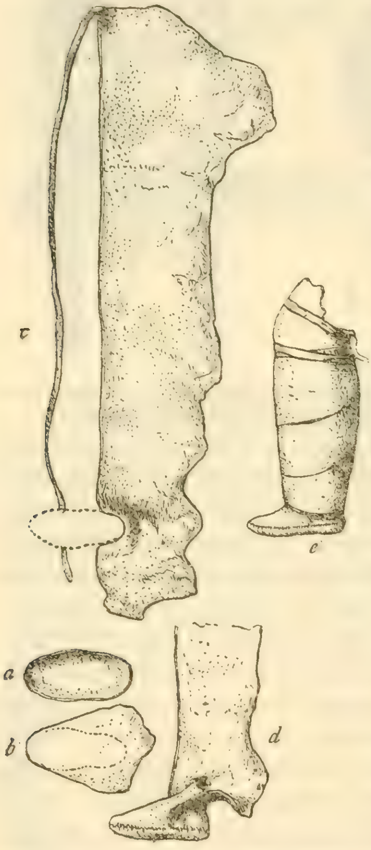


FIG. 27.—WOMAN'S MOCCASIN LEGGING. *a*, SOLE; *b*, VAMP; *c*, WRAPPING; *d*, VAMP SOLE AND WRAPPING JOINED; *e*, COMPLETE.

Materials.—The earliest fabric of the Hopi referred to by white men was made of cotton and this textile material is found in the ancient sites of the Pueblo region. Cotton and shredded yucca fiber were the ancient vegetable fabric materials. The use of cotton has survived the introduction of wool, being prescribed for textiles used in ceremonials, the largest work being the wedding blanket (see also Hair cord, p. 261). Cotton was prepared by whipping the fiber-enveloped seeds with a bundle of pliant rods (fig. 29) on a bed of sand, the process being shown in figure 30. This primitive gin removes the seeds and leaves the cotton in a fluffy mass, which is made into rolls by hand. Bowing cotton after the Asiatic method appears to have been unknown in America.

The excellent quality of the Hopi blanket is due to the strong fiber of the wool of their native sheep and to the conscientious work in preparing the yarn. The washed wool is dyed with indigo, a material that has from time immemorial been an article of commerce in the Southwest, where it was introduced by the Spanish. The wool, which was formerly whipped like cotton, is now carded with the toothed appliance which was no doubt introduced on the transfer of the present weaving art to the Pueblos some time after the Spanish-Mexican invasion, formed into rolls and spun on the simple spindle, which consists of a rod about the length and size of an arrowshaft weighted with a perforated disk of wood, horn, or earthenware (pl. 30, figs. 4, 5, 6). After spinning the yarn is stretched and smoothed by taking one turn over a polished corncob and drawing the corncob along, care being taken to regulate the tension, and finally the loose fibers are removed by singeing and the finished yarn laid up in hanks.

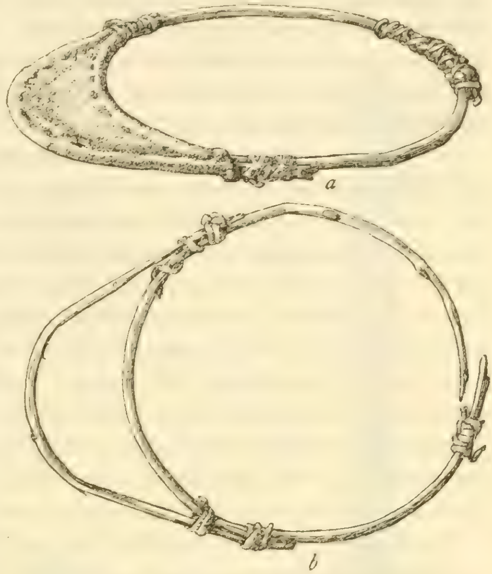


FIG. 28.—*a*. EYE SHADE COMPLETE. *b*. FRAME OF EYE SHADE.


FIG. 29.—WHIP FOR FLUFFING COTTON.

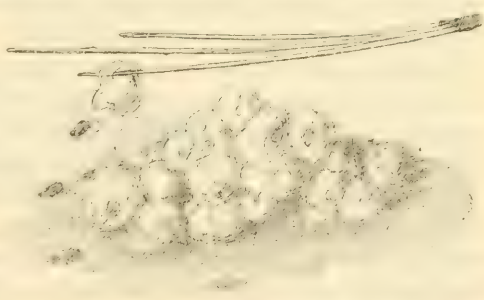


FIG. 30.—PROCESS OF WHIPPING COTTON.

Laying up the warp.—Since the fabric is to be woven to the edges and finished there without selvage or loose ends, the warp is measured back and forward continuously between two rods fastened by means of pegs in the floor at a proper distance apart, and the warp yarn given a regular spacing with a winding of cord which passes through the loop and over the rod, taking in the next loop, and so forth. The warp ends are thus in a line on the periphery of the rods. The lower rod is tied to the floor or cloth beam, and the upper rod is tied at the ends to another rod which receives the lacing of cord which goes over this rod and the supporting beam (pl. 31).

Setting up of the loom.—The warp, with its rods forming a frame, is then stretched between two beams, the upper attached to pegs in the kiva wall and the lower secured by plaited wool rope to sockets bored in a plank set in the floor, which takes the place of the sockets made in the stone slabs of the floor according to ancient practice. The warp frame is secured to the beams by a spiral winding cord and is not applied as among the Navaho, who run the cord under the beam along the edge of the warp. The warp is kept taut by cords which lash the upper loom beam to the wall pegs and may be adjusted if the web becomes slack. One man can set up the warp, but the services of two are preferable. The loom is then suspended in a vertical position and the weaving begins at the lower border.

The heddles are then applied either for plain, checked, or diaper weaving, as required, all three of these methods being sometimes used on the same piece of work. The dress blanket is usually begun with three diaper heddles and with them is woven a broad band of basket pattern, or "birdseye" in blue. The warp is then reversed in the loom frame and a similar band is woven at the other end of the blanket and the termination of each of these weavings is finished with a cording. The body of the blanket of dark brown wool is then put in with two heddles set for plain weaving. The finishing off of this portion of the blanket is very difficult and is effected by means of slender rods which open the sheds. The weaver beats the weft home with a wooden sword or batten, small in case of the belt loom and large in case of the blanket loom (pl. 30, figs. 1, 2, 3). This is also effected at certain points when necessary with a weft comb, which consists of a strip of wood having teeth cut at one end. At the finish a slender bone awl is used for pressing the weft home. The large batten is used to spring or hold open a shed, as the heddles are only actuated by hand, the Pueblo looms being vertical, and on account of this position none of them have the simple but important device for moving the heddles by foot power, which is practicable on the horizontal webs of the Old World. The horizontal loom, however, was used in ancient Mexico,[1] but was of great simplicity. A primitive shuttle (fig. 31), consisting of a stick on which yarn is wound to and fro, is employed.

[1] Dr. Washington Matthews, U. S. A., Navaho Weavers, 3d Ann. Rept. Bur. Amer. Ethnol., 1881, p. 391.

Several very old blanket weaving tools are in the Museum collection, and considerable difficulty has been experienced in definitely ascertaining their use, especially since these tools are archaic to the present weavers. Figure 32 is the oldest and best specimen of browned oak polished by long use and carved back and front with patterns. It was collected by Mrs. M. C. Stevenson, who was told that the notches on the handle of the *tur i kohu*, as it is called, recorded the number of blankets the weaver had made, and the notches on the blade the number of days to be consumed in making a blanket, thus indicating an interesting record or tally stick. The terraced end set with sharp iron point probably served to push in certain threads of the warp to form a special shed for diaper weave. Figure 33 is also of oak with two spurs formed in the end. These probably served as a comb for pressing down portions of the weft. Figure 34, of oak, resembles the

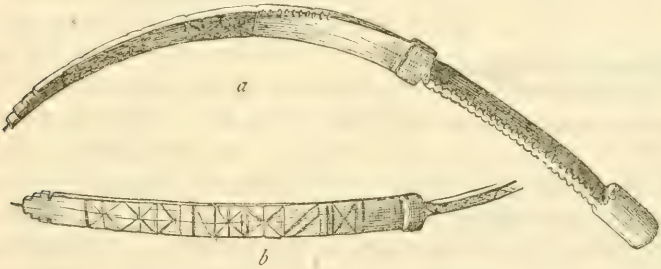


FIG. 32.—*a*, BLANKET WEAVING TOOL. *b*, BACK VIEW.

FIG. 31.—SHUTTLE OF PRIMITIVE FORM.

stretching pins used by the embroidery of blankets (fig. 38). This specimen has also tally notches on the side.

Belt weaving.—The greatest play of fancy in the Hopi textile art is in the weaving of belts. Apparently tapes, belts, and other narrow weavings have a long history and preserve to some extent the primitive art in tools, methods, and designs. Wider fabrics are the product of civilization and have not the long lineage of design that is unbroken in the narrow fabrics. The handicraft that could produce small and greatly varied patterns with a few warp threads was not perpetuated in the fabrics requiring numerous warp threads. An examination of the hand woven tapes and belts of Europe, Asia,

FIG. 33.—*a*, OAK BLANKET WEAVING TOOL. *b*, SIDE VIEW.

and North Africa will prove a revelation in design. The Hopi and other Pueblo belts take their place in this most interesting series that has been generally overlooked by students of textile manipulation and design. In the Pueblo tribes the weaver's art antedates the introduction of wool and dyed yarns on which the present industry largely rests.

Hopi belts are woven on a small loom and worked in all respects like the blanket, except for the taking out of threads at the central warps where the design is woven. They may also be woven with reed heddles, an ancient improvement in weaving methods, which renders the separation of the warp to produce the sheds much easier than by the cord heddles, the latter an invention presumably more ancient than the reed heddles. An interesting feature of belt weaving is that the operator's body forms part of the loom illustrated by a figure in the Zuñi family group in the Natural History Building of the United States National Museum.

Fig. 34.—Stretcher and record in weaving blankets.

The warp, which is attached to a roller of wood secured to a support, is stretched by cords which are fastened to the ends of a yoke passing over the weaver's back and tied to the cloth beam. By movements of the body, the weaver, who sits on the ground in front of her work, can tighten or loosen the warp, an advantage in making the sheds for the passage of the shuttle. This device is in world wide use and appears to be connected with the distribution of weaving from a culture center.

The tools in belt weaving are the same as those employed in blanket weaving but smaller. The roller or cloth beam and the back yoke, however, are not parts of the blanket loom. Instead of using the back yoke of the Pueblos, the Navaho stretch the belt warp in the V-shape opening of a tree fork, which forms a belt loom of primitive aspect, as shown in one of the groups in the United States National Museum.

The warp of a typical belt is set us thus: Two pairs of white threads for edging; 12 red and 12 green on both edges forming plain-woven red and green bordering bands; 60 red yarn and 14 white cotton threads, forming the middle pattern section: and then warps of red and green as above to the other edge, which is bound with two pairs of white threads. Another example has two white edging warps, 12 red, 6 black, 12 red, 20 white, 20 red for center band; and to other edge 12 red, 6 black, 12 red, 2 edging warps. In the pattern band the red threads are worked in pairs, the white always single. The weft is white wool yarn and shows very little in the pattern and not at all in the border bands. The specimen is 1⅛ inches wide and is probably Zuñi.

In Hopi belt weaving the heddles are not applied for patterns, but continuously, to alternate warp threads as in plain weaving, the designs being formed by lifting the required warp yarns by hand with a small wooden blade or batten. This interesting combination of hand and machine work points to a more primitive method as in the Navaho, Chilkat, and Salish weavings.

As remarked, the belts of the Hopi and Zuñi exhibit great skill in technic and ingenuity in pattern. The warp and weft are often of the same yarn, giving uniformity of texture, but usually the warp is partly of yarn of the same thickness as the weft yarn and partly smaller. This arrangement furnishes a fertile field for the play of design. The warp in the central or pattern band of a belt is generally of small white yarn and another color of larger yarn, usually red, the former working out white pattern grounds, having raised figures in red warp, the latter contrast being produced by the difference in size of the yarns, the small warp being worked singly and the larger in pairs.

Wedding blanket of cotton.—The Hopi wedding blanket, following correct custom, should be of plain white cotton fabric, resembling coarse canvas woven in the hand loom (fig. 22). During the year following the investiture of the bride with the wedding blanket it is embroidered on the upper and lower borders with symbolic patterns in black, green, red, and rarely yellow yarn, and on each corner is fastened a large tassel which is formed on a grooved flat stick about which the material for the tassel is wound. The upper corner tassels are usually white and smaller than the lower, which are of black and red. The embroidered band on the upper margin of the blanket is narrower and simpler in design than that of the lower, whose pattern represents rainclouds, rain, squash flowers, and butterflies, applied in a very pleasing ensemble. No embroidered wedding blankets antedate the period when dyed yarns could be procured from the trader and all known specimens are worked with worsteds, but many were collected before aniline colors came into use. As to the character of the wedding blanket before wool was introduced there is no information, though following the method employed in the kilts of the Snake society the garments may have been ornamented with painted designs. It is probable, however, that no large woven blankets were made in ancient times, and no wide fabrics have been found in the cliff dwellings, the widest being 26 inches from Grand Gulch, Utah.

Weaving of kilts.—The kilts worn by Hopi priests in ceremonies are of two kinds, plain woven cloth, which is made of coarse cotton yarn strongly fulled and resembling canvas, decorated with symbolic designs in red, black, and white paint worn by the Snake and Antelope fraternity; and the other of similar canvas decorated with woven designs in bright worsted, worn by the Flute and other fraternities. These are woven in small looms, the tools and procedure being the same as in the blanket loom except that in the second variety the heddles are set to work in the patterns in colored yarns. Sometimes, however, the designs are worked in by embroidering after the piece is finished in the loom. The upper border is corded with black yarn. The lower edge is finished with a braid of black wool sewed to the margin. The corners are finished with small tassels. These kilts are 20 inches wide and 39½ inches long.

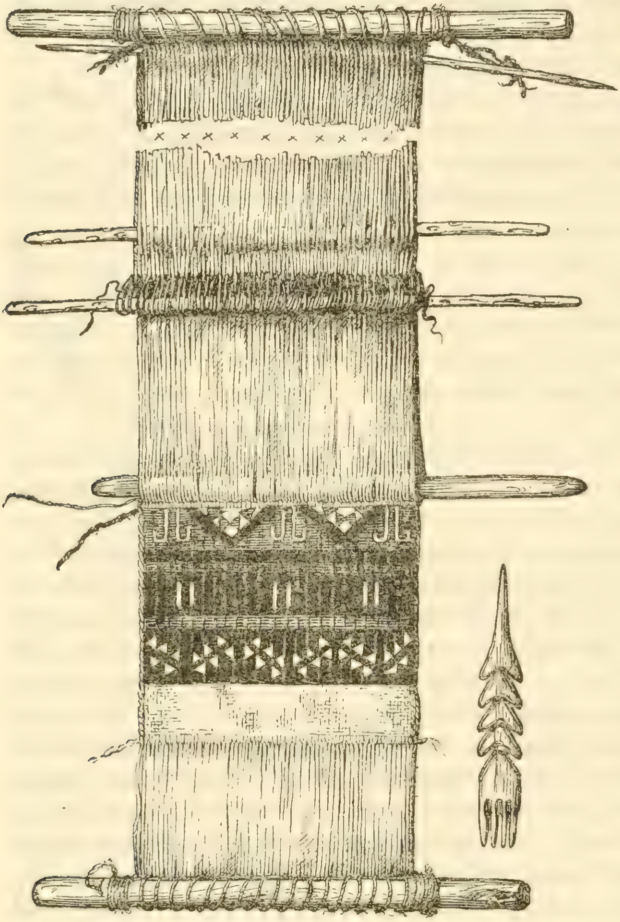


FIG. 35.—SASH LOOM WITH WEAVING IN PROCESS. WEFT COMB (TO RIGHT).

Weaving of sashes.—Sashes worn in ceremonies are panels of plain weaving of cotton or wool, decorated at the end with designs in colored yarns and terminating in a fringe. They are woven plain for part of the length and then the heddles are adjusted to work in the patterns in yarns (fig. 35). Two sections or panels thus made are sewed together at the upper end with a roving of cord. In most specimens in the Museum the warp and weft are yarn of the same size. Where the decorated weaving begins a much finer weft is used.

The effect of this is not to alter materially the surface of the cloth but to narrow the weaving which would have been necessarily much wider on the addition of the worsteds used in decoration. There is also an advantage in narrowing the sash at the end with the effect of making it more graceful. Specimen Cat. No. 166318, U.S.N.M., Hopi Indians, Arizona, collected by James Mooney, has a small warp and a thicker weft. At the beginning of the embroidery the weft and warp cords are made of equal size. This again produces a tapering form and distinctly finer cloth. These sashes are made 9 inches wide and 44 inches long to $10\frac{1}{2}$ inches wide and 48 inches long.

Braiding the sacred white sash.—A typical example of the sacred sash (Cat. No. 22953 U.S.N.M., collected by Maj. J. W. Powell) is composed of 216 threads of white cotton about the size of small package cord braided into a band 8 inches wide and 61 inches long to the termination of the solid braiding (fig. 36). The work is started midway of the cords where a twining is applied temporarily and proceeds toward either end, where the cords are divided into 12 tresses braided into narrow tapes for a short distance. Rings are now slipped on over the cord and secured and the cords divided into sixes are twisted together, hanging down as 36 twists forming a long fringe. The rings (fig. 36), which number 18, have an annular core of corn husk wound with cord and are secured to the cord bundles by tying at the termination of the braided portion of the tape. This most remarkable example of braiding is worked with great skill, and the finished texture is even and compact. No tools are required for this work, and it is only necessary after the braid is begun at the middle to secure this portion between two wooden clamps in order to suspend the mass of cords from a support in the wall. The cotton employed in these sashes is native (the only Pueblo aboriginal cotton that has survived), grown exclusively for ceremonial purposes and prepared by men in accordance with traditional religious usages. Plaited sacred sashes were used by all the Pueblos; it is not known, however, that all the tribes made them; probably most of the tribes procured the sacred cotton or the finished sashes from those Pueblos who lived in the area where the cotton plant could be grown. The art of making the sashes is ancient, as the remains of a square,

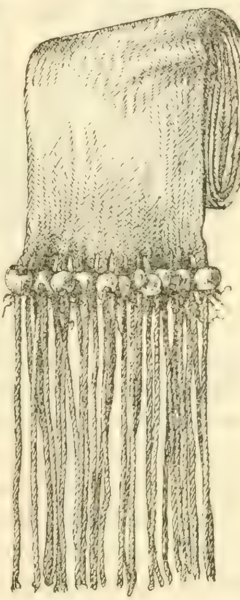


FIG. 36.—BRAIDED SACRED WHITE SASH.

braided (sennit) sash fringe with rings found in Bear Creek Cave, Blue River, Arizona, show.[1]

These sashes, which are kept white by the application of kaolin, are used by the Hopi priests in the Nashnaiya ceremony. They are secured at the waist and hang down in two panels on the left side. The Zuñi use them in the sword swallowing ceremony of the great fire fraternity.[2] The Hopi name for them is *wuko kwewa*, great sash. It is possible that this sash may be of Mexican origin.

Embroidery.—The Hopi embroider ceremonial kilts, sashes, and wedding blankets, and to a slight extent the woman's dress for every-day wear. The art as it exists at present appears to have been acquired from the white man, but it may also have been derived from weaving, as in the raised woven work on the hems of the women's dress or the raised figures on belts.

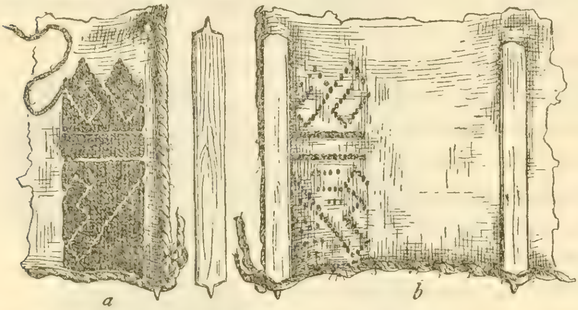


FIG. 37.—*a*. EMBROIDERY ON SASH. *b*. WORK STRETCHED. WOODEN STRETCHER (IN CENTER).

The material to be embroidered is stretched by means of strips of wood having points at the extremities (fig. 37, *a*, *b*, *c*), and when used are buttoned into the goods and the working done with a fine bone awl (now with a darning needle). Larger stretchers, consisting of a strip of notched wood with a pointed rod lashed to the ends, are useful for larger embroidery spans or for stretching blankets (fig. 38).

Tassel making.—Tassels are important adjuncts of the ceremonial blankets, and are sometimes of complicated structure. Ordinary blankets are supplied with rudimentary tassels or "tags" at the corners, and completed wedding blankets have bunch tassels made by the ordinary process; sometimes the shank of the tassel is overlaid with colored cords in basket-weave. The tassels for the white braided sash (fig. 36) are made on a tassel stick, a very old specimen of which is shown in figure 39*a*, a section of the end showing the grooves. A cord is laid on the longer groove and brought down the sides and a cord is wrapped continuously over it on the stick (fig.

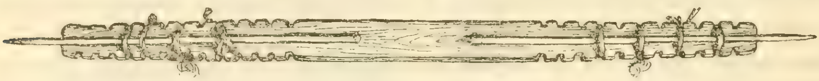


FIG. 38.—LARGE STRETCHER FOR BLANKET WITH ADJUSTABLE PINS.

[1] Hough, Walter, Ancient Culture of the Pueblos of the Upper Gila River, Bull. 87, U. S. Nat. Mus., Washington, 1914, fig. 159, p. 76.

[2] Mrs. M. C. Stevenson, The Zuñi, 23d Ann. Rept. Bur. Amer. Ethnol., pl. 18.

39*b*). The under cord is then cut at the point indicated in the shorter groove, the loops slipped off the stick (fig. 39*c*), and on it is laid a ring of cornhusk, which forms the core of the tassel; the loops are rolled over this ring and the resultant tassel ball formed. This is an example of remarkable imagination and ingenuity.

Knitting.—Many of the Hopi, in common with the Navaho, Zuñi, and other Pueblo tribes, are familiar with the art of knitting, but usually practice it only in the making of leggings of blue yarn. Knitting was learned from the whites, at what period it is difficult to ascertain. An unfinished piece of knitting with wooden needles in place was brought presumably from cliff ruins in northern New Mexico by Dr. Washington Matthews, but the circumstances of its finding are not now known. A coarse horsehair legging and one made of brown (buffalo?) hair were also collected by Dr. Matthews. A fabric resembling the crochet bags which have a wide distribution in the Eastern and Western Hemispheres and are especially common in South and Central America has been found in archeological sites in northern New Mexico and Arizona; no specimens, however, have been found in the southern portion of the Pueblo region. A hook or needle would be indicated for the making of this fabric,[1] but no implements of this character have been discovered except a needle of bone[2] in ancient sites; and it is probable that this method, like knitting, was comparatively recently acquired.

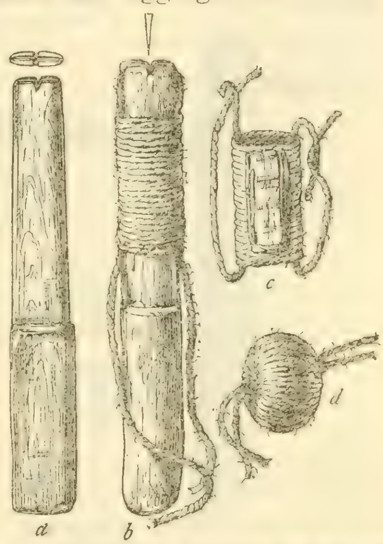


FIG. 39.—*a*. OLD TASSEL STICK; *b*, *c*, *d*. TASSEL STICK AND PROCESS OF MAKING TASSEL. GIFT OF EMRY KOPTA.

Hair cord.—One of the most primitive textile materials is hair, and the kind that is most available is human hair, which without doubt was worked into cord from the earliest times. Among the Hopi hair cord is made by women and at present the art is practically limited to the making of cord used in the coiffure of women. There is evidence, however, that formerly whenever a cord of peculiar strength and wearing quality was needed, cord made of human hair was employed. Some of the earlier specimens collected by the Bureau of Ethnology show uses of human hair cord for a netting over gourd canteens, for the strings of marionette birds, and in ceremonies, etc. On the acquisition of cattle and the horse an abundant

[1] See Mason, Basketry, Ann. Rept. U. S. Nat. Mus., 1902, p. 380.
[2] See Hough, Museum-Gates Expedition, Ann. Rept. U. S. Nat. Mus., 1902, pl. 13.

supply of the material became available. The hair of horses and cattle had some use for lariats, bridles, cinches, and other parts of horse trappings, but not to such an extent as among the Mexicans. It was used in religious paraphernalia, on dolls, etc., to represent human hair. The banner placed above the kiva hatchway, to announce that a ceremony was going on within, is decorated with red dyed horsehair. Hair cord was made by hand or with the spindle. The whirling cord twister, known to the Mexicans and southwestern Indians, was used by the Hopi (fig. 40). (See also p. 253.)

Weaving rabbit-fur robes.—A fabric that long antedates woolen blankets in the Pueblo region is made from rabbit fur cut into strips, wound around thick cord and joined by twined work of wool, cotton, or hair cord (see background, pl. 31). The large blankets thus made are warmer and more flexible than dressed fur skins. In ancient times the cords were overlaid with strips of downy turkey feather and formed into robes and body garments. These were still in use in 1540, but no mention is made at that time of rabbit fur robes. The making of this fur fabric was a widespread aboriginal industry all over the Rocky Mountains, from the mouth of the Columbia to Mexico. There are references to their use among the eastern tribes.

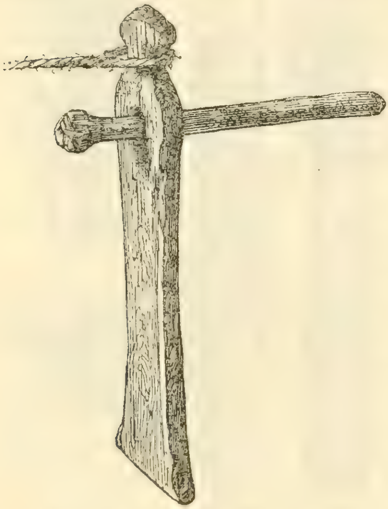


FIG. 40.—WHIRLING CORD TWISTER.

In making fur robes great lengths of fur-covered cord are first prepared, and this generally takes a long time, unless rabbits are plentiful. The skins are cut in strips about a quarter of an inch wide, dampened and wound spirally around the cord, and when the skin is dry it remains rigidly in place. The width of the robe having been determined, a section of the fur cord is bent over and the warp threads tied to it at intervals. The cord is laid to and fro continuously as it is twined in the warp threads, the robes thus having a succession of loops on two edges. When the robe is of proper length, the warp cords are tied to the last breadth of fur cord. The resultant fabric is about an inch thick and warm, but gives a most excellent harborage for fleas and other vermin.

Wound work.—The Hopi practice a variety of textile work that is intermediate between basketry and weaving. The basis is a strip of rawhide or other flexible material wound with colored yarns in a counted order of winds, so that when a number of these strips are laid side by side a pattern is built up. These strips are joined to form anklets, and it requires considerable precision on the part of the worker to wind the strips, which alone are meaningless, but when joined form a pleasing design (fig. 41, *a*, *b*, *c*). The method is very like that of the coiled basket, resembling closely that variety known as "lazy stitch."[1]

The method, however, may be more related to embroidery with quills, which was interpreted in wampum and later in glass beads. Some of the Plains Tribes worked patterns in braided quill on string, which, wound around a pipe stem or other object, revealed the design in the mind of the artist. It is probable that this work was known to many tribes in America, but it has survived in only a few.

Hopi quillwork was confined to the making of anklets identical with those described, formed of worsted and rawhide. Porcupine quills were used and the basis is horsehair. The quills were dyed, split and worked over the hair with a series of half hitches (pl. 32). The Zuñi made similar quill anklets and the method was also known to some of the Rio Grande Pueblos. It is probable that these objects were distributed among some of the Pueblos through exchange.

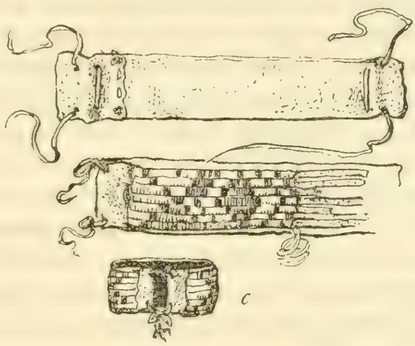


FIG. 41.—WOUND WORK ANKLET. *a*. BACK VIEW, SHOWING LINING; *b* FROND VIEW; *c*. COMPLETE.

BASKETRY.

The working of pliable elements of vegetal origin into basketry and cognate textures is an important feature of the economic life of the Hopi. The great development of the potter's art in this region has not apparently diminished the necessity for basketry, which has a range of employment here comparable with that in other strictly basket regions. The grosser use to which basketwork is put is in the construction of wind breaks in the fields and the twined weaving employed is the simplest and most primitive method known to man. Twining, however, is not well represented among the Hopi, the only instance of its use being the grass stem mat in which wedding blankets are rolled.[2] There have been collected in the Hopi pueblos numerous twined baskets, some of them very old, but these baskets are of Ute workmanship and have been brought to the Pueblos by exchange. Baskets of extraneous origin will be mentioned later.

[1] Mason, O. T., Aboriginal Basketry, Ann. Rept. U. S. Nat. Mus., 1902, p. 249.
[2] Idem, pl. 103.

The use of flat splints or strips gives rise to basket structures of one type having several varieties in complexity, passing from checker to twilled and finally to diaper as the highest expression. Generally this construction produces thin, weak textures familiar in the mats made by many peoples. The Hopi made mats, *apa*, from ancient times down to several decades ago. Formerly throughout the Pueblo region it was customary to enwrap the dead in matting before burial, traces of this material being found in ancient cemeteries.[1] Matting is common in cliff dwellings and ceremonial caves.[2]

The matting hoods over fireplaces are the only survival of this textile among the Hopi. The basket that most characterizes the Pueblo Indians is made from strips of yucca leaf. They are usually in twilled and sometimes in diaper weaving. The forms, which are rarely graceful or regular owing to the roughness of the material, are circular trays often large; squarish baskets with vertical walls; and somewhat bottle-shape baskets. The splints are bent over and sewed to form the edge, and frequently a wooden hoop is used to strengthen the rim, a feature also of ancient baskets of this type.[3]

Neatly formed head rings or pottery jar rests, forehead bands, belt weaver harness, and cradle head bows are of twilled weaving. The Hopi specimens differ little from similar objects made by other Pueblos. None of the Pueblos ever made lids or covers fitting over or telescoping the basket receptacle, a practice rarely absent wherever this style of basket weaving is pursued in other parts of America and in the Eastern Hemisphere. American examples may be cited from the Pimas, Mohaves, Cherokees, Choctaws, and other southern tribes, Mexicans, Central Americans, Guianians, Peruvians, etc.

Wicker basketry, uncommon in America, is prevalent among the Hopi and Zuñi and little used by the other Pueblos. The Hopi wicker baskets are the most artistic to be found in the world, and here the decorations on wickerwork reaches its highest perfection, presenting a surprising range of color and symbolic design. The forms decorated in color are placques, and occasionally small deep baskets; forms with structural decoration are oblong trays. Carrying baskets and one of the two varieties of cradles are of wickerwork. The frames of some of the masks are made by this method. It is worthy of remark that wicker weaving is almost confined to the Pueblo or Oraibi. The common material for wicker basketry are the stems of Rhus, tough and strong, forming the frame work, and the stems of *Bigelovia graveolens*, *Chrysothamnus graveolens*, and *Verbesnia encelioides*, the latter desert plants, commonly called rabbit brush, furnishing innumerable stems of even size, rather soft, but

[1] Fewkes, 22d Ann. Rept. Bur. Amer. Ethnol., 1900 (1904), fig. 60, p. 97.
[2] Hough, Bull. 87, U. S. Nat. Mus., 1914, pl. 16.
[3] Idem, p. 88.

wearing well. The stems are gathered, peeled, rubbed to remove slight irregularities, and dyed. Dyeing is done by various processes and with various materials, subject generally to individual methods and experiences. Body colors as black, white, green, red, and brown, are washed on the splints, or sometimes applied after the basket is finished, the medium being an emulsion of fatty seeds of melon, etc., or saliva, or both, formed by chewing seeds, mixing the resulting liquid with paint and applying to the splints with a tuft of rabbit fur. The colors are ground and mixed on a small flat stone. The materials are kaolin or limestone, white; soot or coal, black; copper carbonate, green; red, brown, and sometimes yellow, iron ochers. Dyes proper, mordanted or not, are subject to the fertile knowledge and inventiveness of the Hopi women, who produce a considerable range of colors, often of great delicacy and beauty. This familiarity with dyes is shown not only in baskets, but in the preparation of bread, which is often given a variety of colors with vegetal dyes. Some little information as to these colors can be set down as follows: Blue is derived from larkspur flowers; dark blue, beans, shells of sunflower seeds, and indigo; green, yellowish to olive, from composite flowers and leaves; yellow, from *Chrysothamnus* and other desert composite flowers; orange yellow, from saffron flowers; red, from bark of alder, berries of rhus, and flowers of the cockscomb; brown, red-brown, and yellow-brown, from plants of *Thelesperma;* black, from ink of resin and iron alum as in dyeing leather. Shades of pink, carmine, violet, and lavender are produced apparently by manipulation of the color from cockscomb. As a rule all these vegetal dyes on wood fade rather soon, especially when subjected to actinic light.

The weaving of wicker baskets is begun by crossing at right angles a number of the rods which form the foundation. The crossing area is sewed with splints, the sewing forming a square area divided into parts by a diagonal stepped line (pl. 34, fig. 1). The great majority of wicker baskets are begun in this manner and very rarely in older specimens is there a modification of the plan. The radiating rods are then diverged evenly and the tangential element worked in. If enough radiating rods have not been provided to fill out the circumference, other rods are added as needed. The edge is finished by a spiral sewing of yucca leaf after the ends of the radiating rods have been bent over evenly. This edging is painted red.

Designs on wicker baskets are similar to those on the coiled baskets, but show greater freedom. They are tangential, while those on the coiled baskets are radial, in both cases due to the technic of the design-bearing element. The radial designs are forced from center to circumference, while the tangential designs are forced to expand from side to side. An identical bird design by the two methods shows this (pl. 33, fig. 1; pl. 38, fig. 6). Occasionally in modern coiled baskets the design is aided by overlaid sewing, to show the beaks and feet of the birds, for example. This is an innovation.

The foundation of coiled baskets is a bundle of grass stems, *takashu* (*Hilaria jamesii*) being used. The sewing, which covers and holds together the coil, is of strips of yucca leaf split with the thumbnail into bands of equal width and smoothed by drawing under the pressure of the thumbnail. The wicker basket requires no tools, but the coiled basket demands an awl, preferably of bone, as this substance does not chip or cut the sewing. The beginning coil must be slender and pliable to take the short turns, hence it is formed of shredded yucca leaf instead of the harsh grass, the latter being added when the coils grow larger and less curved. The coil grows less again on the outer edge of the basket where it tapers to a finish. The lining strip or sewing is secured at one end, passed over the coil, through a hole made by the awl, engaging some of the previous turns and foundation grass stems, and so on until used up, when another strip is started in. In case the pattern requires a color at some point in the sewing, a splint of the color desired is started in. The pattern is regulated by counting the stitches. Both the coil and the sewing are kept moist by burial in damp sand, which the basket weaver keeps near her. These baskets are very strong and serviceable, and more of these are made than of any other kind. They resemble, in the size and substance of the coil, the baskets of North Africa; but they are of ancient use in the western and northern Pueblo region and not the result of foreign influence. Coiled baskets are made in the three towns on the Middle Mesa.

Coiled basket forms are circular placques, most numerous and sometimes very large; deep bowl forms, sometimes at present with un-Indian handles and covers; and vase forms which are modern. About 1872 coiled sombreros were made as an innovation. Though the coiling was the finest ever made by the Hopi, these hats were too heavy for comfortable wear.

Mention should be made of the baskets acquired by the Hopi from other neighboring tribes. At the time of the explorations by Major J. W. Powell in Tusayan, great numbers of these baskets were collected and at first thought to be representatives of the Hopi basket art. These are now in the United States National Museum. They consist of twined pack baskets and pitched water bottles of the Utes and Apaches; strong fine coiled bowls and twined pitched water bottles of the Havasupai; coiled bowls of Ute-Navaho and water bottles probably from the Mohave. These were also rod and splint baskets, evidently very old, whose origin is unsettled. They were found also at Zuñi and in the Rio Grande pueblos. The largest collection of these interesting baskets is exhibited in the United States National

Museum (north alcove, first floor). A descriptive label for these baskets written by Prof. O. T. Mason is as follows:

Made up on a coil of small rods or splints of willow or *Rhus aromatica*. The composition of the foundation coil characterizes basketry of this type as "single-rod coil," "rod-and-splint coil," "two vertical-rod coil," "three-rod coil," "two-rod-and-splint coil," "splint coil," and "straw coil." The coils are held together by an over-and-over sewing with osier splints which pass around one coil, under a small rod or splint of the under coil, each stitch interlocking with the one underneath. The ornamentation of these baskets is produced by substituting dyed or natural black splints and the figures are mostly geometric. The borders are fastened on with the plain stitch of the coils, or with a row of false braid effected by passing a single splint backward and forward under the stitches of the last coil.

They are smoothly and strongly made of well-prepared material, decorated with archaic patterns, follow in the main the forms of ancient pottery, and their appearance suggests great age. It is probable that they are the work of some ancient Pueblo tribe now extinct, and have been preserved among the Pueblos for hundreds of years. Mr. Cushing wrote that some of these baskets had been recovered by the Zuñi from prehistoric deposits. So far as known, no specimen has been found by explorers of the cliff dwellings and none occur in the remarkable basket finds in Grand Gulch, Utah, described by Mr. George Pepper.[1] Some of these interesting baskets are figured by Professor Mason.[2] Baskets of the thick coil type are made by the Pima and Indians of northern Mexico, usually for coarse construction as in granaries and storage baskets. They are not covered with sewing as in the Hopi examples. The Hopi variety of coil basket has an ancient history in the Pueblo region, specimens having been found in the Bear Creek ceremonial cave on Blue River, Arizona.[3]

The tools used in basket making are simple, the awl being most in evidence though needed mostly for coiled basket making. This important tool, which serves for many uses, is at present made from the leg bone of the sheep, but was formerly made of deer bone. It is brought to a fine smooth point on a whetstone and constant use in sewing gives it an exquisite polish. A metal knife and of recent years even scissors, form part of the basket maker's equipment; formerly chips of flint or obsidian may have served. A polishing stone sometimes grooved may be used, though the rods may be smoothed by drawing them over sand rock in place on the mesas. A wrench of antelope or goat's horn (pl. 46, fig. 4), like those employed in straightening arrow shafts, may be used for the larger rods, ancient basketry owes its excellent craftmanship to this tool.

[1] Ancient Basketmakers of Southeastern Utah. Supplement to Journal American Museum Nat. Hist., N. Y., vol. 2, No. 4, April, 1902.

[2] Aboriginal American Basketry, Ann. Rept. U. S. Nat. Mus., 1902, pl. 28.

[3] Hough, 1902, Culture of the Ancient Pueblos, Bull. 87, U. S. Nat. Mus., 1914, pl. 24.

The ornamentation of Hopi basketry, pottery, and other articles is never merely aesthetic or employed for the sensuous pleasure in beauty of form and color. It expresses itself in symbolism of religious meaning, the outgrowth of nature worship which embraces and gives import to design, color and even material. The origin of art in religion and its inextricability from belief, a feature which seems to vanish with civilization, is nowhere better shown than among the Hopi nature-worshippers. The significance of a decorated basket thus is far deeper than its beauty and usefulness and greater than the craftsmanship that created its material structure. The color symbolism is based primarily on the geography of the spiritual domain. The being who rules the northeast quarter is yellow, and all things in nature about him are yellow, the southwest quarter is blue; the northeast quarter is red; the southeast quarter is white; below is black, and above all colors.[1]

The designs on Hopi basketry are not as varied as those on pottery, and are less intelligible on account of the difficulty of expressing ideas in the textile medium, which often reduces them to the lowest terms of convention. The commonest designs are of birds or characteristic parts of birds. The snake is sometimes found. The antelope appears to be the only mammal used in basket decoration, though the mountain sheep may have been represented. Clouds, the rainbow, and perhaps stars are frequently noticed in combination with birds. Kachinas often in elaborate designs are in frequent use, the commonest being the corn maid, avatch or speckled kachina, and man eagle. The tendency in modern baskets is to make these figures more realistic and to accomplish this weaving elements never seen in ancient work are employed. There are also designs in bands or individual figures which have been conventionalized beyond present explanation. On this point it may be said that interpretations of designs secured from modern basket makers are apt to be delusive. The designs must be traced step by step from known designs or parts of designs by the method pursued by J. W. Fewkes on the Sikyatki pottery.[2] Doctor Fewkes used as a basis the designs on paraphernalia made by the fraternities for the various ceremonies current among the Hopi. Except a few interesting pieces of pottery from Oraibi, in which the ancient decorations had survived to some degree, the native ware collected in 1872 and succeeding years showed great deterioration. This is not true of basket designs, other textile designs, and designs used to decorate religious paraphernalia.

The designs shown (pls. 33–41) were selected from the large series in the United States National Museum, from photographs of the "Basket Ceremony," and from specimens in native dyes collected

[1] Hough, Hopi ceremonial pigments, Ann. Rep. U. S. Nat. Mus., 1901, p. 467.

[2] Published in the 17th Ann. Rept. Bur. Amer. Ethnol., pt. 2.

by the writer. They show the unrivalled skill of the Hopi as designers and their inherent aesthetic proclivities. It is hoped they may prove useful in the work of those who are seeking to institute a school of American design which is attracting a lively interest nowadays.

The designs of the Hopi basket maker deal exclusively with life and nature forms, and these may with more or less facility be identified. There are many examples, however, which show the disintegration of such designs sometimes to small units and often these units are placed in geometric combinations which become difficult of solution. It will be seen that the majority of designs are based on the bird form, which is evidently the foundation of most of the geometrics.

In Hopi baskets the color combinations are rarely or never in the order of the symbolic meanings of colors. The wicker baskets are characterized by the greatest variety and brilliancy of colors in contrast with the plainness of Zuñi wicker plaques. The coiled baskets are more sober in color than the wicker and often the coiled plaque is decorated only in two or several shades of natural yucca. The cause of this difference may be in the indication that greater skill in dyeing was possessed by the Oraibi than by the Middle Mesa basket makers. It seems likely also that yucca splints are less susceptible to dye than the brush splints.[1]

Designs are arranged: In two; two with two secondary; four; and four with four secondaries. Designs containing elements in 5, 6, and 7 may be regarded as departures from custom in the interests of modern ideas of beauty or completeness (pl. 33, figs. 5, 6; pl. 35, fig. 6). Three part designs are not found. Designs of more parts utilize the septums of wicker basket structure in simple alterations and repeats (pl. 37, fig. 5). Occasionally the sky band is drawn across the field of a coiled basket, as was the custom in Sikyatki pottery.[2] (See pl. 40, fig. 3.) This band never appears in wicker baskets.

The concave field of the basket is the sky and embraces the whole circle of the visible heavens, in this respect resembling the decorated area of Sikyatki pottery bowls as observed by Dr. J. Walker Fewkes.[2] The center of the field in wicker basket plaques, an usually undecorated circular space is the heart of the sky, the above. The margin line near the edge of the basket is the horizon. In the free area are placed birds, clouds, etc., and any design worked therein is represented as in the sky.

The common arrangement is indicated above, but several different dispositions of the areas are noted. In the case of Kachina figures or masks the whole area is occupied, the demarcations of sky hori-

[1] Hough, A collection of Hopi ceremonial dyes and pigments, Ann. Rept. U. S. Nat. Mus., 1900, pp. 465–471.

[2] Fewkes, 17th Ann. Rept. Bur. Amer. Ethnol., pl. 2.

zon, etc., being obliterated. Sometimes the whole area is occupied with bands of geometric or continuous figures in squares. Several examples show a two part design, probably birds outlining an elliptic or bilobed figure, undecorated, obliterating the central circle (pl. 37, fig. 6). Rarely in wicker baskets are the radiating arms of the prime compass points represented (pl. 35, fig. 4), but frequently in coiled plaques (pl. 38, fig. 1; pl. 40, fig. 2; pl. 41, fig. 1). The middle portion of coiled and wicker plaques is differently treated. In wicker plaques the central area is usually decorated only with a stepped diagonal line in the placket in the center formed by overlaying the crossed splints, rods which form the skeleton of the basket. The circular area is bordered with a band of alternating white and colored rectangles (figures in pl. 35 and others). In the coiled plaque the design begins generally at the second turn of the coil. In bird designs the beaks are placed to the center of coiled baskets and to the margin in wicker plaques (figs. in pl. 33); for coil (pl. 38, figs. 5, 6; pl. 40, figs. 2, 3).

The designs on wicker plaques figured show birds and clouds in recognizable, somewhat realistic forms (pl. 33); modified by the designers, but recognizable (pl. 34); and converted entirely into geometrics (pl. 35). Plate 36 shows kachina and other special designs. Plate 37 shows in figure 1 four antelope in simple line design, which may be compared with the fine realistic designs on the coiled plaque plate 40, figure 1. Figures 3–6 of plate 41 are motion designs and special designs.

The designs on coiled plaques show birds and birds and clouds (pl. 38); four and two bird conventions (pl. 39); antelope realistic design and complex bird designs (pl. 40); and designs of birds and perhaps snakes showing motion (pl. 41).

As designs become more conventional they tend to overlap; thus, birds and clouds represented as stepped figures can not be distinguished. Likewise the bird or cloud form may be reduced to a star symbol (pl. 36, fig. 1), or a dragonfly which would be represented as plate 34, figure 1.

The bird represented is doubtless the eagle primarily, but other birds may occur. The bird in figure 6, plate 38, suggests the bird figures mounted on a rod and pedestal used in certain ceremonies of the Hopi and especially among the Zuñi.

STONE.

Although their arts have been modified by contact with the white man, the Hopi possess a number of uses of stone inherited from another period. These are the metate and mano for grinding corn and the stone hand hammer for working as well as sharpening them;

abrading and polishing stones; the slab for baking bread; mortars and pestles, paint mortars and slabs; slabs for potter's work; and covers for ovens, etc.[1] These are still made by stone art methods, but the Hopi possess and use stone axes, mauls, hammers, knives, arrowheads, "hoes," etc., found in ancient ruins and now having a secondary employment for domestic and religious purposes. Constructions with stone are practically the same now as in past centuries, and pictographs are still cut in rock faces; on the whole the attitude of the Hopi toward stone, except in minor features, has been little changed by the introduction of iron. It may be said in explanation of this unprogressiveness that the introduction of iron has been slow, in small amount and comparatively recent, due to isolation of the villages, and that no Hopi has yet become an iron-worker. The Hopi probably received their first iron from the Rio Grande Pueblos in the form of crude, heavy hoes (see fig. 1). They were also in touch with the trade in iron arrowpoints, a trade at one time of considerable proportions and extending over a vast territory, causing the rapid disappearance of the stone arrowhead. The iron arrowhead appears to have been brought from the Plains tribes by the Taos Indians and traded to the Pueblos. The Utes, Navaho, and Apache retained the stone arrowpoint in large measure until the recent introduction of firearms, while the Pueblos had discarded it except as fetiches long before this period.

The hafting of stone axes and hammers, examples of which have been encountered among the Hopi and other Pueblos, probably in few cases follow the ancient methods, but is a crude application of ingenuity to accomplish the result, much as the problem of mounting an ancient specimen would be solved by a civilized man to whom the genesis of the implement was unknown.

Archeological objects picked up from ruins are valued as fetiches and are placed on the altars or employed in other ways by the secret orders (see fig. 47). Some of these specimens have come down apparently through many generations in Hopi fraternities and are entrusted to individuals for safe-keeping. Other archeological artifacts have been put to practical uses, especially axes and hammers, the resultant misuse without sharpening, tending to reduce an axe to a form resembling that of the hammer and the hammer to a nodule. In many cases metates recovered from village sites have resumed their utility in Hopi households. Stone fetiches were not often made by the ancient Hopi and there is no evidence that they ever made hard stone fetiches in number like those of the Zuñi or from ancient sites on the Tularosa River, but figurines worked from soft sandstone and painted representing zooic and anthropomorphic be-

[1] See exhibit of archeology, second floor, and family group case, first floor.

ings and forming part of the paraphernalia of altars were made.[1] The manufacture of these required little patience and skill.

The Hopi fetiches of stone were commonly natural, such as concretions or stones of suggestive shape or color. These were rarely and then only slightly worked, perhaps in the way of a groove for the cord or other chance modification, as the drawing of an eye, the addition of paint, etc., to identify the fetich. Beads of stone and worked shell, while prized and regarded as indispensable for ornaments as a sign of wealth and of the favor of the gods, are not made by the Hopi, but are secured in trade with the Zuñi and the Rio Grande tribes. Turquoise mosaic earrings, constructed by imbedding small plates of the stone in gum covering a rectangular wooden tablet and finished by grinding and polishing, appear to be still made by the Hopi in perpetuation of the ancient art (see pl. 27, fig. 2).

CLAY.

The culture of the Hopi is inseparably connected with the fictile art. Knowledge of the properties, uses and value of clay was thorough and was displayed in the mixing and application of this substance to house building, as mortar in the setting up of stone walls and as plaster for finishing walls, roofs and floors. The most striking use of clay, however, was in pottery, whose high development and wide employment in every avenue of social life marks a characteristic and remarkable feature of Hopi art. The diversity of pottery forms appears to have been in response to the limitations of the environment (see prefatory remarks on basketry) and the presence of excellent clays. The explanation may not be as simple, since there is also required a certain genius and adaptability in the people undergoing development, these qualities differing widely among groups of men placed in the same environment. There is also to be considered the contact with older and more advanced tribes. It is instructive to note here the comparatively negative effect of Pueblo culture and semi-arid environment on the Navaho and Apache intrusions in the Pueblo region. Those tribes which have sojourned in this environment for nearly 800 years have developed nothing resembling Pueblo material culture and have absorbed little from contact with the Pueblos and retain practically unchanged the characteristics of their sub-Arctic culture. Thus they have never made pottery or erected stone houses or taken the close affiliations of village life which mark the culture of the Pueblos.

The making of pottery among the Hopi is exclusively woman's work and they carry on all the operations without other assistance. The clays are found in small seams between the great beds of sand-

[1] See case of fetiches, north side.

stone forming the mesas and must be dug out and carried to the village with considerable effort. Several varieties of clays whose qualities are known to the potter are found in the various strata of the cliff. These form the basis of the ordinary ware made in the pueblo of Walpi. Very fine clay, which was used by the ancient potters, is taken from the mesa near Sikyatki. This clay is used for very fine work by one or two of the Walpi potters. White clay of the proper quality for washing the surface of vessels is found in this locality, the source of the material being near one of the buttes south of the villages. This kaolin is only used to produce a finish on ware made from the coarser local clays. The body of the ware is a paste, made by mixing two of the local clays in about equal portions. The material is freed from stones and sand and placed in a bowl and soaked with water. When it has been softened and a portion of it is desired for use, it is removed to a smooth stone slab and carefully spread out. During this process some of the moisture of the clay is absorbed in the stone and some dried out by the air, and in a short time it approaches readiness for use. After a course of rolling and kneading, it is in proper condition. In case the clay has too much moisture, it is spread out on a stone slab which is later leaned up in a slanting position in the sun. It will be observed also that no temper is mixed with the paste. In forming the vessels the clay is taken between the two hands and molded evenly into a long cylindrical mass. This is wound spirally at the beginning; other similar rope-like masses are added until the work is completed. During the process these coils are pressed together and a vessel of comparatively smooth surface is a result.[1] In large vessels this process can only go on for a few inches at a time as the softness of the clay will not bear up under the weight of the structure. Generally several vessels are under process at the same time. Larger vessels are begun on a concave disk of pottery which admits of the work being turned about with facility. When the vessel is firm though still "green," the surface is gone over with a smooth stone carefully applied with a brushing, rubbing motion, removing all irregularities to bring it to a smooth polished surface. When the vessel is dry a wash of white clay is applied and this in turn is rubbed down with a polished stone. The vessel is now ready for decoration. Material has been prepared for paints by rubbing yellow ochre and dark brown ironstone on a stone slab. Yellow ochre is mixed with water as a medium and burns a bright red on the ware. The ironstone is usually ground with oil made from the seeds of the tansy mustard. This paint burns dark brown. The colors are applied with simple

[1] See Zuñi potters group.

splints of yucca leaf, which are handled with marvelous proficiency by the potter, who holds the vessel on her lap and works out the design with unerring accuracy. The outlines of the solid designs are made first and the surface to be covered is filled in with even strokes.

Slabs of stone on which the clay is worked or dried, stones with which the clay is sometimes crushed before soaking, paint slabs, smoothing stones and other odds and ends of stone lie about the places where the potter works. Some of these are of customary use and others are of temporary or emergency service. As a rule the best potter will have gathered together in her workshop the greatest stock of things that may be useful. The customary tools are spoon-shape formers of gourd for pressing down the coil ridges and for preliminary smoothing; polishing stones, glossy from long continued service; a rabbit fur mop-brush for applying the wash of white clay; and yucca leaf brushes for drawing the designs. Occasionally a small stick is used to punch holes for the insertion of handles or to form the mouths of small vessels. The bottom disk, which is the equivalent of the potter's wheel, is formed by plastering clay over the convex of a basket bowl, removing the shell of clay and baking it, thus nearly all of these specimens bear basket impressions which are in turn imparted to the bottom of vessels formed in them. The potter also makes use of blankets, baskets and sundry cups, canteens, vases and bowls of pottery in her work.

As the potter's vessels are finished, they are set aside in a safe place to await a calm and convenient day for burning them. The preparation for burning pottery entails much arduous work on the potter. She must gather slabs of sheep dung from the floors of the corrals on the benches below the mesa and carry them in her blanket to the place selected for the kiln. Here also she brings a blanket load of white sandstone and transports from the house on the mesa the pottery to be burned. She clears off a circular space of ground and builds in the center a small fire of dry dung and around this fire disposes the pottery so that it may be evenly heated and thoroughly dried. The pottery in this heat becomes lead color and when adjudged sufficiently hot and dry is compactly set up over the ashes of the fire, bits of sandstone being used to separate the pieces as stilts are employed by the civilized potter. Around the pile is built up a circular wall of the slabs of sheep dung closed over the top with large slabs. This structure, at once fuel and kiln, ignites from the remains of the previous fire and soon produces a high heat, the pottery assumes a bright red color, and when the kiln has burnt out the ware will be thoroughly baked. The kiln needs constant attention to prevent pieces of the fuel falling on the ware, which would produce blemishes. Also if a breeze should start up the potter must shield the kiln with a blanket. On account of superstition the potters maintain silence when the burning is in process lest the spirits be offended and cause the vessels to break. This is probably in part a fire taboo and in part due to a belief that a proper spirit inhabits each piece of pottery.

Pottery-making among the Hopi is at present confined East and Middle Mesas, having become obsolete at Oraibi. There is evidence that the art which in ancient times produced the superb ceramics of Sikyatki and the interesting and beautiful ware of the ruined pueblos of the Hopi clans had declined and become almost extinct in the late seventeenth or early in the eighteenth century. On the arrival of a group of Tewans from the Rio Grande, who were settled at Hano on the East Mesa, about 1700, the art was revived by these potters, but the style of decoration was necessarily foreign and remains so to this day. Pottery, especially vases, collected at Orabai by Major J. W. Powell in 1872, probably represent a transition or survival of the ancient Hopi art. These unique specimens which are exhibited in the United States National Museum [1] were in use by the Oraibi, but were evidently antique and were not still made at the time of collection. The designs show transition, and the forms, while following that of the ancient and graceful Hopi vases, are cruder. Some of the old Oraibi pottery imitates Zuñi form and design. Ancient Hopi pottery is yellow, orange, and cream color and was never surface washed with other clay. While traditionally some of the Hopi clans occupied formerly the region where gray ware decorated with black was prevalent, this ware was never made by the Hopi since they occupied their present location. A few specimens of a particularly fine gray ware have been found in ancient Hopi ruins on the Little Colorado near Winslow, Arizona. The loss of the art of making gray and red ware by the Hopi presents an interesting field for study, which contains important data on the history of this people.[2]

WOOD.

The timber supply in proximity of the Hopi villages is not now and probably never was large or varied. The only tree of general use in the vicinity is the cottonwood, *Populus monilifera*, *pa she hurps be*, of the Hopi, a quick-growing tree along washes, near springs, or wherever there is water. The cottonwood forms the chief basis of the Hopi wood-working industry, and on account of its religious associations and economic uses may be termed the Hopi culture tree. The pinyon, *Pinus edulis*, which grows farther away, is somewhat useful for beams, etc.; but the great pines of the mountains are too distant to be available. The most prevalent tree, the juniper,

[1] West north hall, first floor.

[2] A splendid collection of the ancient Hopi pottery is exhibited on the second floor, east north hall of the Natural History Building.

Juniperus occidentalis, is valuable for firewood, but its brittleness and crookedness render it almost valueless for Hopi construction. For minor uses the oak, *Quercus gambelli*, is brought from long distances to the north for bows, digging sticks, clubs, weft battens, etc. (see pls. 30, 44), and the mountain mahogany *Cercocarpus*, also brought from the north, has its chief use for small weft batens and combs employed in belt weaving. Among the minor wood stuffs having economic value may be mentioned yucca flowering stalks and wands of the rhus and willow.[1]

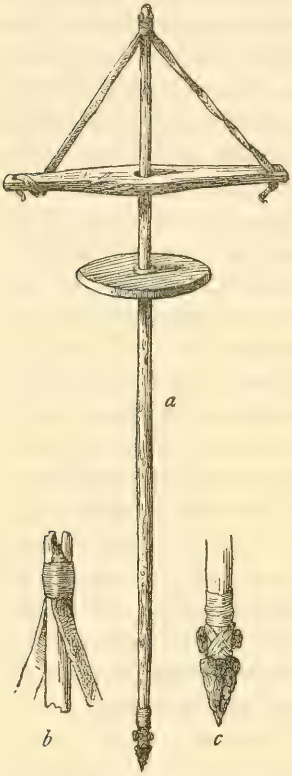


FIG. 42.—*a*. PUMP DRILL. *b*. DETAIL OF AFFIXING THE STRAP. *c*. DETAIL OF POINT.

Timbering by the crude processes pursued by the ancient Hopi consisted of felling the larger trees and cutting them off to lengths by means of fire. Smaller growths were cut with the stone axe, limbs broken off with the stone hammer-maul, and saplings and stems sectioned with the saw-scraper.[2] The logs were peeled with the stone axe. So far as can be determined the wedge for splitting wood was not known. In the further operations of woodworking the stone rasp, the knife and saw of chert, and the drill and smoothing stones were used. Of the stone-age tools only the rasp and drill (fig. 42, *a*, *b*, *c*) have survived to the present, iron tools having been substituted. This change appears to have taken place recently in regard to most of the implements.

The objects of wood, which are carved, consist of dolls (pl. 42), *tihus;* parts of masks, animal figurines as birds, feather boxes (pl. 43, figs. 2 to 5), etc.; and pahos of great variety. Joined work consists of masks, headdresses, slats of wood, altar frames, lightning sticks (see fig. 45) and other religious paraphernalia (figs. 43, 44). Joining is effected with leather thongs or fiber cord and wooden pegs and pinyon gum. Among the various simple objects of wood made by the Hopi are firemaking sticks, digging sticks, rabbit clubs, bows and arrows, weaving tools, parching rods, traps, loom parts, etc., which are described under their appropriate classes. Wood was worked in the main like stone, and some wooden objects like dolls were ground

[1] For wood used in house construction see Mindeleff Pueblo Architecture, 8th Ann. Rept. Bur. Amer. Ethnol., 1886, p. 102.

[2] Hough, Bull. 87, U. S. Nat. Mus.

to shape on stone without the interposition of any tool. Short simple implements like weaving battens and digging sticks were ground in this way and with an abrading stone of convenient shape held in the hand all the mechanical requirements for sculpture in the round, the undercuts, ridges, chamfers, grooves, etc., were possessed by the Hopi woodworker. It is observed also that the quality of workmanship in wood shown in the ancient specimens[1] has not been advanced by the possession of iron tools in the modern epoch. It appears that iron tools have only served to increase the facility of getting the raw material and the speed of manufacture of the products.

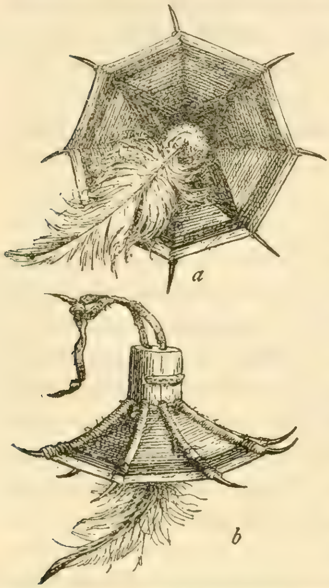


FIG. 43.—ORNAMENTS FOR SIDES OF MASK. *a*. FRONT VIEW. *b*. SIDE VIEW.

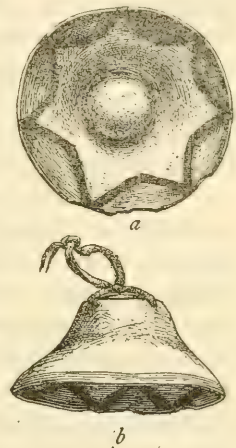


FIG. 44.—MASK ORNAMENTS OF PAINTED GOURD. *a*. FRONT VIEW. *b*. SIDE VIEW.

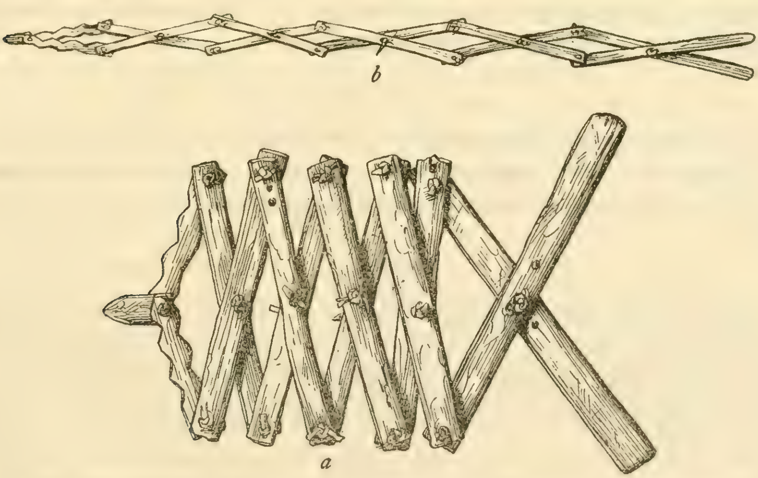


FIG. 45.—*a*. LIGHTNING FRAME CLOSED. *b*. SAME EXTENDED BY PULLING HANDLES TOGETHER.

The absence of the wedge which generally precedes the saw or any other primitive tool and useful in the procural of masses of wood

[1] Fewkes, Dr. J. Walter, 17th Ann. Rept. Bur. Amer. Ethnol., pt. 2, pls. 164–5; Hough, Bull. 87, U. S. Nat. Mus., 1914.

with plane surfaces was a great drawback to Pueblo woodworking. Such wood sections of small size and of very fissile wood as the flower stalk of yucca and like plants were indeed made in some localities, but in small amount and probably by splitting with the flint knife. Usually such pieces were ground down on sandstone from larger masses of wood.

Cottonwood trees often decay, forming hollow shells of thin wood which the Hopi appropriate for drums.

HORN.

The Hopi formerly made a limited use of horn in the arts, chiefly for large spoons used in preparing and serving food. For these utensils the material was the horns of the mountain sheep which already approximated the form desired. The horn was rudely dressed and bent to shape with heat, and the finished ladle is rough and clumsy, probably owing to the difficulty in working the substance by the abrading methods practiced by the Hopi. Identical horn ladles are found in all the Pueblo villages and their number indicates the abundance of mountain sheep formerly existing in the mountains of New Mexico and Arizona.

The disk whorl of the spindle was sometimes made of horn, and hooks for the pack strap and combs for weaving were occasionally of the same material. Horns of the antelope were used entire as hooks planted in the walls of houses; sewed to certain helmet masks or perforated to form a wrench for straightening basket wands, arrowshafts, or other rods (see pl. 46, fig. 4). Entire horns were also used as bells or rattles (see pl. 22, fig. 1).

BONE.

Bones of animals entered little into the arts of the Hopi, the chief use being for awls (see pl. 46) and leather-working implements. Scapulae were used in music (see pl. 51) and as scarecrows (see pl. 22, fig. 3).

SHELL.

Shell work is sparingly practiced by the Hopi, but when possessed of shells from the sea, which they value highly, they are able to perforate them for stringing as necklaces and rattles; but they do not make beads or do any work in shell comparable to that found in the ancient ruins.

LEATHER.

The environment of this portion of Arizona is not animal and there was always a scarcity of skins for clothing and other uses. In consequence weaving became much developed among the Hopi. Nevertheless, the trade in tanned deerskin was very important and comprised the chief exchange with less advanced tribes living on the range of the deer. The most valued skins were procured from the Havasupai living in Cataract Canyon, about 100 miles west of the mesas. Less valued skins came from the Apache of the White Mountains, to the south. Formerly great herds of antelope roamed over the rolling grassed plains of the basin of the Little Colorado River. A disease of some unknown character is said to have diminished their herds in historic times, and on the introduction of great numbers of cattle, with the consequent depletion of the grasses, the antelope became practically extinct. This animal, though difficult of capture, no doubt furnished a certain amount of food, but its skin is thin and weak and of insufficient value to repay tanning.

Dyeing leather by infusions of bark, etc., was known to the Hopi; and they applied colored earths by rubbing them into the open texture of the surface of soft tanned skins. Colors were also applied mixed with some medium as saliva, or an emulsion of oily seeds, etc. The mordant for infusion or vat color was almogen or crude native alum.[1]

In dyeing leather black an advanced process like that known by the Navaho was employed in which an iron tannate (ink) is found. The knowledge of this process appears to be derived from the white man and probably came in with the weaving of wool like the secret of mordanting indigo, this dye being introduced to the Pueblos at an early date at the Spanish settlements on the Rio Grande (Santa Fe, Espanola), in order to encourage the industry on the Crown lands of Mexico. It appears, however, from archeological data, that mordanting was known to the ancient Pueblos, but not to the extent indicated by the black dyeing process mentioned, which resembles more the crude rule of thumb recipes developed with the European industries before the knowledge of chemistry became accessible. The lines of progress of the dyer's art have been followed to a greater or lesser extent by most uncivilized tribes; thus some of the processes now reduced to scientific exactness are observed in their crude tentative shape among people of low advancement. In some environments the conditions are rarely favorable for their utilization. They are put to use in areas where a civilization is developing under what may seem unfavorable surroundings and the needs of the population must lay under contribution for products lands situated at great distance; thus Peru drew on the Amazon Valley; Mexico on its tropical coasts; and the Pueblo region on its subsidiary environments. It can readily be seen that the Pueblos would have developed a much more complex and markedly higher material civilization if tropical or subtropical sources of supply had been accessible. The

[1] Hough, A collection of Hopi ceremonial pigments. Ann. Rept. U. S. Nat. Mus., 1900, pp. 463–471; Pepper, The Making of a Navaho Blanket. "Everybody's," Jan., 1902, p. 37.

Hopi, thrown on their own resources, made a creditable showing in the application of color to materials beginning with the most primitive and advancing as follows: Staining with earth and mineral colors; dye infusions of flowers, seeds, bark, etc., simple or in combination, or combined with mineral colors; the discovery of fixing or saturating material with color by boiling in infusions; and the discovery, by chance perhaps, of a mordant through empirical experimentation. Tools used in tanning have not been seen among the collections from the Hopi, as these collections have all been gathered in recent years since the game became scarce. From prehistoric sites there have been recovered leatherworking tools, consisting of breakers of deer tibia and pelvic bones and fleshers of femurs. Such bones on account of their shape and availability were generally used by the American tribes. The cutting of leather by primitive methods presents some difficulty, and it would seem probable that among the American Indians before the introduction of iron elaborate leather work would be difficult and for costumes perhaps robes to a large extent served the purpose of formed garments. Rawhide and tanned skin can be cut with chips of chert, chalcedony, and obsidian, the latter being very good for the purpose, but none of these stones are as effective as iron. All leather cutting in prehistoric times was done with chips or flakes of stone and no classified implement for the purpose has been found. The chief tool in leatherworking is the bone awl, whose point makes possible fine sewing as that with the needle. Awls are found in profusion in the ancient sites, those for leather sewing being characterized by a fine slender point.

Another important use of tanned leather is for moccasins (see figs. 15, 16, 27). The method of making them is as follows:

The outline of the foot is traced on the piece of rawhide, the thick skin on the back of cattle being regarded as best. Outside of this outline a margin of about half an inch is traced and marked, and the sole cut out to this outline. The next step is to soak the sole, form it up at the edges, and around the edge is cut a slit for the welt. The welt is then bent up and the vamp which has been cut out is sewed on with sinew by means of the bone awl. When the sewing of the vamp is completed, the moccasin is turned inside out and the heel portion sewed on, care in every case being taken to hide the stitches, the resultant work being extremely neat. The heel leather is cut with a flap which goes over the ankle and is buttoned as in the Navaho moccasin, or tied with a buckskin thong. It will be seen that as the sole is larger than the foot, the surplus rolls up over the sides, giving an excellent protection for the foot against sharp rocks, thorns, etc. Often, according to taste, the vamp and heel portion are of different colored leather.

A variety of small pouches of buckskin are made, usually being simple pursings of leather, or with little sewing. The most complicated is in the shape of a crescent moon, the opening supplied with a flap, being at the center. Thongs for carrying the pouch are tied at the ends of the horns. This pouch resembles those of the Zuñi (fig. 46).

Another use for leather is in making ceremonial shields and masks, and for this purpose rawhide is used. Some of this work, especially in imitating the form of horns of the mountain sheep, is very skillfully done.

One of the important uses of leather at present is connected with the horse and burro for sinches, hobbles, pack saddles, bridles, whips, etc. Lariats braided from buckskin were formerly made, and the work on them is very neat.

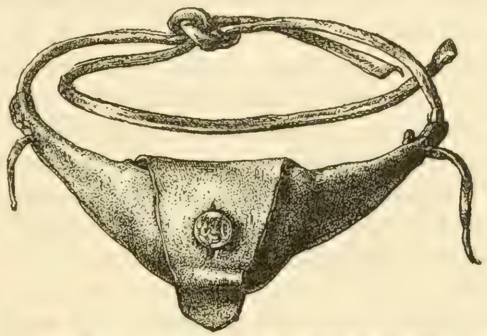


FIG. 46.—LEATHER WAIST POUCH WITH WAIST CORD.

WORK IN FEATHERS.

Feathers are of prime importance among the Hopi on account of their extensive use in ceremonial paraphernalia and objects nearly connected with religion. In this respect they are used on ceremonial costume, masks, prayer sticks, prayer offerings, and offerings of felicitation at the Soyaluna ceremony (see pl. 43, fig. 1), and many others. There is little if any secular use of feathers, but quills were used in a kind of textile work (see pl. 32), and as bird snares. Anciently feathers of the turkey were applied to cords with which blankets were made, and these blankets preceded the rabbit skin robe.

MASK MAKING.

The skill of the Hopi is displayed in the making of masks, which with other complicated religious paraphernalia, demand a many-sided ability for construction.[1] Masks covering the head are formed of a width of dampened rawhide, sewed at the edges and pushed or formed into shape. Orifices are cut for the mouth and eyes. When dry the leather is firm and the mask is painted and decorated. Teeth are sometimes cut from a strip of leather and fastened on with sinew. The tongue, if required, is a strip of leather painted red and thrust through the mouth orifice. If a beard is required, it is made from horsehair or fur and sewed on. Lashes of hair are placed over the

[1] Examples may be studied in the west-north hall of the United States Natioinal Museum.

eyes and a mass of horsehair or fur sewed to the top of the mask. The nose is often a cylinder of wood sewed in place with sinew or pegged on, or it may be the neck of a gourd, and the ears are often blocks or tablets of wood or flaps of leather. Many masks are supplied with a visor consisting of a section of coiled basket. Some of the masks require snow on top, and this is simulated with cotton; feathers, grasses, etc., also decorate the masks. Around the lower margin of some of the helmet masks is tied a roll of painted cotton cloth or fur or pine twigs as seen also in Zuñi helmet masks.

Cap masks have for a foundation a bowl-like wicker or twilled basket structure, or in modern times the crown of an old felt hat. Horns of the antelope are pierced with holes at the base and sewed on or imitation horns of the mountain sheep ingeniously molded in rawhide are sewed to the masks to form the headdress of the Alawimpkia or priests of the Horn Fraternity. The necks of gourds are also used to represent horns. The horns and cap of these masks are frequently formed of one piece of skin, and to cut the pattern so that it will join properly requires considerable ingenuity.

Masks representing women resemble masks with which civilized man is familiar. The face is modelled with some art and when surfaced with pinkish clay and supplied with a wig have a striking similitude to Hopi women. Women's masks or those representing female beings are supplied with ears representing squash flowers formed by wrapping bright yarns over a radiating frame of splints or martynia spines (fig. 43 *a*, *b*). A coronet around the top of the mask is sometimes formed in this way. Flowers are often carved from disks of gourd (fig. 44 *a*, *b*) or consist of a wooden disk with wooden petals stuck around the periphery, or they may be of carved wood. Bangs on the woman's masks are made of horsehair dyed red. This is made in a strip, the ends of the hairs held tightly by a braiding of three cords. Sometimes the bang is made of white goat's hair. All the ancient female deities wore bangs.

The masks of joined wood are remarkable pieces of work. They are fan shape and consist of numerous bits of wood ground to shape and joined with wooden pegs to represent flowers, stars, rainclouds, birds, etc. They are erected on a semicircular frame of wood or rods covered with cloth which fits over the sides of the head. They are gaudily painted with bright earths and are very striking. In the apex is a ring of cornshuck which rests on top of the head when the mask is in place, and the mask is secured to the head by leather straps or buckskin thongs. Some of these masks are made up of rain-cloud tablets sewed together and have a rectangular opening for the head. Some of them consist of a framework of rods covered with painted cloth or skin. This construction is carried out in other religious paraphernalia. The several types of masks used by the Hopi may be classified as follows:

1. Helmet masks of rawhide, which cover the whole head. Bag masks after the helmet type.

2. Face masks modeled in rawhide to represent the human countenance, animal, or monster heads.

3. Cap masks of basketry with curving horns modeled in skin or made of necks of gourd. Hat masks of one piece of skin forming the head part and two upright horns.

4. Coronet or tablet masks of joined pieces of wood or skin stretched over a framework. With these is worn a visor or band passing around the head and having eye, nose, and mouth holes cut in it. Such visors are also worn with the cap masks.

There is an immense amount of inventive ability, mechanical skill, and artistic labor displayed in the construction of ceremonial paraphernalia—the scenery of the religious rites, if it may be so called. The personal paraphernalia of costume masks and objects collected, with the participation of the celebrants, run the gamut of complexity in their preparation, but the requirements of the collective setting of the ceremonies are even more far-reaching. The difficulty of the mere record of the preparations and mechanical conduct of a single ceremony is enormous. The altars alone, erected by the different fraternities during the rites, are marvels of complexity. Some ceremonies demand mechanical manipulations that are surprising in their production and in their effect on the beholder. One of these is the Palulukong ceremony, excellently described by Doctor J. Walter Fewkes,[1] which huge mechanical snakes emerge from orifices in the altar frame or from great jars and struggle realistically together or with the celebrants.

An invention of the Hopi which shows ingenuity is a folding frame used in ceremonies to represent lightning (figs. 45 *a*, *b*).

WEAPONS AND HUNTING.

The social organization of the Hopi is very complex, being interpenetrated by the rules and laws of an extremely involved religion, itself a partial fusion of ideas of varied origin.

In its elementary form the organization is based on the clan and its group of laws, secular and religious. The case of a single clan occupying its own settlement is comparatively simple. Here the government would be administered by the circle of clan elders who act both in a religious and secular capacity, directing all the practical work of the clan, but on a religious basis—that is, all activities are to be referred to the direction of the supernatural powers, appeal to which would be through the fraternity. The approximation

[1] Fewkes, Dr. J. Walter and A. M. Stephen. The Pa lu lu konte: Journ. Amer. Folk-Lore, vol. 6, Oct. and Dec., 1903, pp. 269–284.

of several clans in one village requires adjustments, but these give rise to no serious changes in the organization. A coalescence of clans gives rise to no higher social functions, and it may be said that at the arrival of the Spaniards the executive or gubernatorial functions of the Hopi were not invested in a single head. This feature was forced on the Pueblos by act of the United States Government by the appointing of civil chiefs, whose power in effect was nothing unless it coincided with inherited clan delegation of authority.

The displacements of the social organization at times are very curious. Ordinarily when a ceremony is not in progress such regulation of the activities of the pueblo as are necessary is provided through the council apparently without action of a fraternity. During a ceremony the pueblo appears to be in the control of the fraternity or fraternities holding the ceremony. This is shown in the closing of the trails leading to the pueblo to prevent profanation, first observed by the Spaniards under Espejo in 1583. The patrols who even to this day order white men away during ceremonies seem to point to this feature. It would appear that clan control of the village was the usage at times of a ceremony held by members of a clan.

It is true, however, that all ceremonies by any clan whatsoever are held for the common good of the associated clans constituting the village.

War and hunting are also features of the social organization. War or protection was socio-religious and was entrusted to a fraternity. Hunting belonged to the communal type and was a feature entering into the rites of some fraternities.

HUNTING.

Hopi legendaries say that before the advent of the white man their country was covered with excellent grass and consequently there was much game. There appears to be a substantial foundation to this legend, since we know that by wasteful methods of overstocking, the grasses and other herbage of Arizona have been reduced by the white man to a minimum in some parts and exterminated in others. In former times, then, the range of animals may have been extensive where now they are restricted. The antelope was, as we know, plentiful in all portions of the open country, and probably deer of several species ranged with them. Bear also had a more extensive range on account of food, there being evidence that juniper forests were much more widespread than at present. Smaller mammals, like the fox, coyote, wolf, skunk, raccoon, porcupine, badger, prairie dog, rabbit, hare, mice, etc., may or may not have been more prevalent. Birds are still numerous; reptiles and insects are yet in sufficient quantity.

The above is a summary of the animal resources, near and far, which were available to the Hopi and use was made of all of them.

The capture of the larger mammals was effected by battue, the game, principally antelope, being driven into corrals having pockets. This method was pursued anciently but was greatly accentuated on the acquisition of the horse and the iron axe. The Hopi, however, did not pursue this method to the same extent as the Navaho, preferring rather to depend upon the number engaging in the hunt and individual agility which rivaled that of the animals themselves. They also wore as decoys the heads of antelope prepared for the purpose, thus taking advantage of the well-known curiosity of this animal.

Hunting was, to a great degree, ritual, ceremonial hunts being an accompaniment of certain ceremonies, as the Soyaluna. Hunting undertaken as such by individuals was attended with ceremony and aided by fetiches, but chance flushing and pursuit of game had no religious character. The curved flat club-boomerang was the favorite weapon for killing small game, and in good hands was almost as accurate within its range as the bow and arrow, but the latter had necessarily a more extensive use. Skill in throwing rocks may be mentioned in connection with the capture of game. The capture of animals depended upon the habits of the animals themselves and upon circumstances. Thus, during heavy rains, rivulets were conducted into the burrows of prairie dogs by means of a hoe, and the animal coming out in half-drowned condition was dispatched with a stick, dozens being so captured in a short time. The habits of animals were well known to these Indians, and this knowledge was brought in play when the occasion arose.

Animals taken ceremonially for use in religious observances are required to be captured without mutilation and without shedding of blood. This taboo is based on the prescription of perfect offerings and has given rise to the use of the club-boomerang, regarded as a ceremonial hunting weapon for the capture of small mammals, instead of the bow and arrow.[1] Birds whose plumage alone is desired in its utmost perfection are therefore not killed with the club or the bow and arrow, but snared and trapped. Small birds are taken with a series of nooses secured at intervals along slender rods planted near springs where birds congregate. The nooses now used are of horsehair. Seeds are scattered about the place and the birds feeding become snared in the nooses. Eagles are caught with far greater difficulty, the method being to build a circular tower on some high elevation, place over the top a frame of rods lashed together, and

[1] The Zuni prescription for the ceremonial taking of deer is that the animal shall be smothered. Mrs. M. C. Stevenson, 23d Ann. Rept. Amer. Bur. Ethnol., p. 439.

upon which is tied a rabbit. The hunter after ceremonial purification enters the tower and patiently waits for an eagle to swoop down upon the rabbit, and when this occurs the man reaches through the frame and seizes the eagle by the legs. In its struggles to escape the eagle becomes exhausted, rendering its subjugation easier, but the hunting needs, on the part of the Indian, great patience, courage and address.[1] Eagles so captured are impounded until the feathers are needed. The Zuñi keep them in cages.[2] Especially important in Hopi ceremonies is eagle down and the supply is gathered from young birds taken from the nests whose ownership is vested in the clans.[3] These birds are brought to the pueblo, stripped of down and killed by pressure on the sternum and buried in the eagle cemetery. The wild turkey was formerly kept for its feathers[4] and at present the domestic turkey is used in its stead. The great demands for feathers of various birds in the ceremonies necessitates efforts to maintain the supply, and extraordinary skill in capturing them.

Communal hunts, so-called, should be considered from the social and religious side of Hopi life rather than from the economic standpoint. The origin of the custom may have been utilitarian, necessitated by the habits of game in an open country, the primitive gregarious method of Hopi hunting by driving, running down, and surrounding the quarry, the protection of numbers in the presence of enemies, and finally the carefree enjoyment of such hunts in company with congenial spirits intent on getting the most out of the occasion. In fact to an observer of a hunting party in action, the peaceful people seem to be anything but that, and to have let themselves loose with the intention of massacring everything living in sight. The hunt may be divided into two periods—the departure to the field with hilarity, the fierce hunt, though only for rabbits, and the subdued return with whatever the gods of the chase have awarded in the way of game.

The Hopi trap the coyote, the fox, and other mammals and birds. The common form is the deadfall, the weight consisting of a flat stone held up on a peg with rounded ends, the lower resting on a convex surface of wood, giving a very unstable support. The bait is tied to the peg and a slight pull upsets the support and releases the stone. A similar trap is found among the Zuñi. The simplicity of this device is noteworthy; it can be prepared in a short time from material readily at hand and without tools, the rubbing necessary to round the sticks being done on stones. The figure four device is not known to the Hopi and indeed on account of the meager environment

[1] Property rights in eagles among the Hopi, J. Walter Fewkes, Amer. Anthrop. (n. s.), vol. 2, Oct.–Dec., 1900, p. 70.

[2] Zuni Folk Tales, F. H. Cushing, New York, p. 34.

[3] Fewkes, Amer. Anthrop. (n. s.), vol. 2, 1900, p. 69.

[4] Winship, in 14th Ann. Rept. Bur. Amer. Ethnol., p. 517.

the rather complicated inventions which characterize the traps of the tribes who depend largely upon the chase are not developed here. The name for trap is *cha-kom-i*, appearing in continuation as *ish-chakomi*, coyote trap; *peha-chakomi*, bird trap.

WEAPONS.

One of the most curious of American Indian weapons is the throwing club, "boomerang," called *putc kohu* (pl. 44, fig. 4, Cat. No. 126348 U.S.N.M.). It is made of oak, *Quercus gambelli*, a very hard tough wood, presenting great obstacles to working, especially with the crude tools and appliances of the Hopi. The club is flat, about one-half inch thick, and the curve is produced by working from wood selected for its natural bend. At one end a hand-grip is cut and the other end is usually apexed. The club is smoothly finished, often polished, and is painted red with a customary—perhaps prescribed—design in black, representing rabbit feet. The careful finish of the club appears to be for the purpose of expediting its passage through the air. It is held in position for throwing with the concave edge front brought down with a sweep and released in a horizontal position (pl. 53). It rotates in the air and on striking the ground or an obstacle executes a series of evolutions, often for several yards around the point of contact, touching the ground and erratically flying up several times, but has no tendency to return to the thrower. The Hopi use this club with considerable skill in hunting rabbits and rarely miss the quarry. The weapon appears to be very ancient and may at present be assigned almost exclusively to the Hopi. Clubs that suggest the beginnings of the flat *putc kohu* are frequent (pl. 44, fig. 1, Cat. No. 69480, U.S.N.M.) and are the common form of the Zuñi. This club is often flattened on the sides (pl. 44, fig. 2, Cat. No. 69534, U.S.N.M.) and when more flattened and formed at one end for grasping (pl. 44, fig. 3, Cat. No. 69443), the resemblance to the typical *putc kohu* (pl. 44, fig. 4) is apparent.

The bow and arrow must be regarded as having been the most important weapon of the Hopi, but as the innate character of the people is peaceful, their name expressing this aspect, the extent and development of weapons among them is very limited. The bows, so far as may be determined from specimens collected within forty years and which no doubt represent modified survivals, are small. They are made of a hard and elastic oak, *Quercus gambelli*, procured in the mountains far to the north of the villages, and though short are strong and effective. They are self bows and there is no evidence that they were backed with sinew, as was the custom with their neighbors and enemies, the Ute, Navaho, Apache, and other tribes. As mentioned, the formation of a bow from tough oak by means of the crude stone-age tools, was difficult; the procural of the wood itself required exceptional labor, especially as the wedge was not known. As among most American tribes, fire and the stone ax were the chief agencies used in timbering. The bow was worked out from the rough wood and finished by attrition on sandstone and with gritty rubbing stones (pl. 45, fig. 1, Cat. No. 69532, U.S.N.M.). The curve in the back of the bow is formed by heating and bending the wood. The nocks are not deep. The string is of sinew looped at one end and wound and half hitched to the bow at the other end. Most of the bows are painted, which indicates their connection with religious observances. This has been the case with ceremonial offerings of bows, etc., from ancient times. Arrows are made from sprouts of Rhus, oak shoots or wild currant smoothly finished (pl. 45, figs. 2, 3, Cat. Nos. 69,603; 84,318 U.S.N.M.), the triple feathering of hawk's plumage wrapped on with sinew. The shaft is grooved, as was the general custom in America. Reed shaft arrows have not been used by the Hopi since their settlement in their present location; but the reed, *Phragmites communis*, has almost disappeared from the southwestern United States, and its extinction was gradual up to the time of settlement and grazing, when it passed away very rapidly. No Pueblo stone pointed arrows exist, iron having superseded them, and the stone points are frequently used as charms (fig. 47). The bark was scraped off, the rod ground and polished with standstone abraders (shown in archeological collection), straightened with a horn wrench (pl. 46, fig. 4), feathered, the point set in, and the shaft painted with yucca splint brush (pl. 46, fig. 1) from a paint pot of four colors (pl. 46, fig. 5). The awl and primitive basket for holding resin are also property of the arrow maker.

FIG. 47.—STONE ARROW USED AS A CHARM AGAINST LIGHTNING

To protect the wrist from the recoil of the bowstring, a leather wristlet is used (pl. 45, figs. 4, 5, Cat. No. 75700, U.S.N.M.). The examples in the United States National Museum are made from harness leather procured from the white man and have attached to them plates of tin ornamented with pierced work or punching.

It appears probable that lances were never used by the Hopi, or if so, only to a slight extent. They have been observed among some of the Pueblo tribes, who, it is thought, adopted this weapon from the Spaniards. The lances referred to have iron heads, often bearing the name of the maker and date. The iron-head lance of the Comanche, Kiowa, and other plains tribes may have had as a prototype a shaft tipped with a chipped stone head, like those which are known to have been used in Mexico and which have come down to recent times among the northwest coast tribes and Eskimos.

While objects which appear to be shields of the flimsiest character are made use of by the Hopi in ceremonies, no effective shield has ever been found among them. A large basketry shield is noted from the ancient ruins of the Canyon de Chelly.[1] This forms the only evidence that the shield was used by the ancient Pueblos. The eastern Pueblos used shields, and it is worthy of consideration whether they were introduced from the plains.

There is no trace of the throw stick among the Hopi, nor has it survived in any of the southwestern tribes, though formerly its use was widespread. There is evidence that the throw stick had been invested with a ceremonial character even in ancient times among the Pueblos, a feature which often marks the decline and disuse of an implement. It is improbable that the stone axe or stone head club ever had important or general use as warlike implements of the Hopi, which seems to be borne out by the scarcity of such stone age relics in the ancient ruins. Nevertheless, a weapon or implement, called *pu u kong*, traditionally having a stone head, has given its name to one of the Hopi ceremonies. It may be possible that the stone head club mentioned was the peculiar weapon of one of the clans aggregated to the Hopi in former times and retained as a ceremonial element in the rites observed by the clan. The characteristic weapons of the Hopi appear to have been the bow and arrow and the wooden club. There is a tradition that a stick curved at one end like a shepherd's crook was anciently used as a weapon, but in a manner not explained. These crooks are associated with warriors in ceremonies and it is surmised that they may have been used for hurling darts somewhat as the throw stick. Frank Hamilton Cushing suggested the evolution of the bow from a stick of this kind having a cord stretched from the end of the crook to the straight part of the shaft, a dart being projected in a manner intermediate between the method by the bow and throw stock. The sling, which, with the throw stick, seems to be connected with the development of the bow, was never an aboriginal weapon of the Hopi.

The warrior according to Hopi ideas is represented in plate 52. The older weapons have become playthings for children, for whom are made bows, arrows, targets, clubs, etc. These weapons have also survived as ceremonial objects and one of the chief contributions of religion to the history of culture is the preservation of obsolete forms.

GAMES AND MUSIC.

Athletic games are limited among the Hopi, the game of shinney or bandy being almost the only open-air sport. The shinney is a

[1] 24th Ann. Rept. Bur. Amer. Ethnol., pl. 1.

stout curved club of Gambell's oak, brought from the mountains to the north, the ball being of buckskin stuffed with wool (pl. 47, figs. 1, 2). Foot races, hunts, and mêlées in the basket dance are ceremonial. Games of pursuit and capture follow the snake dance and are not considered sports, but general expressions of good feeling.

Children's games and toys consist of buzzers (pl. 47, fig. 4), tops which are actuated by a whip (pl. 47, fig. 6); handball (pl. 47, fig. 7); and pea shooters of gourd and yucca stalk, the spring being a strip of elastic wood (pl. 47, figs. 5 and 8).

The Hopi have a variety of the guessing game, widely disseminated among the Indians. For this game they use four cylinders of wood excavated at one end into a cup-shape cavity and decorated with painting, burnt work, carving and feathers (pl. 48, figs. 1–4 and 5–8, two sets. Cat. No. 128763 and 22330, U.S.N.M., collected by Mrs. M. C. Stevenson and Major J. W. Powell, respectively). The game is played by hiding a small object beneath one of the cups, having the opponents guess where it is concealed. A bundle of scoring straws keep the record.

The cups figured on plate 48 are excellent specimens of work in wood, and of decoration, especially by pyroligny.

The kicking game of the Zuñi and other southwestern tribes does not occur among the Hopi. Mention has been made of the custom of shooting with bow and arrow and of throwing stones at a mark. Feather darts of corncob are thrown at a rotating ring of corn husk (pl. 47, fig. 3). This game, which is called "Motoun," throwing the wheel, is ancient in the Pueblo region. It is played by boys. Women in the Owaculti ceremony throw arrows at a similar wheel.[1]

Hopi children, having few toys, are compelled by the exercise of imagination to make the simplest objects serve in their child drama-play. It is interesting to observe the seriousness with which the little children conduct their play and the great psychologic reactions stimulated by a few corn husks, bits of stone, etc., gathered and spread out in some quiet place serving as the imaginary theatre. The Hopi are very fond of their children and do as much as they are able to contribute to their amusement. The practical side of most amusements is generally uppermost and play and education for future duties are cunningly combined. Objects in miniature are made for children. The potter constructs toy vessels, rattles, and dolls (pl. 49, figs. 1, 2, and 3), and sometimes manufactures models of houses (pl. 49, fig. 5). Toy cradles (pl. 49, fig. 4) are the most common and the most prized possession of the little girls. A little boy is given a bow and target. It is difficult if not impossible to differentiate the religious and secular ideas and usages in respect even to

[1] See Culin in 24th Ann. Rept. Bur. Amer. Ethnol., pp. 495–497.

children's toys. From the standpoint of adults, children's toys are given a religious significance through connection with ceremonials, but without doubt the children employ the toys secularly according to their limited knowledge. Dolls, therefore, are not the impersonal figurines of civilization, but are representations of spiritual beings. There are no dolls which can be named Flora or Mopsey; the name is that of some awe-inspiring ancestral or nature spirit. In fact the Hopi infants have no dolls as the name is understood in civilization. The figurines called dolls are *tihus* (see pl. 42), a word like the Nahuatl *teo*, translated god, and are prepared by celebrants in Katchina ceremonies to represent the being to be impersonated by the actor. After the ceremony the *tihu* is given to a child, who thus may become acquainted with the characteristics of the being and who probably is supposed to secure also some guardianship or other benefit from its possession. The *tihus* are respected and treasured by the children, who are not expected to fondle them as dolls, but such is sometimes the case.

MUSIC.

The meaning of the rattle is complex. It is principally a device for marking rhythm and is so used in the cycle of songs in the Flute and other ceremonies as well as in the meetings for instruction in singing. The rattle is also sounded at intervals in ceremonies as though marking an event in the performance. The sound is thought to have a magic influence and really has a hypnotic and inspirational influence.

Several kinds of rattles are possessed by the Hopi, this class of musical instruments showing great variation. Simplest are the fringes of seeds, hoofs, shells, etc., attached to ceremonial garments and sounded by movements of the body. The rattle of cedar berries is called *le pos te qua bi*. Not much in advance of this are the rattles of mountain sheep horn (*al te qua bi*). These consist of three horns pierced at the apex, provided with a thong, tied together and to a cord a cotton loop for suspension as with the horn bells mentioned below used by the rain priests in their morning runs to bring rain (see pl. 22, fig. 1).

Hoofs of cattle also pierced at the point, knotted on a thong and bunched, are frequently used in the same manner as the horns.

Bells of mountain sheep horn with clapper of the same material are sometimes bunched with other horns and hoofs and carried on their rounds by rain makers. The Zuñi occasionally make globular pottery bells, apparently a frank copy of a sleighbell, and in the ancient ruins in the Jettyto Valley, once inhabited by Hopi clans, small pottery bells of this form are somewhat frequently found. Occasionally they are of metal in the ruins south of the Colorado

Chiquito and have been evidently derived from Mexico. The bell must then be included in the list of Hopi musical instruments. Of the same nature as the bell are trinkets of shells of *olivella* and *conus*, worked or unworked, prevalent in ancient sites, and of hoofs, seeds, etc., occurring on existing religious costumes and paraphernalia. A curious scarecrow, consisting of a ring of twigs wound with cotton cloth, to which are tied, with wool cord, shoulder blades of a sheep and a tin can, is one of the oldest specimens from this region in the United States National Museum. (Cat. No. 9571, collected in 1870 by Dr. Edward Palmer.) (See pl. 22, fig. 3.)

Rattles of peculiar sacredness, made from the shells of the water tortoise, are called *yung uh sho na* (pl. 51, fig. 5). These animals are collected in the Colorado Chiquito, eviscerated without injury to the shell and the latter brought to the villages for use in the ceremonies. In making the rattle, antelope hoofs are fastened to thongs and sewed to a strip of buckskin provided with a loop to tie through the arch of the shell. A thong is passed through the other arch of the shell for fastening the rattle to the left leg of the dancer just below the knee. The movements of the dancer strike the pendant hoofs against the dome of the shell, producing a sharp sound. Some of these rattles in the National Museum collection are much worn from continual use. The Sia and perhaps other Rio Grande Pueblos bore holes through the shell for the thongs which secure it to the leg. The rattles of hoof fringing the snake kilt are called *shi la la*, and when of conical metal tinklers like those used by many Indian tribes, are called *shi va mash e*. The natural rattle of the dry seed pods of an *astragalus* used to amuse children are also called *shi la la*.

Rattles of which the sounding portion is the shell of a gourd are very common (pl. 50, figs. 1, 3, 4, 5). They are oblate, pear-shape and conical. The handle is of wood, either tapering regularly or with a shoulder formed on it, inserted in openings cut in the shell of the gourd, the latter resting on the shoulder and held by a peg passing through the projecting end of the handle. In the oblate specimens the handle passes through the gourd horizontally and in the pear and other forms vertically. The handle is short in most cases, but sometimes the gourd is placed at the end of a long staff of yucca flower stalk used in one of their ceremonies. A buckskin or cotton cord is passed through the base of the handle for suspension. Gourd rattles are always painted in bright colors and appropriate symbolism, the tendency being toward movement symbols. They are repainted and refeathered at the recurrence of the ceremony for which they are used, but sometimes a worn specimen is employed in soothing a child to sleep or for marking time in the singing classes. Rattles of skin are only used by the Snake, Antelope, and Soyal fraternities. They consist of a hoop of wood forming a frame over which dampened skin is stretched. The short handle is enveloped by the surplus leather and fastened with thong. This rattle is always painted white. Its sound is likened to the warning of the rattlesnake.

Pottery rattles, following the form of the gourd rattles or as small toys for children, are sometimes made, but have no use in religion (pl. 50, fig. 2).

Clean, white quartz pebbles, in some cases small crystals picked up from ant's nests, are put in the rattles; and frequently, as is the Zuñi custom, sacred white meal is added. The Pima use wheat or white quartz pebbles as a rattling material, and the Yaki the seeds of the Washington palm. The Zuñi use white quartz pebbles and sometimes pink glass beads, and the Rio Grande Pueblos, in examples examined, pebbles of various colors, red predominating.

All rattles when prepared for ceremonies have attached to them downy feathers of the eagle on sacred cotton cord. This appears to be a form of consecration, the "breath feather," as it is called, giving communication with the spiritual world (pl. 50, fig. 4).

Some of the ceremonies have special rattles belonging peculiarly to them, as the *pa a ya* of the Flute ceremony, which consists of a crook bearing at the end a bunch of shells; and with the crook are tied a grass stalk and a rod set with disks of gourd, the bundle forming an object used only in the Flute ceremony.

Another form of rattle, *truh kun pi*, is one in which the sound is produced by rasping a rod of wood or a sheep's scapula over a row of notches cut in a stick (pl. 51, figs. 1–4). The notched stick is laid over the open mouth of a jar or gourd to increase the resonance. This rattle is entirely ceremonial, and is played by the men who represent the female Kachinas in the dances, hence it was called by observers "hermaphrodite stick" among the Pueblos and southwestern tribes. There is only one doubtful example going to indicate its antiquity in the Pueblo region, a notched bone discovered in a ruin near the Petrified Forests of Arizona. In Mexico, however, numerous notched human femurs used as rattles have been recovered.

The Pueblo notched rattle shows careful work in wood, and often bears carving and decorative painting. The Hopi specimens usually terminate in a terrace cloud carving. The Rio Grande notched rattle is generally sounded with a rod of wood, while the Hopi and the Zuñi use a sheep's scapula.[1]

The Hopi collection in the United States National Museum contains several specimens, consisting of a disk of pottery or stone pierced with two holes through which pass cords, the disk being rotated by the alternate twisting and untwisting of the cords, the motion of the

[1] Archeological Fieldwork in Arizona, Ann. Rept. U. S. Nat. Mus., 1901, pl. 56.

disk producing a buzzing sound. The instrument is familiar as a toy of civilized children, and the Hopi probably have received it from the white man, especially since it has not become a part of the religious paraphernalia (see pl. 47, fig. 4).

One of the simplest yet most remarkable and very widely diffused instruments of music is the bullroarer, the rhombus of the ancient Greeks, consisting of a tablet of wood whirled through the air by a free-arm movement at the end of a string, producing an awesome groaning sound (pl. 51, fig. 6). The Hopi bullroarer is used exclusively in religious ceremonies, following in this respect its employment by almost all peoples, now or formerly. In civilization the instrument sometimes continues its usefulness as a child's toy. There is evidence of its antiquity in the Pueblo region.[1] The Hopi bullroarer is a rather thick tablet, pointed or terraced, usually at one end, supplied with a cotton string sometimes tied to a short handle. It is painted with white, red, black, or other pigment and decorated with the lightning symbol. In the Snake Dance it is intrusted to the war priest, who whirls it vigorously for a short interval at the commencement of the open-air ceremony of both the Snake and Antelope Fraternities. It is used also in the Soyal and other ceremonies. In all cases it is kept a mystery. The Hopi associate the sound with meteoric phenomena, and its use may be in effect an incantation to bring rainstorms.

The Hopi drum has a shell of cottonwood taken from a decayed tree trunk, and in most cases little modified by artifice, the shell thus showing irregularities of the surface and diameter of the tree. The heads are circular pieces of goatskin from which the hair has been removed; the skin is cut larger than the diameter of the shell, dampened, lashed on by a continuous thong, passed through holes cut alternately in the edge of the skin and fastened off. Sometimes a thong turned over each member of the lacing is passed around the middle of the drum. A thong for suspending the drum is tied in the lacing. The stick is short and has a padded beater of cloth tied on with string, and the drum is struck in the center of the head. One of the heads is often decorated with four animal figures. The Hopi drums in the United States National Museum are from 8 to 15 inches high, and from 12 to 18 inches in diameter. The native name is *pur shuk pi po ya*. A thin two-head, properly a tambourine, is also used. It has a shell of cottonwood 3 inches high and 16 inches in diameter. The heads of goatskin, lashed on as in the large drum, are decorated with a symbolic design representing a sun shield. There is no evidence of the antiquity of the wooden shell drum among

[1] Hough, Bull. 87, U. S. Nat. Mus., 1914, pl. 26.

the Hopi or other Pueblos, no specimens having been found in the cliff shelters or in locations where perishable material would be preserved. It appears probable, however, that the principle of the production of sound by vibrating membranes was known anciently to the Pueblos, and the pottery single-head drums of the Zuñi and Rio Grande tribes may be the surviving form. The pottery drum is not found at present among the Hopi. The Hopi wooden drum is very crude compared with those of the eastern Pueblos, and seems older, but neither the drum or tambourine appear among the musical instruments used in the unmasked or more archaic ceremonies, and for this reason seem to have been introduced by clans from the Rio Grande. (See cases in exhibit of Ethnology.)

The most important wind instrument possessed by the Hopi is the flute, an object regarded with peculiar veneration by the American Indians, as it is also by the Chinese (pl. 51, fig. 7). Two cognate Hopi religious organizations, the Blue Flute and Drab Flute fraternities[1] base their ceremonies upon this instrument, and the clans to which the ceremonies are assigned also derive their name from it. The flute belongs to the direct class, being held vertically and blown across the end; has five holes, and is made of a tube of the ancient prescribed material, but now often of cane procured from a distance.

FIG. 48.—WHISTLE OF TWO POTTERY DISKS INCLOSING A LEAF.

The Hopi wish to incorporate light with the charm liquid or medicine, and in ceremonial purification. This is done by a reflection of sunlight from the facet of a quartz crystal. Smoke incense is added by blowing the vapor into the medicine and music by sounding a flute or whistle in the liquid. The same observance is presumably indicated when during the Flute ceremony, flutes are blown in the springs. The Flute clans are said to have come from the south, and in the ceremonial caves of the upper Gila objects made to represent flutes have been found, which were perhaps offerings from these clans. Small transverse flutes of reed are also found.[2]

The ancient and modern tribes used whistles of bone of the wing of the eagle, like those used by most Indian tribes. The bone has an opening in one side and a mass of pitch or resin is put in the bone to force the wind over a sharp edge in the bone, vibrating the column of air to form the sound. These whistles are called *tur turk pi*, and

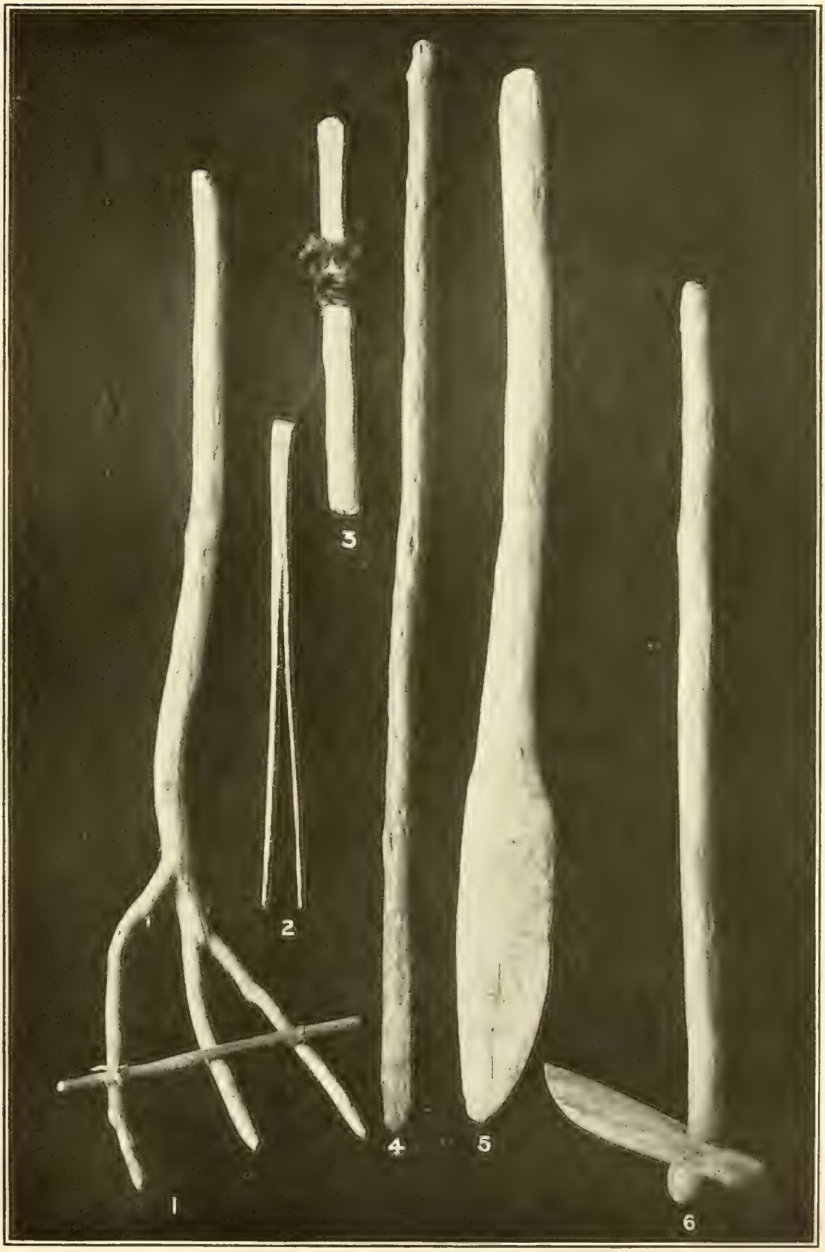
[1] Fewkes, 19 Ann. Rept. Bur. Amer. Ethnol., pt. 2, 1900, p. 957.

[2] Hough, in Bull. 87, U. S. Nat. Mus., p. 126, fig. 328, 1901; Ann. Rept. U. S. Nat. Mus., p. 322, pl. 56, fig. 2.

are used like the flute in ceremonial consecration of medicine as well as to imitate bird calls. A whistle made by enclosing a leaf or grass blade between two pottery disks is sometimes used (fig. 48).

The Hopi use a flute consisting of a gourd having a sound hole. This interesting object is a decoy for deer. (Cat. No. 22865, U.S.N.M.) Gourd trumpets or megaphones supposed to represent the hoarse bellowings of the great plumed serpent, are used in the *Pa lu lu kong* ceremony.

As will be seen from the descriptions above, the Hopi have merely a few primitive instruments, the flute being the highest in the scale of invention. No string instrument occurs among the Hopi.

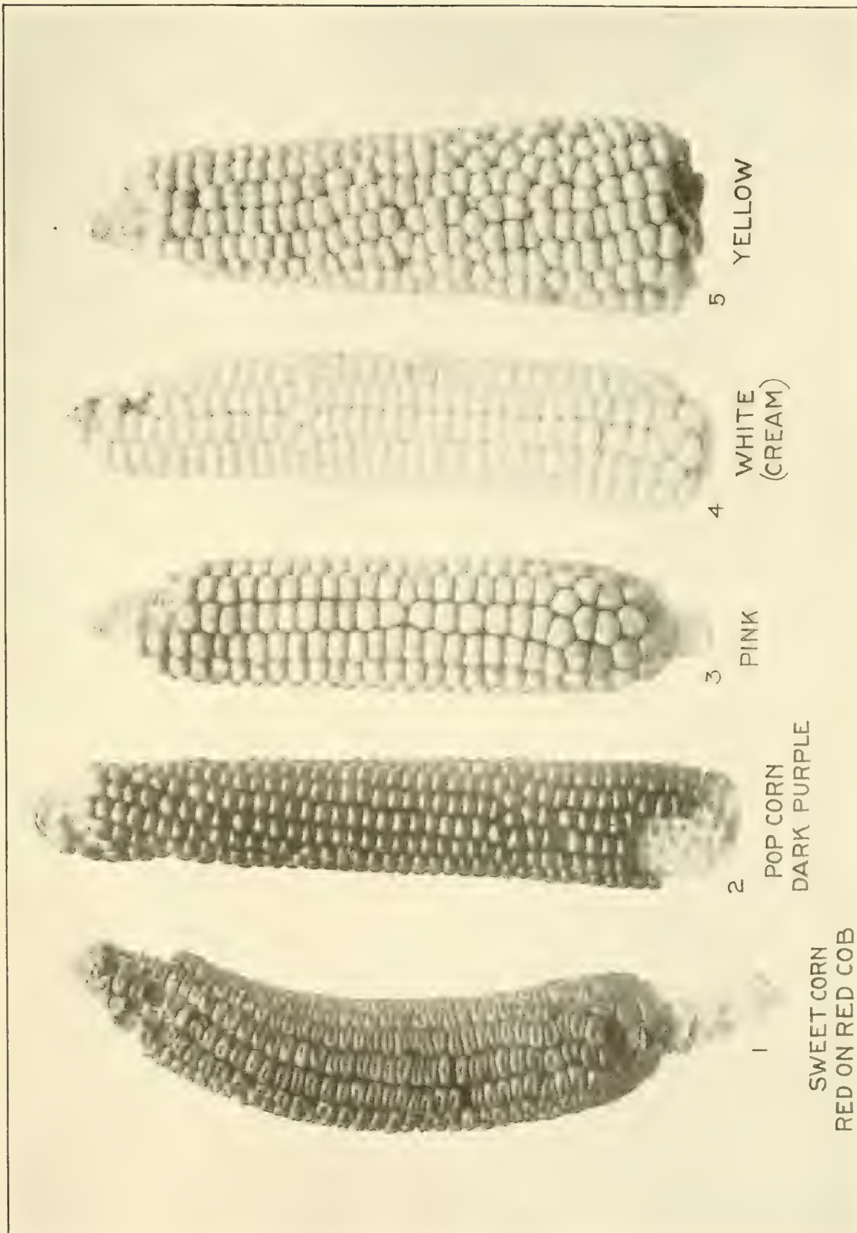


AGRICULTURAL IMPLEMENTS.

FOR DESCRIPTION SEE PAGES 236–237.

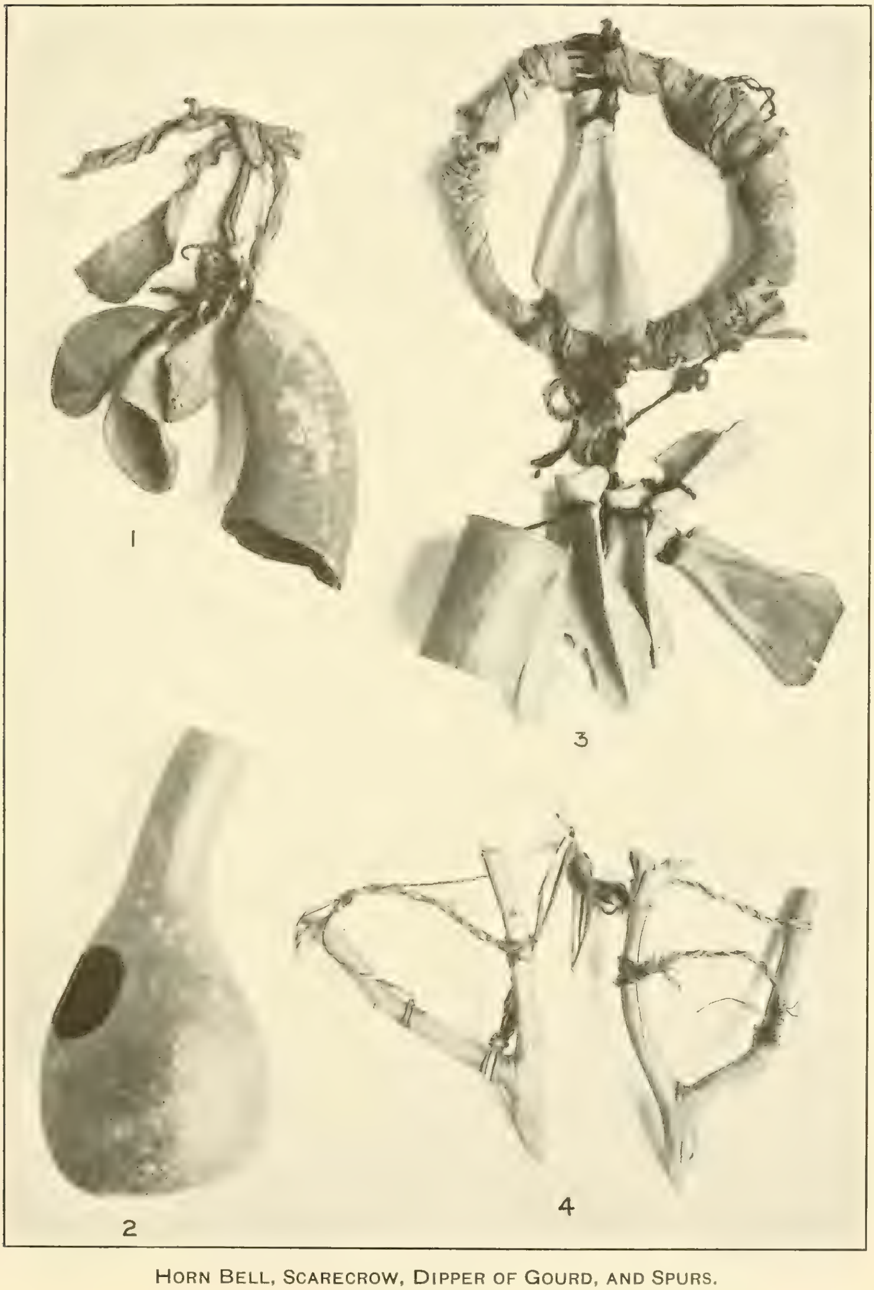
SUNNING AND SORTING CORN.

FOR DESCRIPTION SEE PAGE 237.



EARS OF HOPI CORN.

FOR DESCRIPTION SEE PAGE 237.



HORN BELL, SCARECROW, DIPPER OF GOURD, AND SPURS.

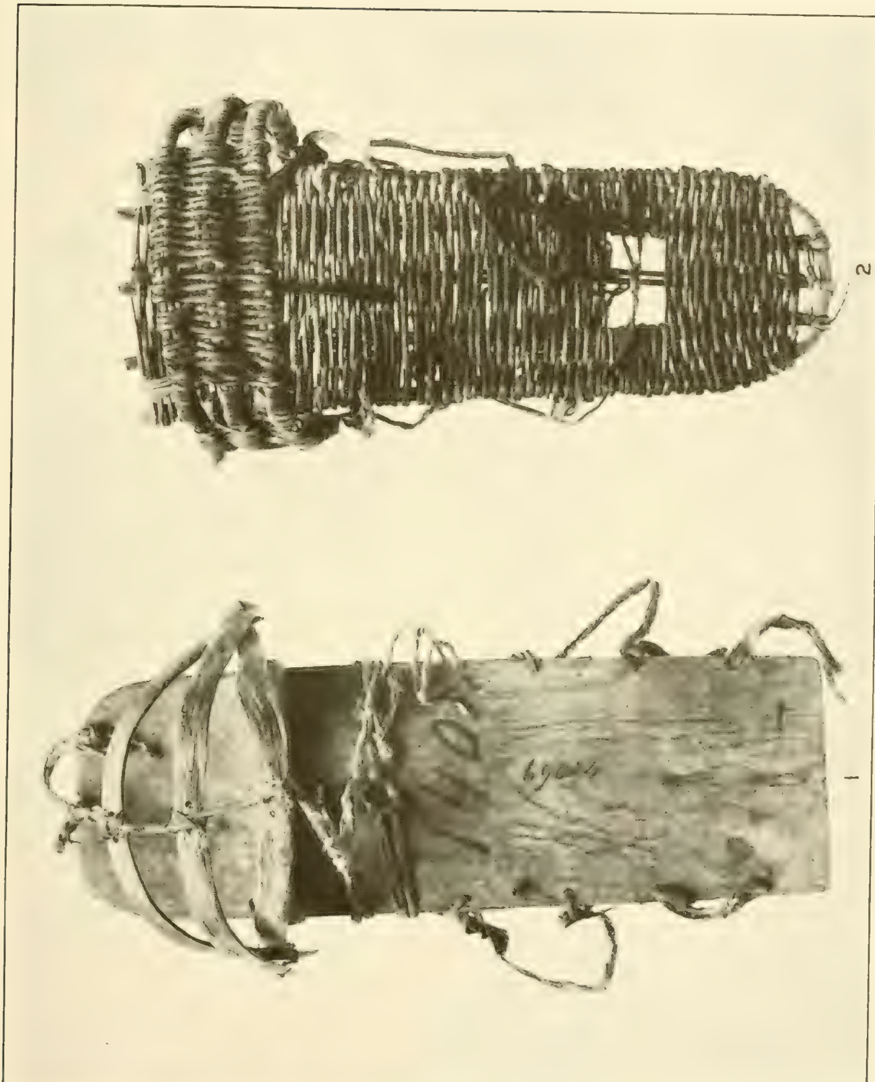
FOR DESCRIPTION SEE PAGES 237, 238, 278, 291.

DOMESTIC VESSELS OF POTTERY.

FOR DESCRIPTION SEE PAGE 239.

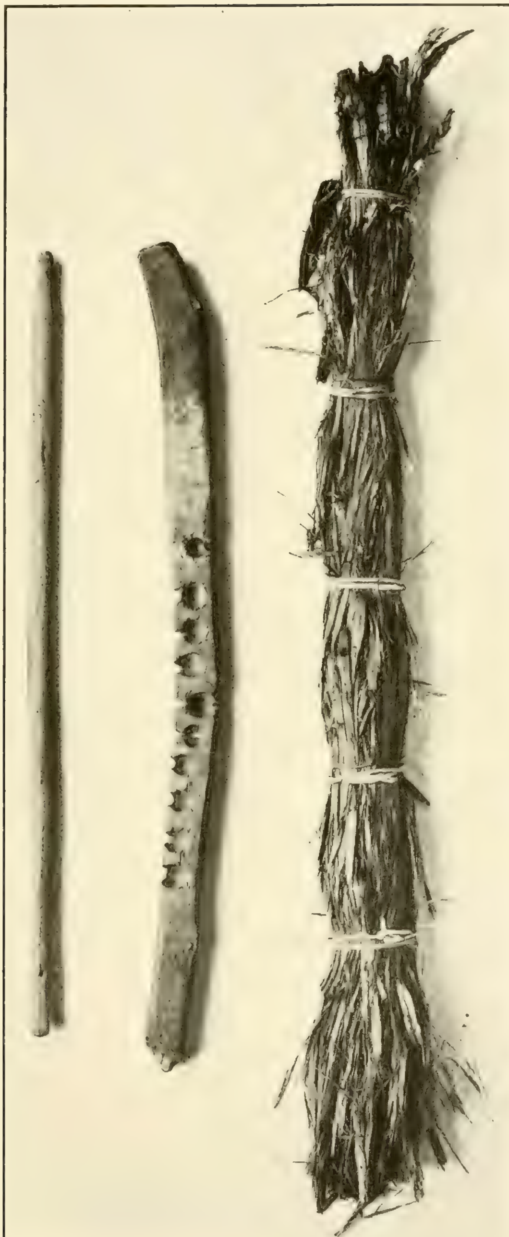
VESSELS OF GOURD.

FOR DESCRIPTION SEE PAGE 240.



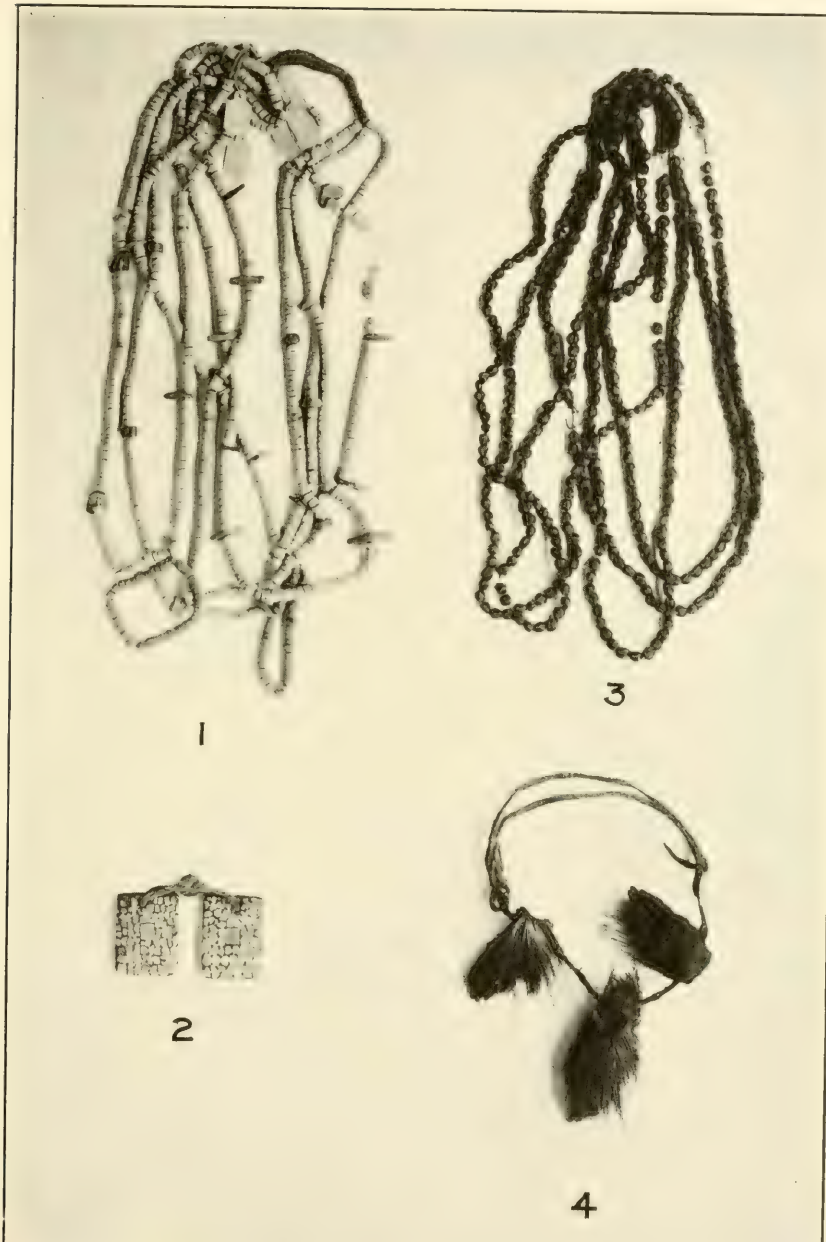
CRADLES.

For description see page 241.



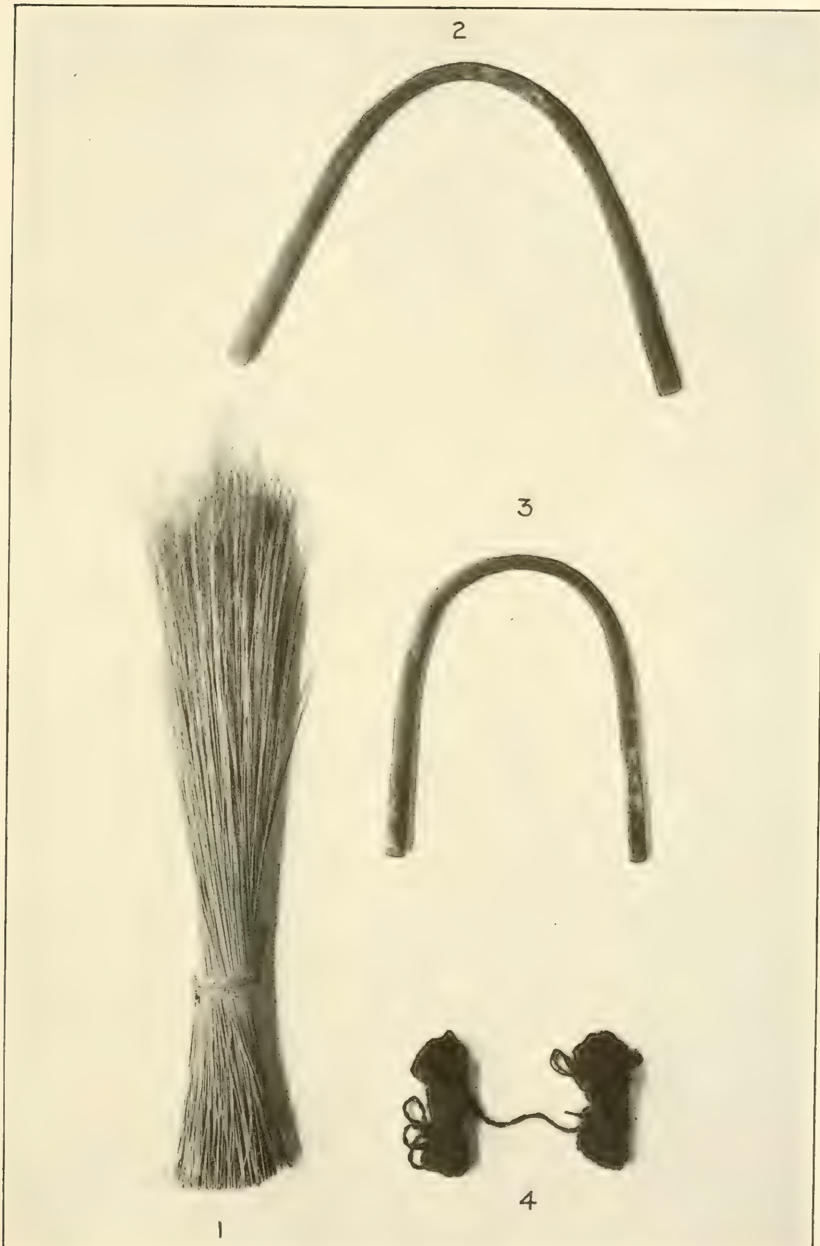
FIRE-MAKING STICKS AND SLOW MATCH.

FOR DESCRIPTION SEE PAGE 242.



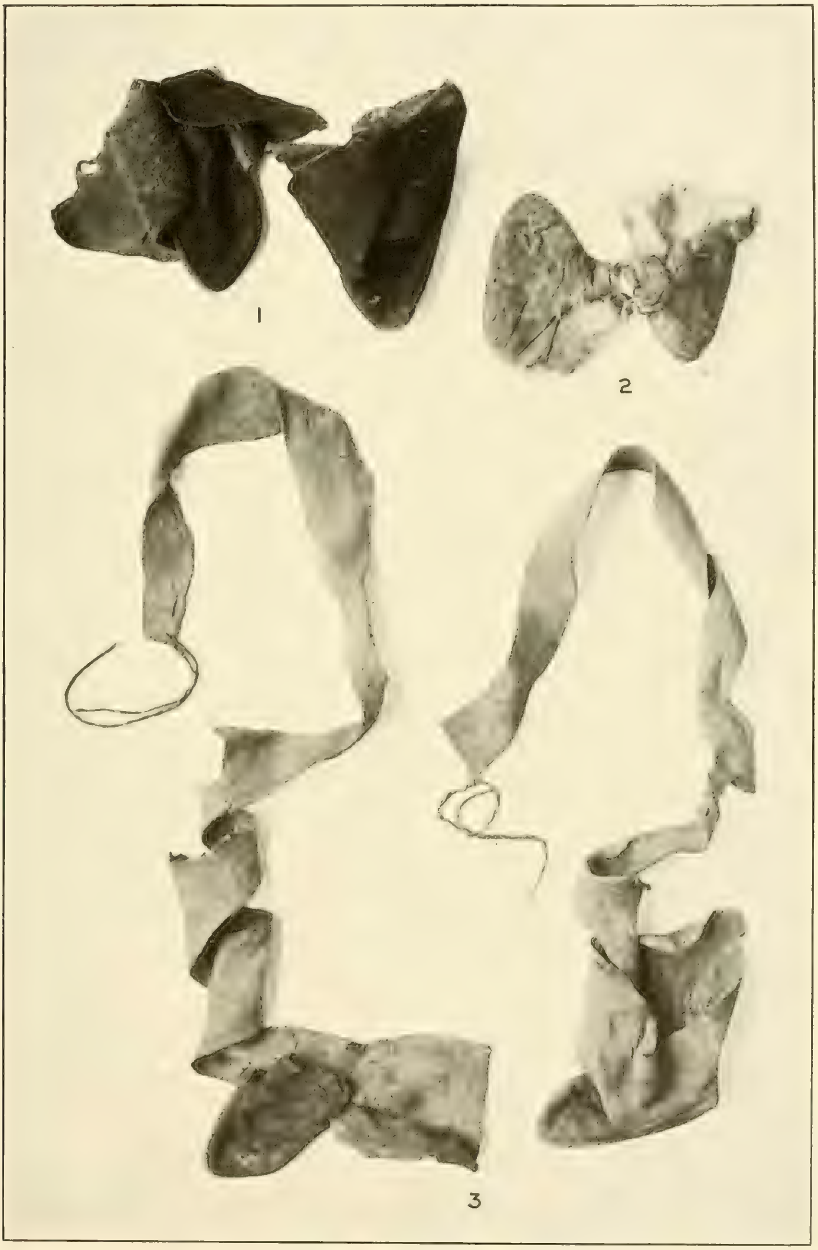
JEWELRY WORN BY MEN AND WOMEN.

FOR DESCRIPTION SEE PAGES 245, 251, 272.



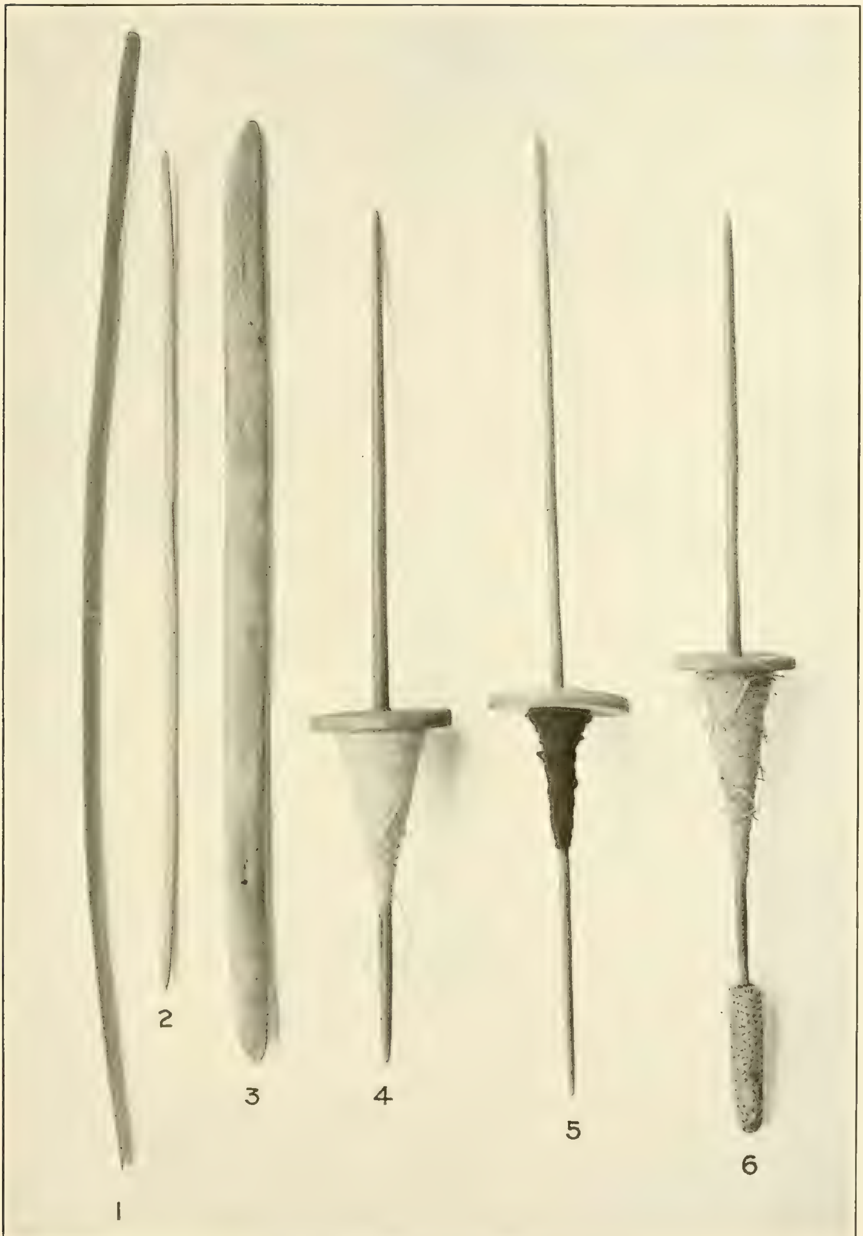
Articles for Hair Dressing.

For description see page 249.



FOOTWEAR OF CHILDREN.

FOR DESCRIPTION SEE PAGE 251.

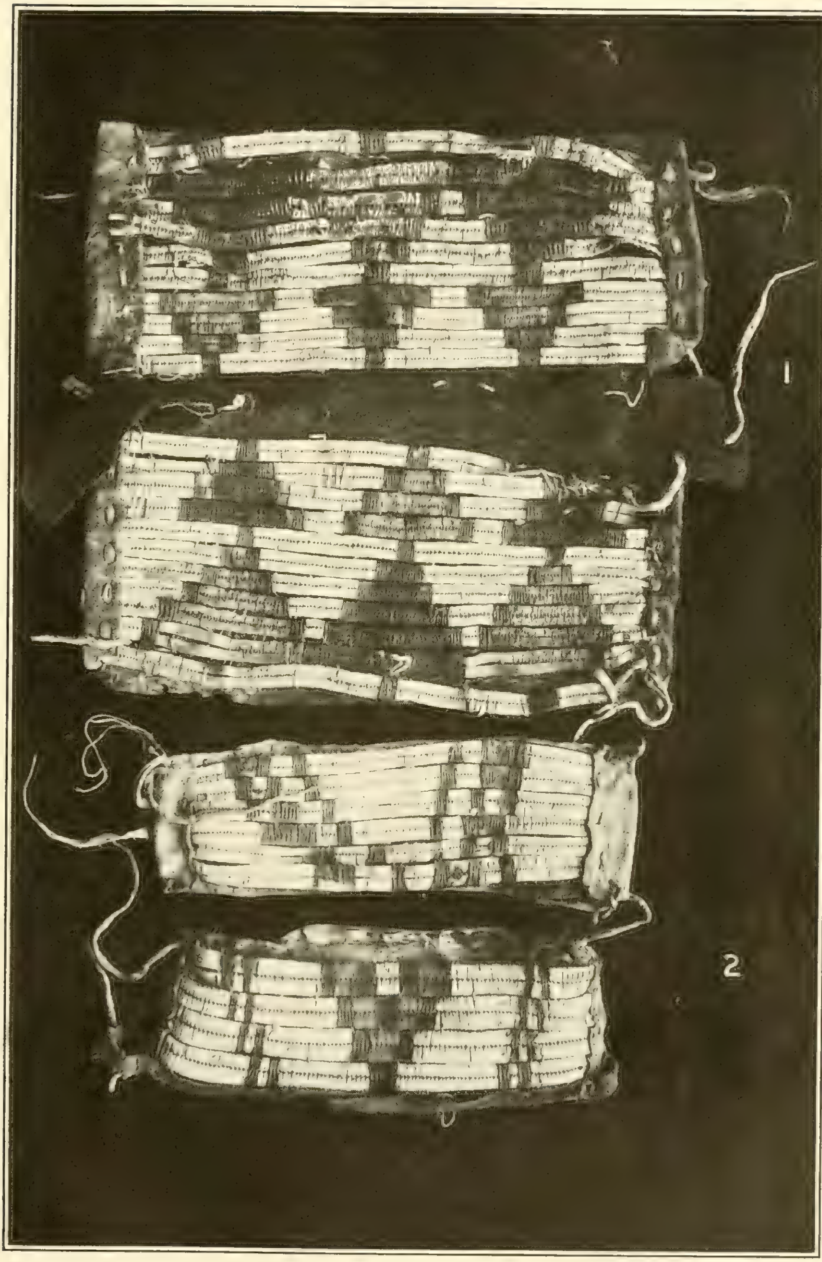


WEAVING BATTENS AND SPINDLES.

FOR DESCRIPTION SEE PAGES 253, 254, 276.

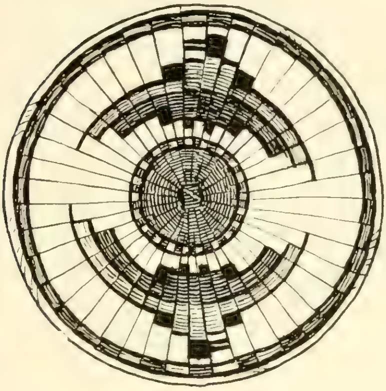
HOPI LOOM AND WEAVER.

FOR DESCRIPTION SEE PAGE 254.



QUILLWORK ANKLETS.

FOR DESCRIPTION SEE PAGE 263.



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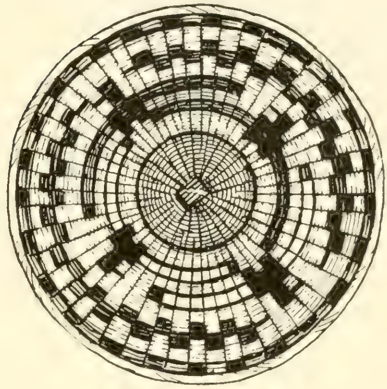

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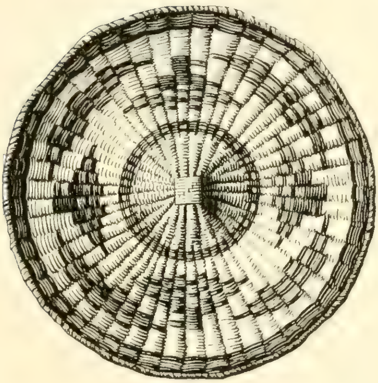

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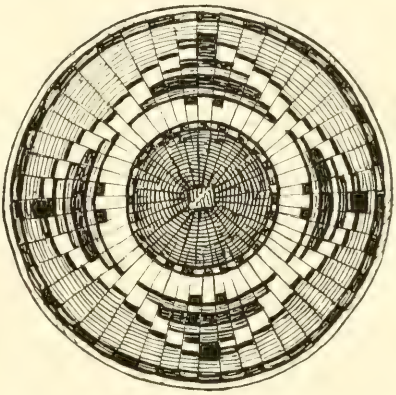

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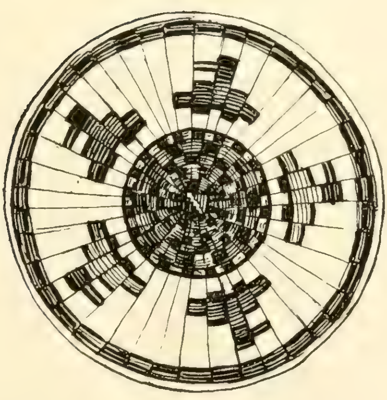

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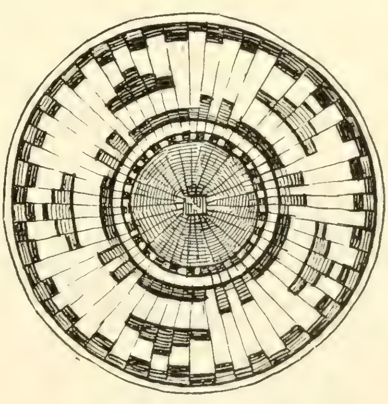
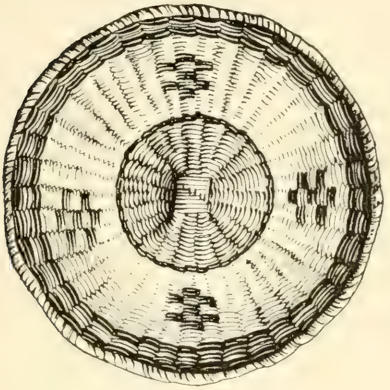


6

WICKER BASKET-TRAY DESIGNS.

FOR DESCRIPTION SEE PAGES 269-270.



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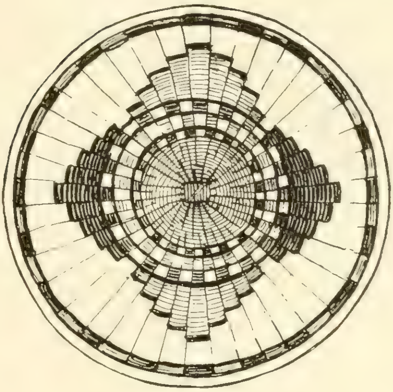

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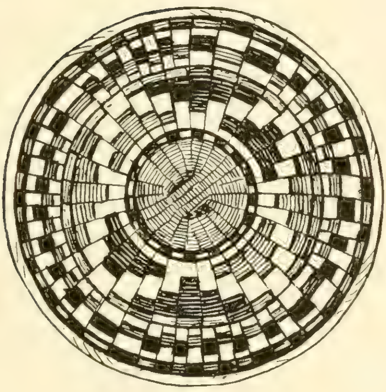

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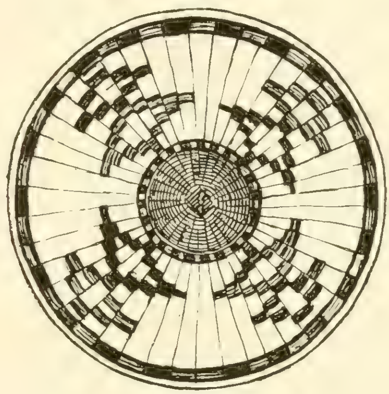

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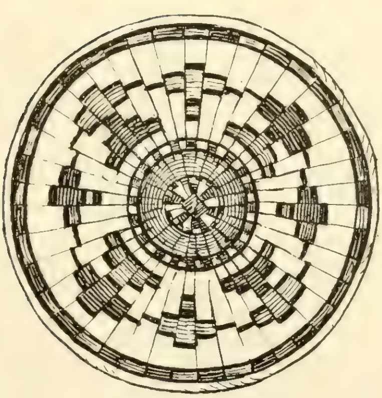

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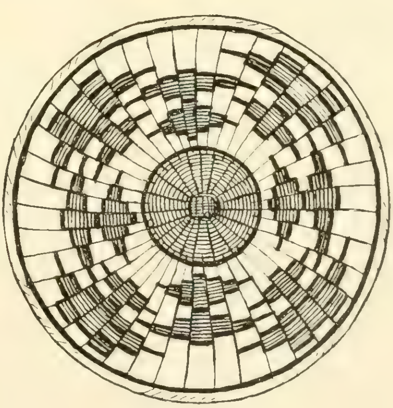

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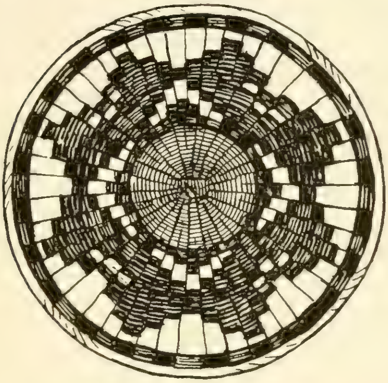

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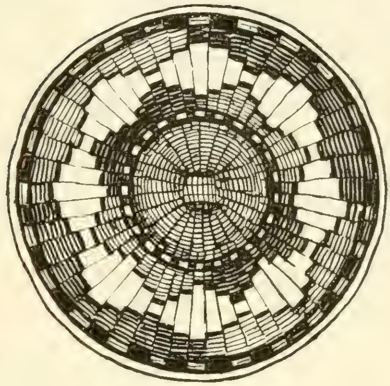

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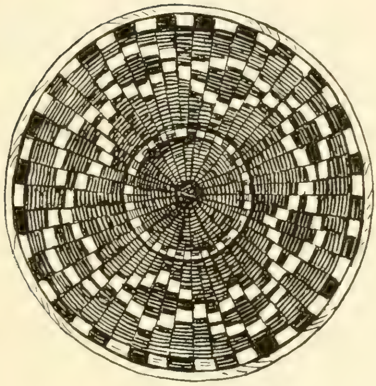

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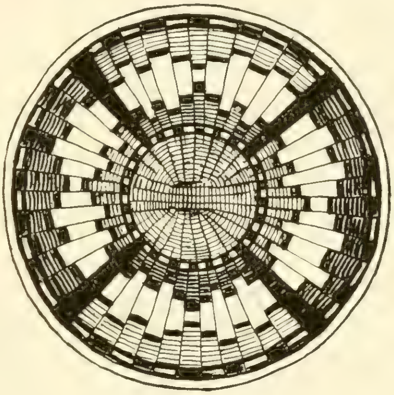

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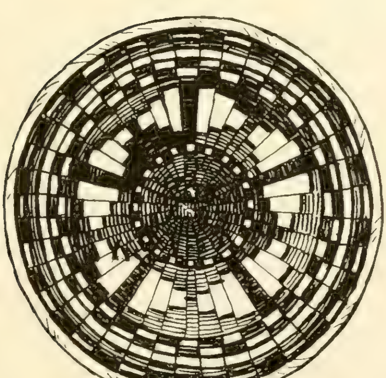

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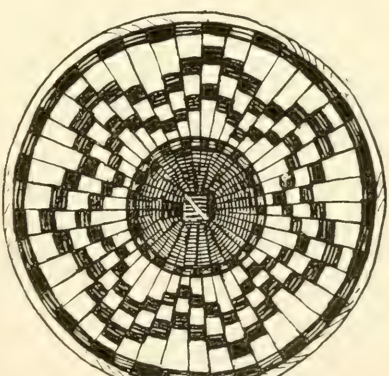

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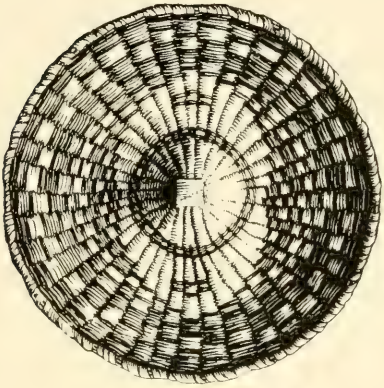

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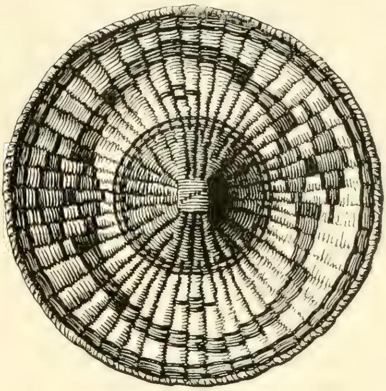

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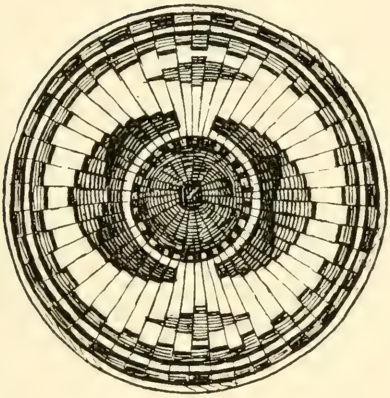

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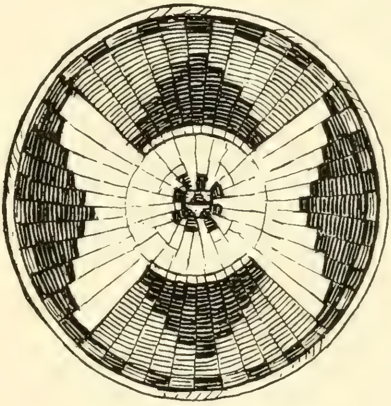

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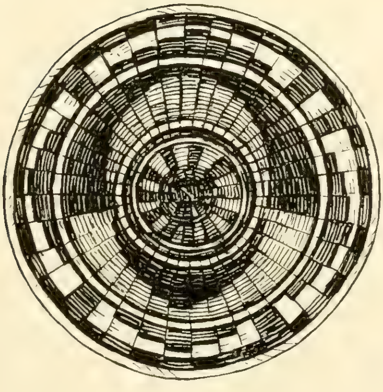

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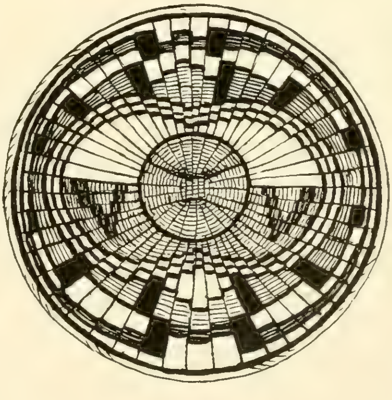

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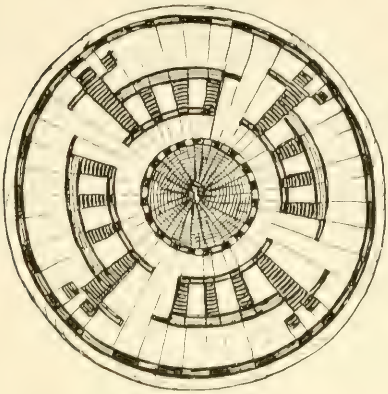

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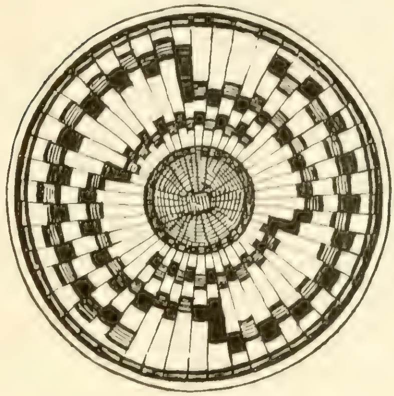

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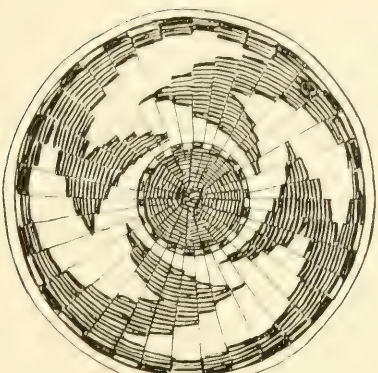

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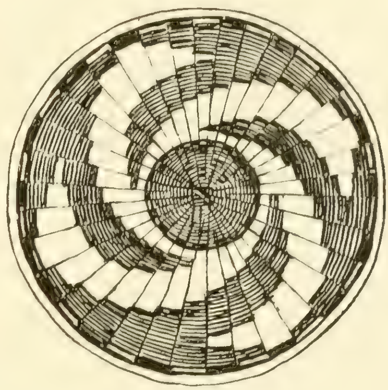

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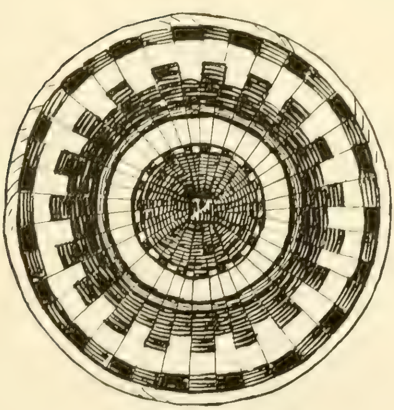

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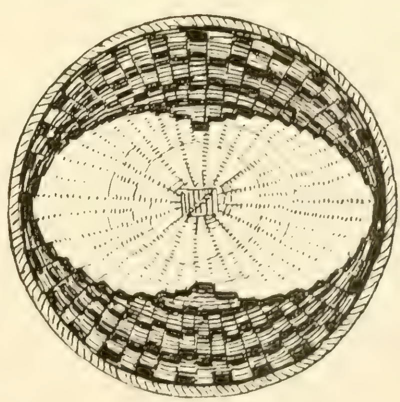

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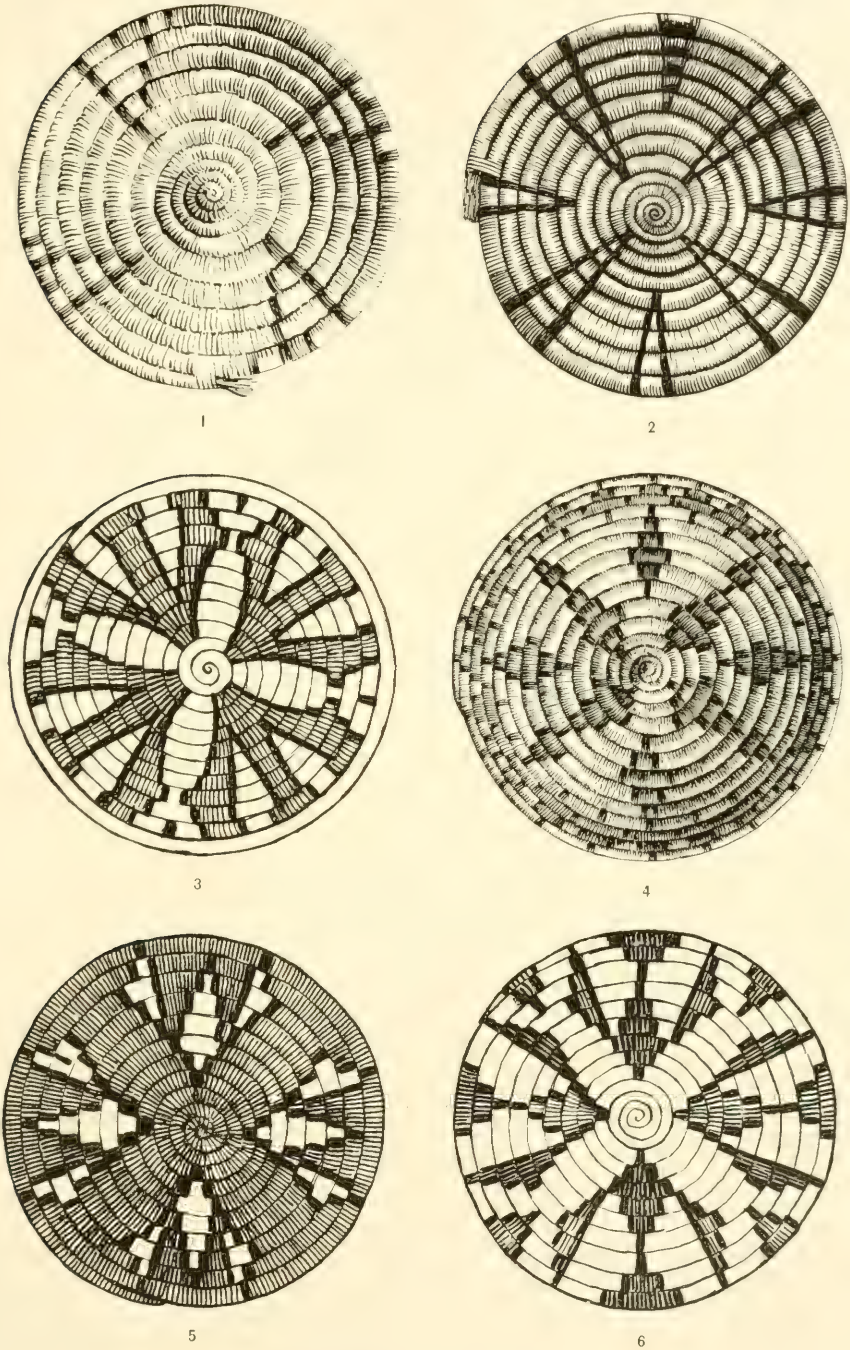

COILED BASKET-TRAY DESIGNS.

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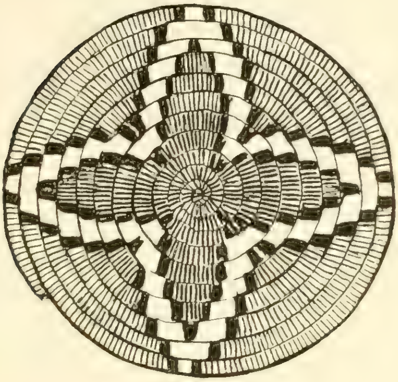

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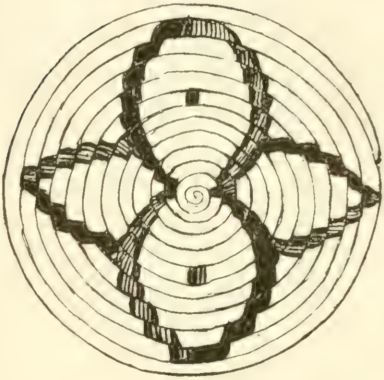

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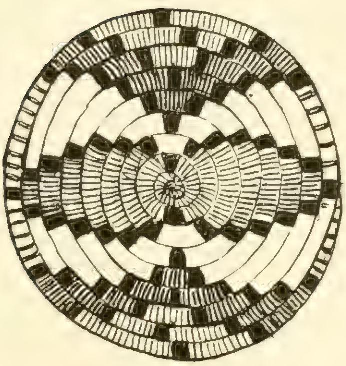

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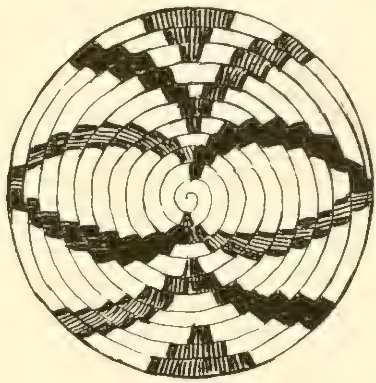

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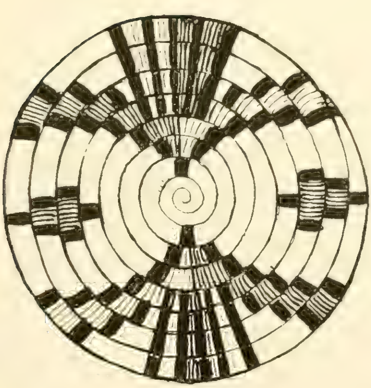

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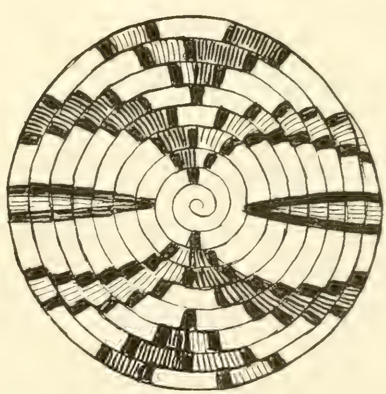
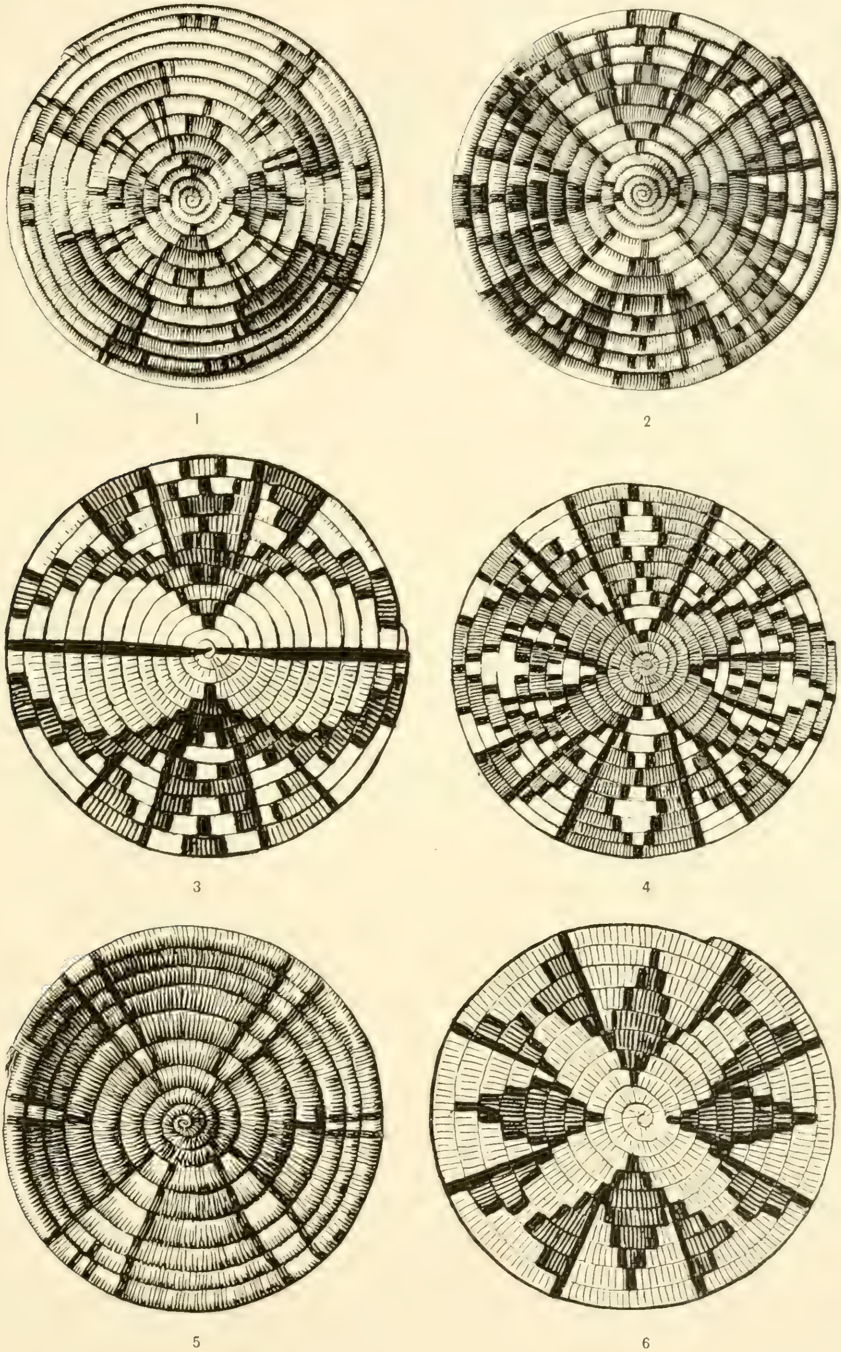


6

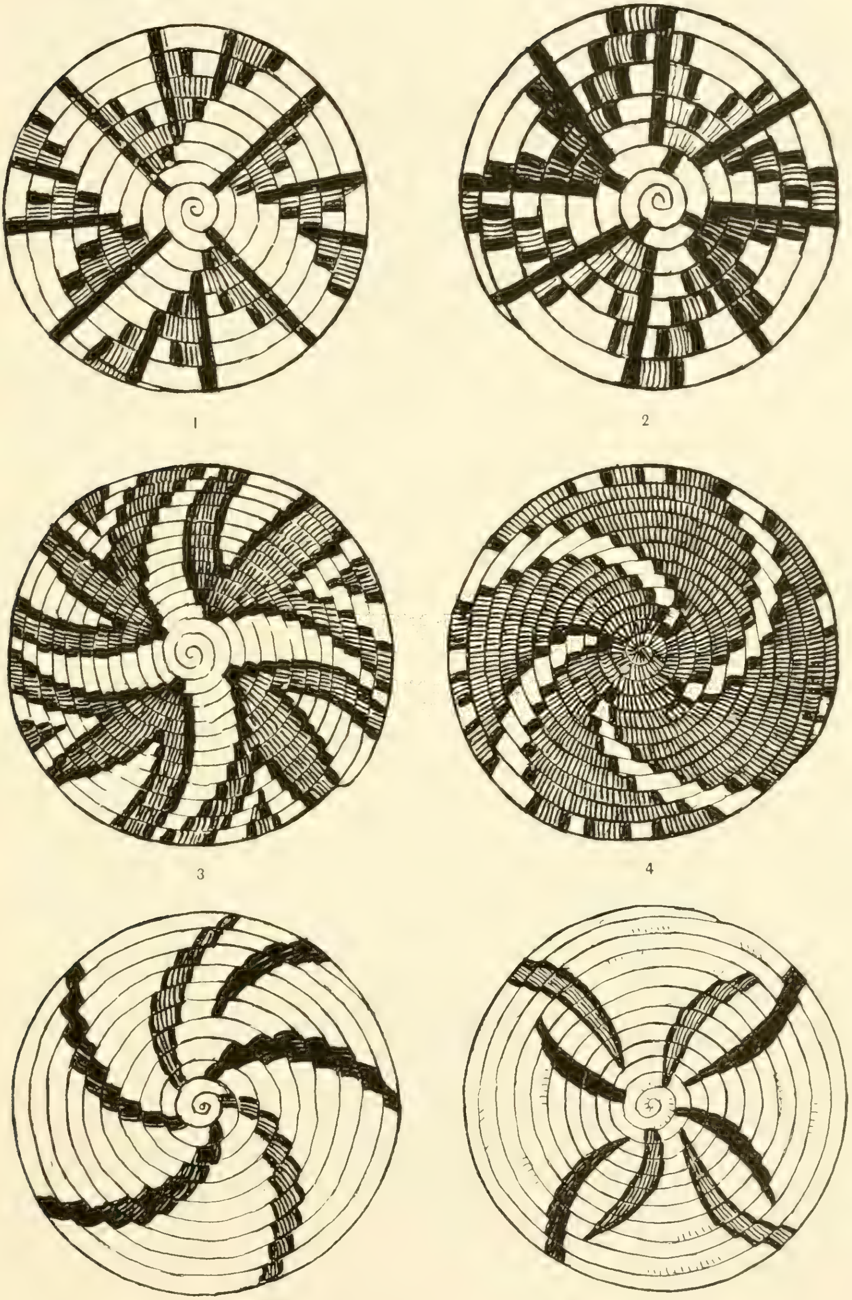
COILED BASKET-TRAY DESIGNS.

FOR DESCRIPTION SEE PAGES 269-270.



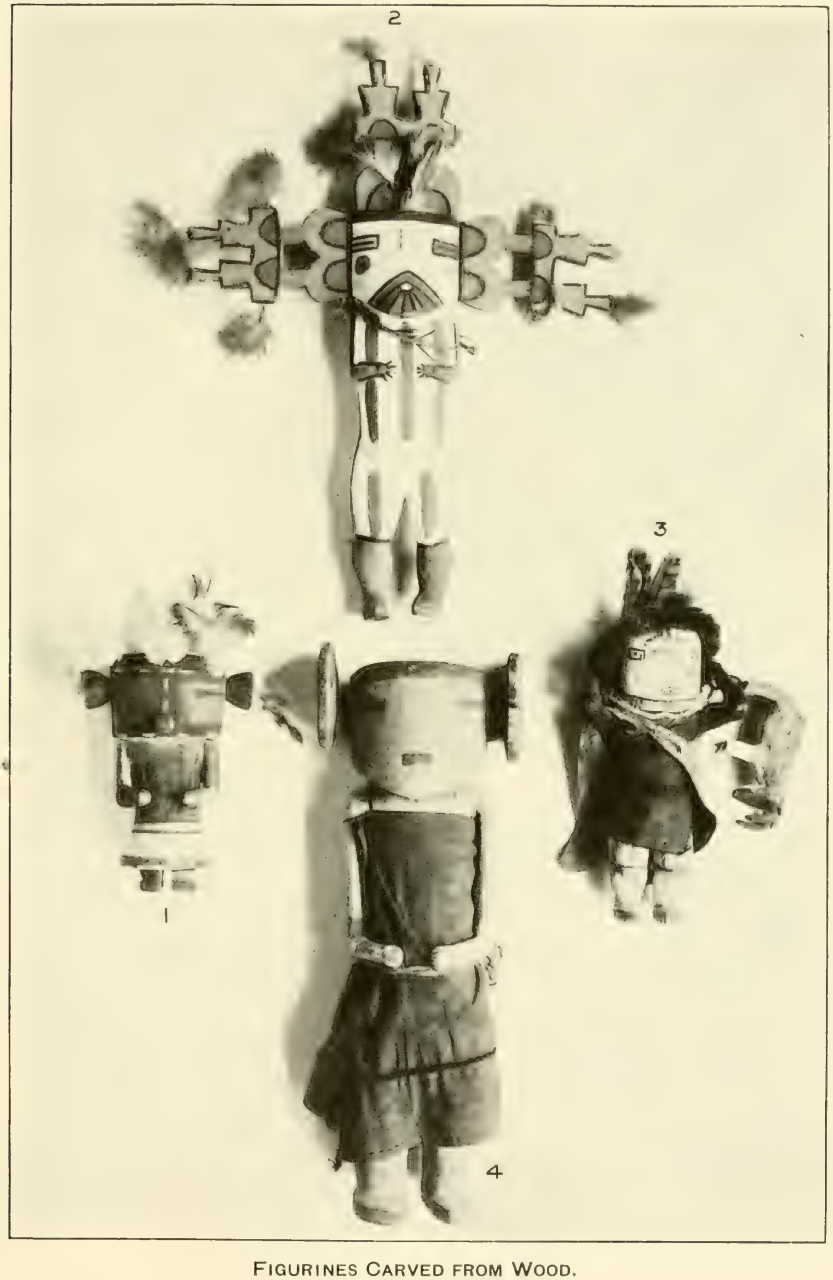
COILED BASKET-TRAY DESIGNS.

FOR DESCRIPTION SEE PAGES 269–270.



COILED BASKET-TRAY DESIGNS.

FOR DESCRIPTION SEE PAGES 269-270.



FIGURINES CARVED FROM WOOD.

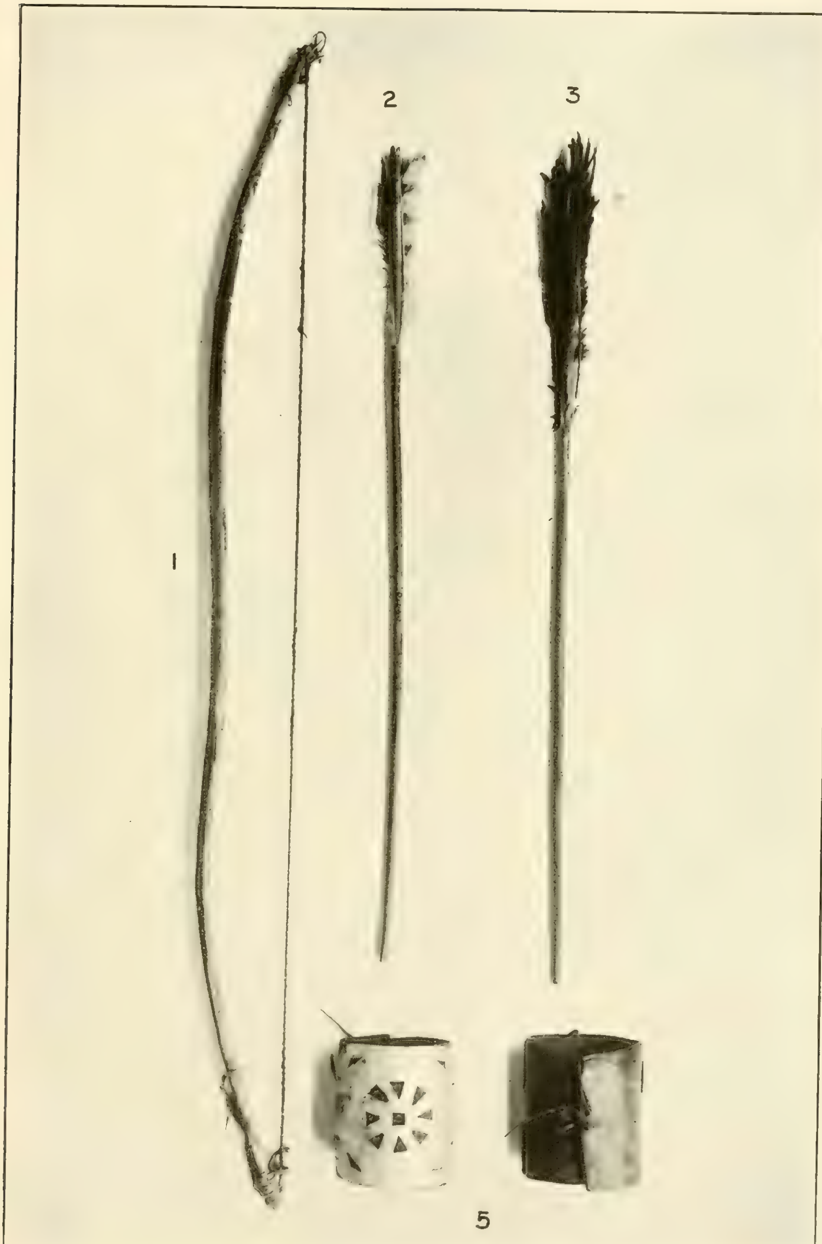
FOR DESCRIPTION SEE PAGES 276, 291.

SOYAL FEATHER OFFERINGS AND BOXES FOR FEATHERS.

FOR DESCRIPTION SEE PAGES 240, 276, 281.

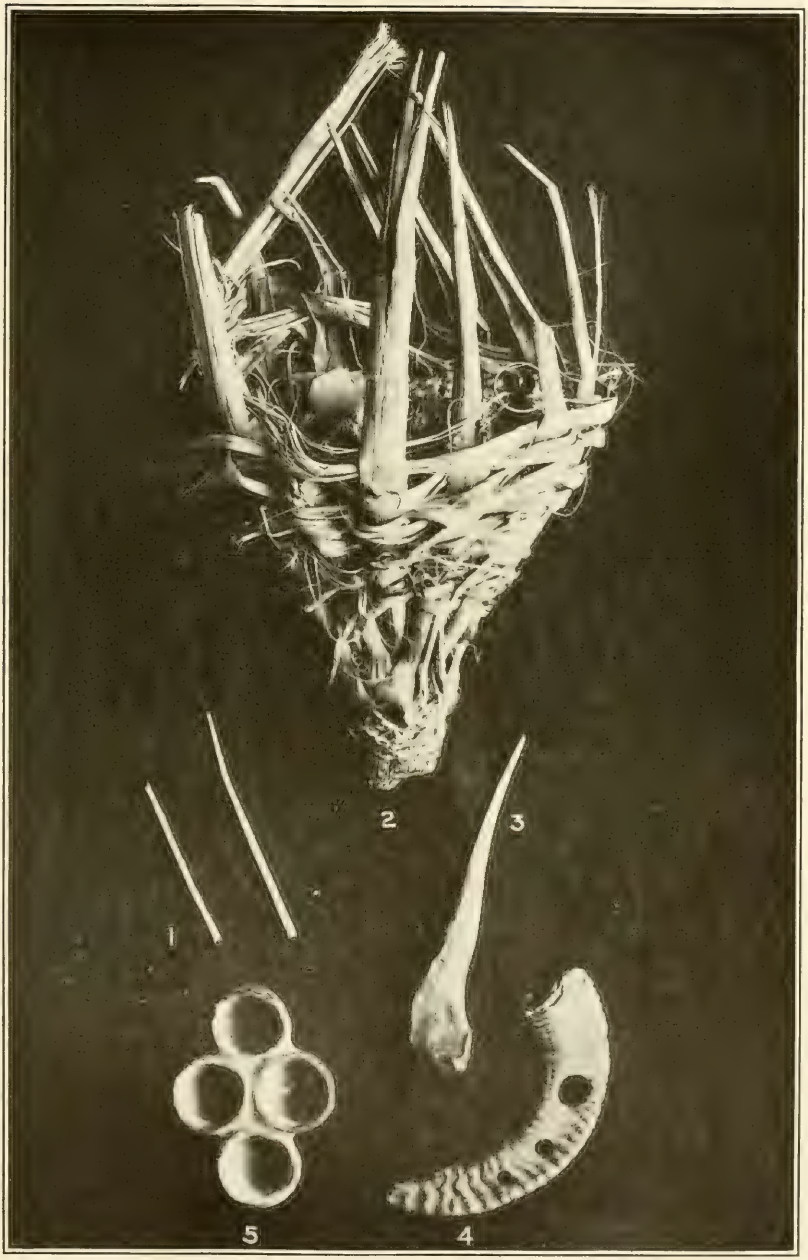
FORMS OF THROWING CLUBS.

FOR DESCRIPTION SEE PAGES 276, 287.



BOW, ARROWS, AND WRISTGUARDS.

FOR DESCRIPTION SEE PAGE 288.



ARROW-MAKING TOOLS.

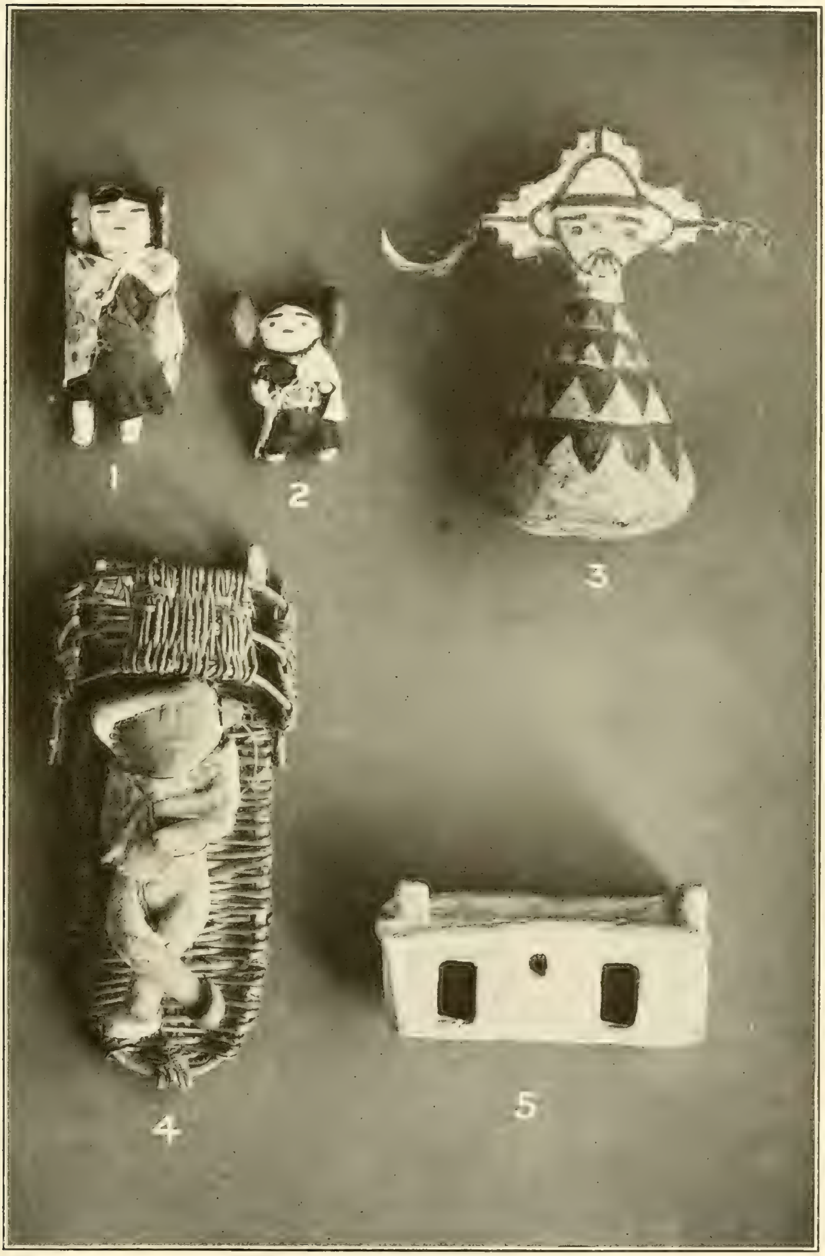
FOR DESCRIPTION SEE PAGE 288.

GAMES AND TOYS.

FOR DESCRIPTION SEE PAGE 290.

CUP-AND-BALL GAME SETS.

FOR DESCRIPTION SEE PAGES 240, 290.

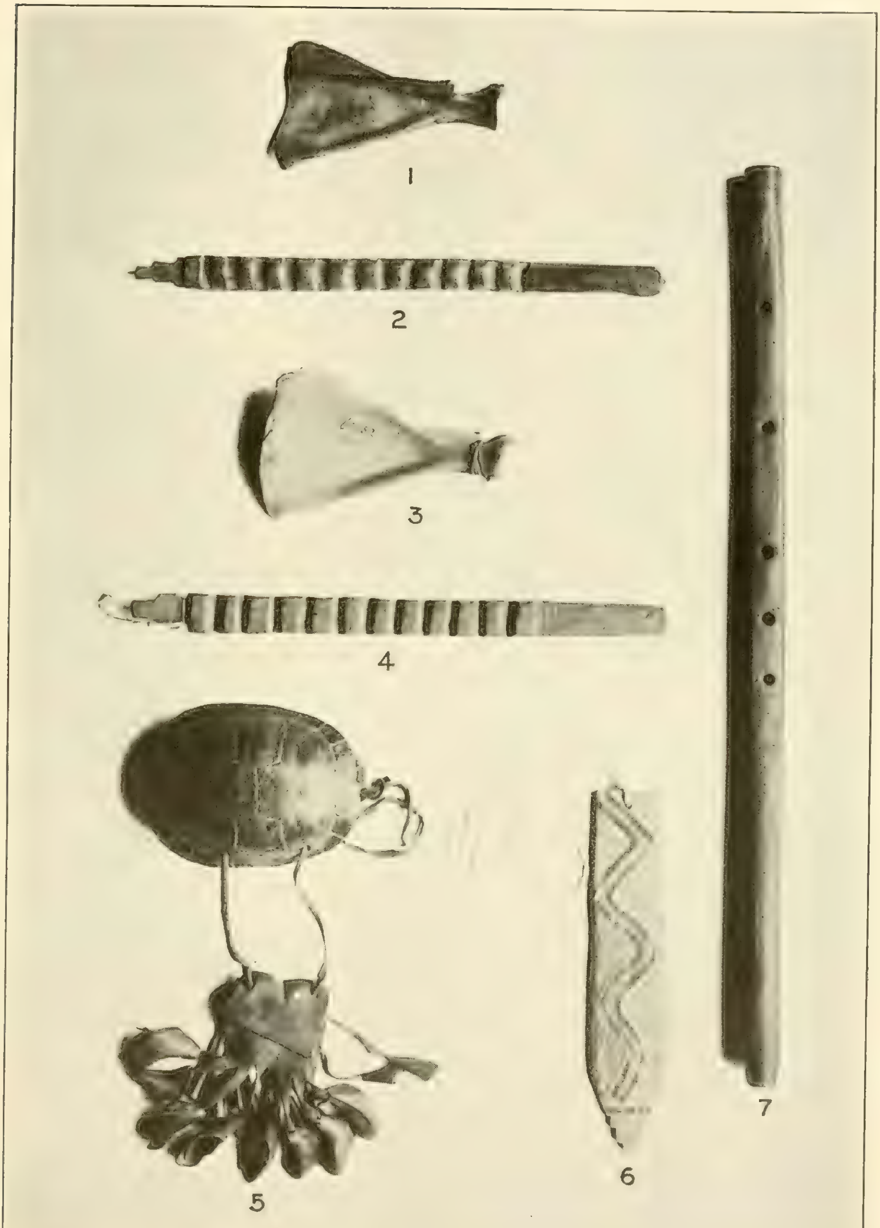


DOLLS AND TOYS.

FOR DESCRIPTION SEE PAGE 290.

RATTLES OF GOURD.

FOR DESCRIPTION SEE PAGE 292.



MUSICAL INSTRUMENTS.

FOR DESCRIPTION SEE PAGE 292.

COSTUME OF WARRIOR.

FOR DESCRIPTION SEE PAGE 289.

THROWING THE RABBIT CLUB.

FOR DESCRIPTION SEE PAGE 287.

THE FISHES OF MOHAVE RIVER, CALIFORNIA.

By John Otterbein Snyder,

Of Stanford University, California.

The Mohave River has its origin in the San Bernardino Mountains of southern California. Its tributaries drain a relatively small area of the northern slopes of the ranges which separate its basin from that of the Santa Ana River. It flows down the mountains and almost directly across the Mohave desert, where its dwindling current is at length consumed by evaporation or absorbed by the dry earth. Throughout the greater part of its course it receives no addition to its volume except the water of an occasional spring.

Relief maps do not seem to indicate that the river ever had an outlet in the direction of its course, the sink where it disappears lying in a depression which is mostly surrounded by low mountains except where the river enters. From the San Joaquin basin the Mohave is separated by the high mountains which connect the southern Sierras with the Coast Ranges; besides, a wide expanse of desert intervenes between these mountains and the river channel. The flow of the Mohave is rather fluctuating and uncertain, sudden desert storms and long dry periods contributing in turn to an inconstant river volume.

The fishes of the Mohave River belong to a single species,[1] a member of the genus *Siphateles*,[2] a channel and lake minnow which occurs in the Sacramento-San Joaquin, Klamath, Oregon Lake, Columbia, and Lahontan systems, and Owens River. The species of this group are very closely related, intergradation of distinctive characters being not unusual. In a measure they resemble geographic races or subspecies of birds and mammals as usually defined, except that being fluvial and lacustrine forms, the range of each is definitely circumscribed, and no intermingling or interbreeding of individuals of different forms is possible. Species of *Siphateles* are not known from Santa Ana or Colorado rivers.

The Mohave species was recorded by Girard in 1856 as *Algansea formosa*.[3] It was then identified with examples of the genus from Merced (Mercede) River, a tributary of the San Joaquin, and until recently the species was regarded as synonymous with *Hesperoleucus*

[1] The river has not been thoroughly searched for fishes. A collection made near Victor by Mr. Clarence H. Kennedy, and some specimens secured by Mr. Dane Coolidge at Barstow have served as a basis for these notes.

[2] Bull. Bureau Fish., vol. 35, 1915–16, p. 60.

[3] Proc. Acad. Sci. Phila., 1856, p. 183. Cotypes of *Algansea formosa* are in the U. S. National Museum, No. 196 from Merced River, and 197 from Mohave River. They are not well enough preserved for careful comparison, although they serve to show without doubt what species the author described. Merced River is the first locality mentioned, and therefore the name *formosa* may be retained for the Sacramento-San Joaquin form.

(*Rutilus*) *symmetricus*.[1] The large series of specimens from the Mohave reveals a considerable degree of differentiation when comparisons are made with specimens of *S. formosus* and *S. obesus*, the two species which are geographically nearest them. *S. obesus* is indigenous to the Lahontan system and Owens River. The immediate relationship of the Mohave form, which may be known as *Siphateles mohavensis*, can not be determined with certainty from an examination of the fishes, and unless the geology of the region points to some previous connection between the Mohave basin and the Sacramento-San Joaquin or the Lahontan systems, the question may remain only partly answered. There is reason to doubt the possibility that the species reached the Mohave through stream capture near the headwaters, as the species of *Siphateles* appear to be lacustrine and channel forms and are not known to migrate far up into the smaller tributaries. The occurrence of the genus in streams without deep, slough-like channels or direct connection with a lake is rare, and individuals are not at any time found at a distance from such places.

Tables intended to illustrate some of the more evident differences which separate *S. mohavensis*, *S. formosus*, and *S. obesus*, and a description of *S. mohavensis* follow.

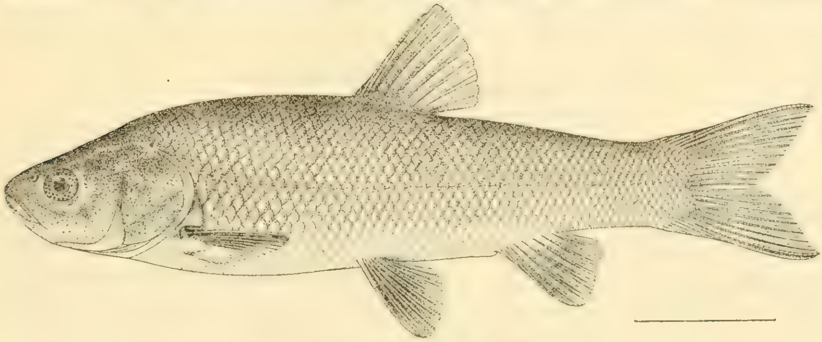
Scales lateral series	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
S. mohavensis			1	5	10	11	15	10	14	13	6	1					
S. formosus	2	6	12	18	13	17	19	16	9	4	2						
S. obesus							1	2	2	13	6	16	13	5	7	4	1
Scales before dorsal	22	23	24	25	26	27	28	29	30	31	32	33					
S. mohavensis		4	10	17	16	19	14	6	1								
S. formosus	1	8	10	16	13	9	2										
S. obesus						4	9	17	16	18	3	2					
Scales below lateral line			5	6	7	8											
S. mohavensis				27	25	2											
S. formosus			5	13	1												
S. obesus					43	22											
Height dorsal fin	.16	.17		.18	.19	.20	.21	.22	.23	.24	.25	.26					
S. mohavensis		3		12	4	12	2										
S. formosus				2	1	5	16	10	13	7	2	2					
S. obesus		15		8	10	8	5										
Height anal fin	.12	.13			.14	.15	.16	.17	.18	.19	.20						
S. mohavensis		3		8	11	8	1	1									
S. formosus					1	15	6	18	12	4							
S. obesus		7		12	12	9	6										
Length caudal fin	.21	.22		.23	.24	.25	.26	.27	.28	.29	.30	.31	.32	.33	.34		
S. mohavensis				3	9	10	6	4									
S. formosus						1	1		7	9	12	8	11	6	4		
S. obesus	1	1		7	15	12	8	6	4		1						
Number of dorsal rays				8	9												
S. mohavensis				48	5												
S. formosus					59												
S. obesus				85	3												

Description of *Siphateles mohavensis*, type No. 76837, U.S.N.M., from the Mohave River near Victor, California, August 14, 1915. Clarence H. Kennedy, collector.

Total length, 149 mm.; length to base of caudal, 122; head, 3.5 in the length; depth, 3.5; depth caudal peduncle, 8; length snout, 3.6 n head; diameter eye, 5.2; with interorbital space, 2.9; scales n lateral series, 50; between occiput and dorsal fin, 26; above lateral line, 12; between lateral line and base of ventral, 7.

[1] Bull. U. S. Bureau Fisheries, vol. 27, 1907, p. 137.

The species has a large head, deep and heavy body, short and rounded fins. The snout is short, the maxillary oblique, the interorbital space broad and rather flat, the dorsal outline of the head slightly concave. The origin of the dorsal is immediately over that of the ventrals, halfway between the anterior border of the eye and end of last vertebra. The lateral line is complete. The gillrakers are short and pointed, flat, and triangular. They decrease in size gradually from the middle to the ends of the arch. They number



SIPHATELES MOHAVENSIS.

from 21 to 24, 6 or 7 on the short limb of the arch. Pharyngeals short and heavy, the teeth slightly hooked, with broad grinding surfaces. There are usually 4, sometimes 5, on the right side; 5 on the left (gillrakers and pharyngeals from paratypes). Upper surface of head and body dusky, the fins all dark. Each scale with a definite dark border and a lighter center.

The following measurements are expressed in hundredths of the length:

Length of body......mm..	122	115	107	113	105	99	107	95	95	102
Length head..................	.29	.29	.275	.28	.28	.29	.28	.285	.29	.29
Depth body..................	.29	.29	.28	.275	.265	.27	.28	.29	.31	.29
Depth caudal peduncle.....	.125	.12	.12	.125	.12	.12	.125	.12	.12	.12
Length caudal peduncle...	.20	.19	.195	.18	.20	.20	.21	.18	.21	.195
Length snout..............	.085	.08	.08	.09	.08	.08	.08	08.	.08	.09
Diameter eye...............	.056	.058	.053	.055	.055	.06	.055	.06	.06	.06
Interorbital width	.10	.10	.093	.10	.09	.095	.095	.095	.09	.10
Depth head..................	.21	.20	.20	.20	.195	.20	.19	.20	.20	.20
Snout to occiput...........	.21	.22	.205	.21	.22	.22	.21	.22	.20	.21
Snout to dorsal	.55	.565	.535	.55	.57	.56	.56	.56	.55	.57
Snout to ventral	.55	.56	.57	.56	.56	.54	.54	.58	.55	.565
Length base of dorsal	.125	.125	.12	.13	.105	.12	.12	.105	.125	.105
Length base of anal........	.09	.095	.08	.09	.085	.095	.08	.09	.09	.08
Height dorsal	.175	.195	.18	.175	.17	.18	.175	.18	.19	.17
Height anal..................	.135	.15	.14	.145	.13	.14	.13	.15	.16	.13
Length pectoral.............	.18	.19	.175	.175	.17	.18	.18	.18	.21	.19
Length ventral.............	.15	.17	.16	.155	.15	.16	.16	.155	.18	.16
Length caudal.............	.25	.24	.23	.24	.24	.23	.235	.25	.24	.24
Dorsal rays..................	9	8	9	8	8	8	9	9	8	8
Anal rays..................	8	8	8	8	8	8	8	8	8	8
Scales lateral line..........	50	49	53	49	53	53	52	48	54	54
Scales above lateral line...	12	13	12	11	11	12	12	11	11	12
Scales below lateral line...	7	7	8	7	7	7	7	7	7	7
Scales before dorsal........	26	25	28	26	24	25	27	23	26	27

NEW SPECIES OF NORTH AMERICAN FOSSIL BEETLES, COCKROACHES, AND TSETSE FLIES.

By T. D. A. Cockerell,
Of the University of Colorado, Boulder.

The following notes upon new American fossil insects are the result of studies upon several small lots of specimens submitted to me by the United States Geological Survey. All of these specimens have been transferred to the United States National Museum and the catalogue numbers of the types will be found given under the descriptions of these species. For convenience of reference the paper has been divided into three headings, as noted below.

1. FOSSIL COCKROACHES FROM THE PENNSYLVANIAN.

The insects described below were collected for the United States Geological Survey by Dr. Harvey Bassler, of the Maryland Geological Survey, during 1916. Two localities are represented, and the material adds considerably to our knowledge of the subject.

(A) Rock quarry one mile northeast of Mercer Court House, Pennsylvania, above State hospital. (Bassler.) The horizon is 10′ below top of Conoquenessing.

(1) Blattoid pronotum, slightly over 13 mm. broad and about 10.8 long; the posterior portion shows transverse striae, as in the living *Archimandrita marmorata* Stoll, from Guatemala. Such striae have also been observed in a pronotum obtained by Schlechtendal in the Upper Carboniferous of Saxony.

(2) Blattoid tegmen, with the following characters:

ATIMOBLATTA REDUCTA, new species.

Tegmen about 32 mm. long and 13 broad; interneural structure obscure, appearing rugose, but in the cubital field it can be seen that it consists of cross-veins, variably united by transverse veins in the middle, producing a reticulation of the same general character as that in the living *Blaberus trapezoideus* Burmeister. Venation and shape of tegmen like that of *Atimoblatta curvipennis* Handlirsch; anal field long; cubitus with five simple veins below; media with three branches above, the middle one forked, the forks of the middle branch and that produced by the last branch leaving the stem both more remote from the apex than in *A. curvipennis;* radius not well preserved, but with three branches, more or less divided distally; subcostal venation obliterated. Probably the pronotum described above belongs to this species; its size is such as would be expected. This insect is considerably smaller than *A. curvipennis*, from the "Upper Pottsville" at Scranton, but the structure is scarcely different.

Holotype.—Cat. No. 64342, U.S.N.M.

(3) Fragment of an apparently new Blattoid genus, probably related to *Adeloblatta* from Mazon Creek and *Mesitoblatta* from Commentry. There is not enough to justify a description and name

(4) Smaller, unrecognizable fragments of Blattoid tegmina

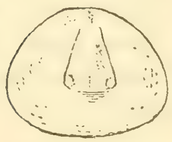


FIG. 1.—PRONOTUM OF BLATTID PROBABLY ATIMOBLATTA REDUCTA.

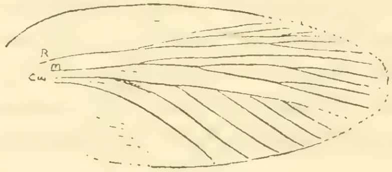


FIG. 2.—ATIMOBLATTA REDUCTA R.=RADIUS. M.=MEDIA. CU.=CUBITUS.

(B) Humphreys Clay Pit, Port Barnett, one mile east of Brookville, Pennsylvania. (Bassler.) In the Brookville Clay horizon 10′–15′ above Homewood shales. The insects are in shale. All the insects are Blattoids.

(1) Blattoid tegmen, lacking the apex and anal area.

PHOBEROBLATTA RETICULATA, new species.

Plate 54, fig. 4.

Tegmen about 44 mm. long, the subcosta ending about 24 mm. from base; surface between the veins finely reticulated, as in *P. grandis* Handlirsch. Costa somewhat less convex than in *P. grandis;* costal area 4.3 mm wide at level of first fork of radius; subcosta with a short apical fork. then (counting backward) three oblique branches which have branchlets from their upper side (the second with two, the others each with one), then a simple branch, then a branch forked near base. then a few weak strongly diverging branches (no distinct basal division as is described for *P. grandis*); radius with two main divisions, the upper with a small apical fork and two other branches from its upper side, the first (counting backward) with a small apical fork, the second with a very long fork, the upper branch of which forks near margin; lower branch of radius forking a little before level of fork of upper, both divisions again forking, the upper by its branching enclosing six cells on margin, the lower with each division at least once forked, the inferior much sooner than the superior; media very straight, forked a little beyond origin of third branch of cubitus, the lower division soon forking again, the two together by their branching enclosing at least seven cells on margin; primary branches of media four, all except the first distinctly above; cubitus long, not rapidly descending, ending far beyond middle of wing, with no distinct superior appendage, but the last three forks are symmetrical, the branches are six, very oblique, the first, third, and fourth with long forks.

Differs from *P. grandis* by the smaller size and the structure of subcosta and cubitus, but is evidently congeneric. *P. grandis* came from an unknown horizon at Fishing Creek Gap, Pennsylvania, in the lower part of the Anthracite series. There is also a hind wing which I refer to *P. reticulata.*

Holotype.—Cat. No. 64343, U.S.N.M.

(2) Blattoid tegmina, representing a new genus.

COBALOBLATTA, new genus (Archimylacridae).

Large insects with broad elongated tegmina; costa convex, rapidly descending to apex, which is either in lowest fork of radius or in interval between radius and media; surface between the veins with very distinct and numerous cross-nervules, which anastomose to form a reticulation, but the general effect is that of very many cross lines, not the distinct polygonal reticulation of *Phoberoblatta;* costal area narrower than in *Phoberoblatta*, only about 3.6 mm. wide at level of first fork of radius; some of the branches of subcosta forked; radius with two main divisions, the first with four primary branches above, the first of these branches forking, with each branchlet forking again near margin, the second and third branches forking once; second division of radius forking, with each division again forking, and the first, second, and fourth of the branchlets so formed again forking; media nearly straight, little complicated, its branches essentially below, the main branches two, the second simple, the first forking, and its upper branchlet forking again; cubical field large and broad, the cubitus rapidly descending, with no appendix; branches of cubitus five, the last forming one side of the short apical fork, the second to fourth once forked, the first forked, with each branchlet again forked; and area broad and short, with six veins, the second, fourth, fifth, and sixth branched, the fifth with its lower branchlet again branched.

Type of the genus.—*Cobaloblatta simulans*, new species.

COBALOBLATTA SIMULANS, new species.

Plate 54, figs. 1, 2.

Tegmina about 44 mm. long, 18 wide; anal field about 15.5 mm. long; end of subcosta about 28 mm. from base of wing.

There are two specimens, each with reverse.

This fine insect is close to *Pachyblatta* Cockerell, from the Mount Savage clay, but it is much larger;[1] the costa presents a regular curve, the branching of the subcosta is much more simple (in the basal part of the costal area there is merely a vague reticulation), and the media is less complicated. In my tables it runs near *Kinklidoblatta*, from Pittston, Pennsylvania, but it is very much larger, with the cubitus entirely different. The cubitus is suggestive of *Olethroblatta*, from Germany, but the subcosta is quite unlike that genus. Superficially the species looks like *Phoberoblatta reticulata* from the same locality, but it shows many differences in detail.

Holotype.—Cat. No. 64344, U.S.N.M.

(3) Tegmen lacking apex.

BRACHYMYLACRIS BASSLERI, new species.

Plate 54, fig. 3.

Probable length of tegmen 14.5 mm., width about 8 mm.; length of anal area 8 mm.; end of subcosta from base of wing 8 mm.; interneural structure consisting of very fine cross-veins, which occasionally unite laterally. Subcosta with four branches above, the second with two branchlets above; radius early dividing into an upper and a lower part, the upper with three branches, the first of which again divides near its origin; lower division of radius forking, each division again forking, the upper branchlet of the lower division forking (there may be more complexity, the apex of the wing being missing); media dividing early, each division with two branches below; cubitus very simple, with only one main branch, which soon divides, and each division again forks, the fork of the upper division very long, that of the lower very short; anal area with 13 veins on margin, these forming two groups, that of the first four (counting backward or from above) and that of the others, separated by a wide interval basally; in the lower division of the anal veins are three forks.

Allied to *B. cordata* Handlirsch, but differing in the more simple cubitus and other details. *B. cordata* is from Tremont, Pennsylvania (Anthracite series).

Holotype.—Cat. No. 64345, U. S.N.M.

(4) Tegmen representing a new genus.

[1] *Pachyblatta convexa* Cockerell has the tegmen 30.5 mm. long, the subcosta ending 23 mm. from base of tegmen and 7.5 mm. from level of apex.

PTILOMYLACRIS, new genus (Mylacridae).

Medium-sized insects with broad subparallel-sided tegmina; surface between the veins without visible structure. Costal and radial areas reduced, approximately equal, the radius ending near the middle of the costal margin. Media greatly expanded, much branched, enclosing ten cells on margin; cubitus long, with nine branches, of which only the eighth is forked; anal area with seven nervures, the lowest forked.

I have been much perplexed concerning the interpretation of this tegmen, but after close examination in various lights and with different instruments, the above seems correct. The natural question is, whether all of the apparently extended and complicated media belongs to it, but it seems to do so. The genus is evidently related to *Promylacris* Scudder and *Paromylacris* Scudder, both from Mazon Creek, Illinois.

Type of genus.—Ptilomylacris medialis, new species.

PTILOMYLACRIS MEDIALIS, new species.

Plate 54, fig. 7.

Length of tegmen about 17.5 mm., width 9.5; length of anal area 8 mm.; end of subcosta about 8 mm. from base of wing. Subcostal branches obliterated; radius apparently very simple, with three simple branches from its upper side (compare *Goniomylacris* Handlirsch); media complex, with four branches from upper side, the first two (arising close together) each once forked, the third and fourth each with two simple branches from upper side; cubitus with nine branches, only the eighth forked. The media is not wholly unlike that of *Mylacris;* it also resembles that of *Paromylacris* in its general features.

Holotype.—Cat. No. 64346, U.S.N.M.

(5) Fragments of another mylacrid species, insufficient for recognition.

(6) The following fragment of a tegmen.

STENOMYLACRIS, species.

A fragment having exactly the characters of this genus, so far as the material shows, but the median and radial fields are wholly missing. Subcostal region broad, ordinary for Mylacridae; branches of cubitus exceedingly oblique and close together, the branching, if any, close to their origin; anal area long and rather narrow (length, 10.5 mm.), with numerous veins which form exceedingly acute angles with the margin. The type of *Stenomylacris* came from the Mammoth vein, Sharp Mountain Gap, Pennsylvania.

(7) Part of tegmen of unknown Blattoid, costal and anal regions and apex missing. Remarkable for the very long simple cells in forks of radius and media; interneural surface finely reticulated.

(8) Tegmen representing a new species.

PHTHINOMYLACRIS (?) PAUPER, new species.

Plate 54, fig. 5.

Probable length of tegmen (the apical part is missing) about 17.5 mm.; apparent width 7.5 mm., but a little of the lower margin is concealed, so that the width was probably fully 8 mm.; interneural structure a fine reticulation, very distinctly preserved. Subcosta straight, ending about or nearly 10 mm. from base of wing, with four branches arising separately, the two middle ones each forked, the last, with the end of the main stem, enclosing a long cell; radius gently curved upward beyond the middle, with four branches above, the first forking early, producing a very long cell; the second also forking early, but each division again forked; the third forking only toward the apex; the fourth forking before the middle; media with two long branches, each forked, below and toward the apex two branches above; cubitus with four branches, the first soon forked, the others simple. The anal field is not preserved.

I have been much puzzled where to place this species. In my key to the Mylacrid genera it runs to *Phthinomylacris*, but differs from that genus in the strong interneural reticulation, the narrower tegmen, and the more complicated media. It can be made to run nearly as well to *Hemimylacris*, as typified by *H. ramificata* Handlirsch, but unfortunately the type of *Hemimylacris* is *H. clintoniana* (Scudder), which has Archimylacrid characters and is surely not congeneric. Very probably *P. pauper* should be regarded as the type of a new genus, but the single specimen is imperfect, and it may suffice to leave it in *Phthinomylacris* for the present. It is much smaller than the previously described species of that genus.

Holotype.—Cat. No. 64347, U.S.N.M.

(9) Tegmen of a new species.

ATIMOBLATTA (?) FLEXUOSA, new species.

Plate 54, fig. 6.

Probable length of tegmen (the apical part is missing) about 28 mm., width 12.5 mm.; anal area 13 mm. long, its greatest width a little over 6 mm.; interneural structure consisting of very fine close transverse veinlets, which frequently anastomose laterally. Subcosta long, the inclosed region narrow and bandlike, but the subcostal branches can not be made out; radius with four branches above, the first twice forked, the third and fourth once forked (there is doubtless more complexity, now obliterated); media little curved, with three branches above, the first forked a little beyond the level of origin of the third; cubitus gently curved, with seven long simple branches, which are strongly curved apically; anal field with nine veins, the first dividing near base and each division forked, the second forked near apex, the eighth forked.

This differs conspicuously from the type of *Atimoblatta* in the broader tegmen and the flexuose branches of cubitus, but it does not seem advisable to propose a new generic term at present. There is also some resemblance to *Parelthoblatta*. These forms are related in a general way to *Archimylacris* and appear to represent an early type of Archimylacridae.

Holotype.—Cat No. 64348, U.S.N.M.

2. BEETLES FROM THE EARLY TERTIARY ROCKS OF COLORADO.

Recent investigations have shown that in the region of North Park, Colorado, there exist rocks of early Tertiary age containing elytra of beetles. Two of these insects were described under the names *Calandrites hindsi* and *Ophryastites hendersoni*.[1] Additional material recently received from the United States Geological Survey includes two species, one of which proves to be *O. hendersoni*, while the other is considered new. At the same time I find two more new species in the museum of the University of Colorado, and these are herewith described. The fauna or faunæ represented by these remains must be considerably older than the beds from which Scudder obtained his Eocene beetles. With the elytra alone, accurate generic determinations are impossible; and indeed, considering the antiquity of the fossils, they probably belong to other than the modern genera which they most resemble. The deposits are doubtless of fresh-water origin.

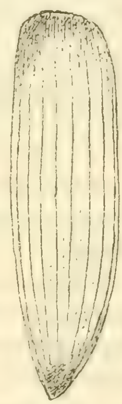


FIG. 3.—CARABITES ARAPAHOENSIS.

CARABITES (?) ARAPAHOENSIS, new species.

Elytron 5.7 mm. long, 2 mm. broad; truncate basally, nearly parallel-sided except apically, where it is pointed; surface only slightly convex, with eight longitudinal striae, not punctured.

Type.—University of Colorado Museum 5822: "Eocene, one mile west of Spicer, Arapahoe Pass Road, North Park, Colorado, 2½ miles south of fork of road; August 2, 1911 (N. E. Hinds)."

The elytron rather closely resembles *Carabites exanimus* Scudder, from the bank of White River, Utah, but it is much smaller.

BALANINUS (?) BEEKLYI, new species.

Elytron 2.6 mm. long, a little over 1 mm. broad; convex, acutely pointed, with eleven punctured striae.

[1] Proc. U. S. National Museum, vol. 51, 1916, p. 105, pl. 2, figs. 2 and 3.

U.S.G.S. locality 7120. "NE. ¼, NE. ¼ sec. 7, T. 9 N., R. 80 W., east of Lake, one-half mile east of Higho, North Park, Colorado. (A. L. Beekly and H. Bassler.)" This is evidently Locality 54 of Bulletin 596, U.S.G.S., p. 63, and is in the Coalmont formation. This elytron has the general form of the acorn weevils of the genus *Balaninus*, and it is to be noted that species of *Quercus* occur in the Coalmont formation. The elytron is more acute than in the Florissant species, of very much later date, described by Scudder.

FIG. 4.—BALANINUS BEEKLYI.

Holotype.—Cat. No. 64349, U.S.N.M.

OPHRYASTITES HENDERSONI Cockerell.

Two elytra. U.S.G.S. 7287. "NE. ¼, NE. ¼ sec. 9, T. 7 N., R. 81 W., west end of bluff 3 miles northwest of Coalmont, North Park, Colorado. (A. L. Beekly and H. Bassler.)" Collected August 21, 1911. This is locality 73 in the Coalmont formation, recorded on p. 65, Bull. 596, U.S.G.S. *Glyptostrobus* is recorded from the same place.

CALANDRITES (?) URSORUM, new species.

Elytron 8.6 mm. long, 2 or very slightly over wide, with nine sharp striae, and no punctures; the scutellum appears to have been large.

Type.—University of Colorado, 5817. "Eocene; south of Grizzly Creek, about 4 miles southwest of Spicer, North Park, Colorado, July 31, 1911 (F. F. Grout)."

This looks something like *C. hindsi*, but is remarkably long and narrow, with entirely different sculpture. It presumably represents an extinct genus, which can not be properly defined from the elytra alone. The reference even to the blanket-genus *Calandrites* is unsatisfactory.

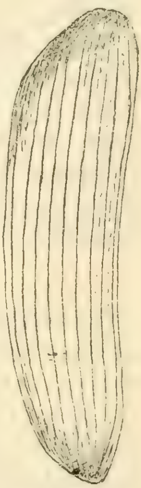


FIG. 5.—CALANDRITES URSORUM.

3. FOSSIL TSETSE FLIES.

Plate 55.

The tsetse flies, the genus *Glossina* of Wiedemann, constitute a very distinct group of the higher Diptera, with rather numerous species. Although they are generally referred to the family Muscidae, which contains the house fly and other common species, they have so many peculiar characters that they may well be regarded as representing a distinct family. The formidable proboscis, ensheathed in the palpi, is directed forward and is always conspicuous. The wings, when at rest, are closed one over the other in a manner observed in no other similar flies—a character which makes it easy to distinguish tsetse flies in the field from various other blood-sucking Diptera. The venation of the wings is unique, the fourth vein (so-called) being abruptly bent or looped up in the middle, where the anterior cross-vein meets it. The mode of reproduction is also very remarkable, since the females lay no eggs, but each one produces a single full-grown larva, which almost immediately becomes a pupa.

Thus the tsetse flies would attract the attention of entomologists on account of their structure and habits alone, were they of no special importance to mankind in general. Thanks to the labors of Sir David Bruce and many others in tropical Africa, we now know that various species of *Glossina* are carriers of parasitic Protozoa of the genus *Trypanosoma*, which cause fatal diseases in man and animals. The nagana disease of cattle, due to a parasite carried by *Glossina morsitans*, is absolutely ruinous to the stock interests in certain districts. The parasite exists also in the wild hoofed animals, which do not become diseased, but serve as reservoirs from which domestic cattle and horses may be infected, provided the proper fly is present. This fact has led to an agitation in some quarters for the destruction of the larger wild animals, such as zebras and antelopes; but it is to be hoped that better means will be found to avoid the spread of the disease. Even more serious is the sleeping sickness of man, due to a trypanosome conveyed principally, at least, by *Glossina palpalis*. Owing to the opening up of trade routes through tropical Africa, this disease has spread far beyond its original area and has destroyed countless numbers of human beings. Medical men have labored incessantly, and no expense has been spared to find remedies and means of prevention. But while the white man is now able to take care of himself in nearly every case, it is an enormous problem to protect the native people all over central Africa. Up to the present time 17 species and 4 recognizable varieties of tsetse flies are known from Africa. The following chronological table shows when and by whom they were described. Synonyms are omitted.

1830. *longipalpis* Wiedemann; *palpalis* Robineau-Desvoidy.

1849. *fusca* Walker.

1850. *tachinoides* Westwood; *morsitans* Westwood; *tabaniformis* Westwood.

1891. *pallicera* Bigot.

1895. *longipennis* Corti.

1903. *pallidipes* Austen.

1905. *palpalis wellmani* Austen.

1910. *fuscipes* Newstead; *morsitans submorsitans* Newstead; *nigrofusca* Newstead; *brevipalpis* Newstead.

1911. *caliginea* Austen; *fuscipleuris* Austen; *medicorum* Austen.

1912. *austeni* Newstead; *ziemanni* Grünberg.

1913. *morsitans pallida* Shircore; *morsitans paradoxa* Shircore.

There is only one exception to the rule that these flies are peculiar to the African Continent; *G. tachinoides* has been found in southern Arabia, as recorded by Captain R. Markham Carter in 1906.

In 1892 (Bull. U. S. Geol. Survey, No. 93) S. H. Scudder described a remarkable fossil fly from the miocene shales of Florissant, Colorado, at that time supposed to be of oligocene age. He considered it to belong to the Oestridae, which contains the bot-flies and warble-flies. The head was unfortunately missing, but Scudder correctly noted the singular course of the fourth vein, which found no counterpart among living Oestrids. It naturally never occurred to him to compare the insect with an African genus, so he described it as a new genus and species, *Paloestrus oligocenus*. In 1907 Mr. Geo. N. Rohwer found a good specimen of this species at Florissant, showing the proboscis, and I was able to determine without difficulty that it was a genuine tsetse fly, astonishing as that might seem. An enlarged figure appeared in the Popular Science Monthly (August, 1908, p. 117). A figure was also published by Bland-Sutton in the Middlesex Hospital Journal (London) for December, 1907. Mr. E. E. Austen, of the British Museum, the principal authority on tsetse flies, quite agreed with the reference of the fossil to *Glossina*.

Thus it appeared that a million years ago, more or less, tsetse flies inhabited Colorado. Prof. Henry F. Osborn had shortly before discussed the possible causes of the disappearance of so many large mammals which formerly inhabited America, and had suggested that there might have been some flies carrying disease-producing organisms, such as the tsetse fly. If at various times and places such diseases as the nagana invaded the herds of Tertiary horses and other animals, these creatures might abruptly disappear, leaving no trace of the cause of the phenomenon. It is naturally out of the question to determine whether these ancient species of *Glossina* did actually carry trypanosomes, but their occurrence in the shales is certainly suggestive.

In 1909 I had occasion to describe a second species of tsetse fly from the Florissant fossil-beds, and named it *Glossina osborni*. It was published in Nature for April 1 of that year (p. 128).

In 1916 Mr. George Wilson was so fortunate as to find two additional specimens of *Glossina* at Florissant, representing additional species. The specimens are now in the United States National Museum. One of them, *Glossina veterna* Cockerell (Nature, Sept. 28, 1916, p. 70) is a truly marvelous specimen, showing not only the proboscis, wings, and body, but even the characteristic hairs on the body. The accompanying plate, kindly made by Dr. R. S. Bassler, shows it enlarged. It is actually 12.5 mm. long, the wings 10.9 mm.

The other species, which I have named *Glossina armatipes*, is not so well preserved, but its salient characters can be made out. The armature of the legs, as the name suggests, is striking. It is a relatively small form, with the wings about 7.5 mm. long. The outer side of the discal cell is curved, more or less S-like, an exaggeration of the condition found in the living *Glossina fusca.* The wings are perfectly clear, the veins very pale.

The largest of the fossil species is *G. oligocena* (Scudder), which has the wings about 16 mm. long; next in order is *G. veterna;* while *G. osborni* and *G. armatipes* are smaller insects, with the wings less than 8 mm. In *G. armatipes* the hind basitarsus carries a pair of stout longitudinally striated spines; similar spines exist in the modern *G. fusca.*

Whether *Glossina* originated in the Eastern or Western Hemisphere may be considered doubtful. There are no closely related genera known, and it is a singular thing that no true Muscidae have been found in the Florissant shales. Grünberg (Zool. Anzeiger, 1906) described *Glossinella schillingsi* from East Africa; a genus and species supposed to be allied to *Glossina.* It is, however, actually very different, with quite different venation. Bezzi in the year following stated that *Glossinella* was not to be separated from *Lyperosia* Rondani, which is now known by the earlier name *Haematobia.*

EXPLANATION OF PLATES.

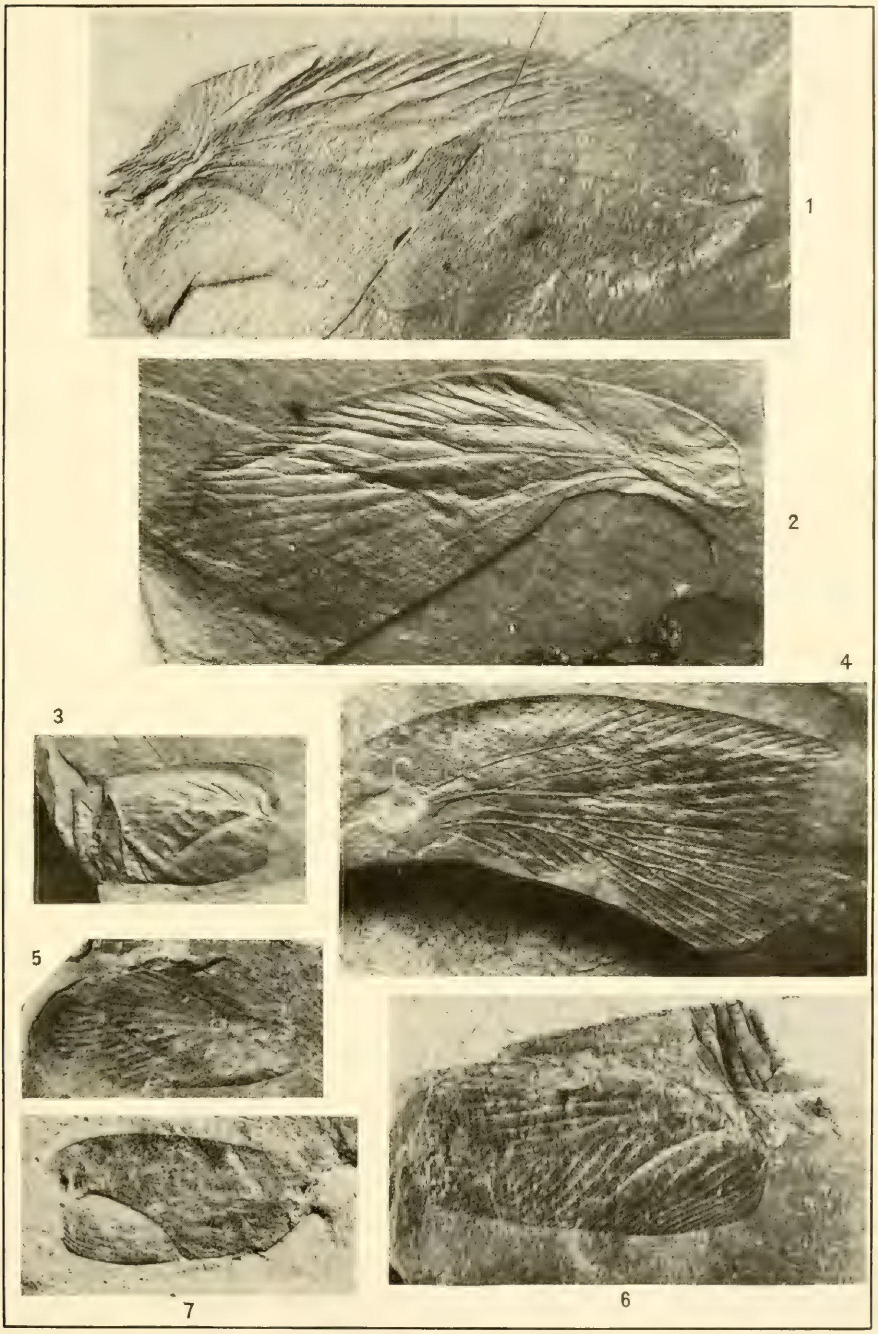
Plate 54.

Fossil Cockroaches from the Pennsylvanian.

Fig. 1. *Cobaloblatta simulans.* Type × 2.
2. *Cobaloblatta simulans.* Reverse of type × 2.
3. *Brachymylacris bassleri.* Type × 2 .
4. *Phoberoblatta reticulata.* Type × 2.
5. *Phthinomylacris pauper.* Type × 2.
6. *Atimoblatta flexuosa.* Type × 2.
7. *Ptilomylacris medialis.* Type × 2.

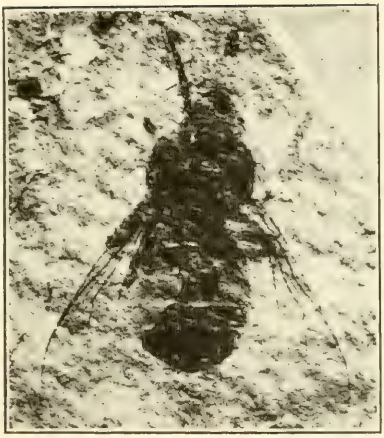
Plate 55.

Fossil tsetse fly. *Glossina veterna* Cockerell.



FOSSIL COCKROACHES FROM THE PENNSYLVANIAN.

FOR EXPLANATION OF PLATE SEE PAGE 311.



Fossil Tsetse Fly, Glossina veterna Cockerell.

For explanation of plate see page 311.

NOTES ON THE NOMENCLATURE OF THE MOLLUSKS OF THE FAMILY TURRITIDAE.

By William Healey Dall.

Honorary Curator of Mollusks, United States National Museum.

In the course of my revision of the West American mollusk fauna, the Turritidae (formerly Pleurotomidae) were reserved until nearly the last, owing to my knowledge of the extremely unsatisfactory condition of their nomenclature.

Owing chiefly to a want of thoroughness and consequent inaccuracy the recent revisions of the group by Tryon and Cossmann were quite unreliable, though to their labors in bringing material and references together and so giving a starting point for investigation I am much indebted. Furthermore several recent writers on the group have in my opinion excessively divided it, forming genera, subgenera, and sections on merely specific, or even individual, characters of no physiological or systematic importance. Of the more than 175 names of more than specific importance which have been applied to members of this family, probably not more than one third are indicative of characters of sufficient value to warrant a separate name.

Another difficulty in a satisfactory treatment of the family arises from the fact that these animals often differ among themselves anatomically in ways not expressed in the shell characters; species generically distinct sometimes having extremely similar shells. This has been amply proved in the cases of *Leucosyrinx*, *Irenosyrinx*, *Steiraxis*, and *Aforia* for instance. Therefore until much more is known of the anatomy of the species any arrangement must be merely tentative, though it is not unreasonable under the circumstances to put like shells of unknown anatomy in the same systematic group for the present.

From the recent species we must reason by analogy to determine the proper place of fossils, as no other course is open. It would require several years' work and access to European collections to place the known species and determine the synonymy of the entire family, a task beyond my powers under present conditions. I shall therefore only attempt to review our West American species, and to determine the original types and consequent characteristics of some of the more familiar genera of the family. To these data I add references to the various names which have been given to members of the group, making a basis from which later workers may be able to proceed with the review of the whole family. Some scattered names may have escaped discovery during my search, but this is a misfortune hardly to be avoided in such work. The rules by which I have been guided in recognition of valid names are those of the International Committee on Zoological Nomenclature and, while applying these rules with precision as far as the facts are known to me, I have endeavored to use in doubtful cases a rational conservatism, changing nothing for the mere love of change and avoiding the whimsicalities by means of which some recent writers have endeavored to justify their retention of familiar but unfortunately invalid names.

The Turritidae are an ancient group, originating in Mesozoic time and have naturally a world-wide distribution. There are probably more species of the family in the recent fauna than of any other family of mollusks. The distinctness of the group was recognized by Rumphius as early as 1704 and his name *Turris* with his typical species has been adopted into binomial nomenclature in its original sense, though the group has been multifariously subdivided since. It is a pity that Lamarck disregarded the work of his predecessors so far as to apply to the group a name different from that by which it had been known for nearly a century, thus necessitating an inconvenient revision nearly another century later.

Genus TURRIS Bolten, 1799.

The name *Turris* for the typical part of the genus was given by Bolten a year earlier than Lamarck's application of the name *Pleurotoma* to the same type. Still earlier, Helbling had given the name *Fusus* to a group consisting chiefly of Turritidae, but fortunately, by applying the method of elimination to his assembly, the name *Fusus* could be fixed upon a small and inconspicuous group of Gastropods, and a shifting of names which would have been practically intolerable was thus avoided. The rejection by the International Committee of the anonymous Museum Calonnianum of 1797, removes that source of confusion from consideration in systematic binomial nomenclature, though in this instance the author of that work merely followed Rumphius, and the sole identifiable species in his list is the type of *Turris* Bolten.

Link in 1807 followed Lamarck, though (possibily due to a typographical error) the name is spelled *Pleurotome* in his publication.

In the quadrinomial system of Dumeril the name is spelled *Pleurotomarius* as a designation for the animal of *Pleurotoma*. To these synonyms may probably be added *Lophiotoma and Tomopleura* Casey, 1904.

Genus CLAVATULA Lamarck, 1801.

The first subdivision of the genus was the proposal of Lamarck in 1801 of a genus *Clavatula*, which was typified by *C. coronata* Lamarck, but which is not *Clavatula* Swainson, 1840, typified by *C. sulcata* Swainson. Synonyms are *Clavicantha* Swainson, 1840, and probably the typical *Drillia* (*umbilicata*) Gray, 1838. Lamarck afterward united his *Clavatula* with *Pleurotoma*, but subsequent investigations have shown that *Clavatula*, according to its type-species, is entitled to subfamily distinction. The operculum, dentition, and anatomy are different from those of the group typified by *Turris babylonius*. It is a west African group in the main.

Genus CLAVUS Montfort, 1810.

Under the name of *Clavus* Montfort separated, in 1810, a genus typified by *C. flammulatus* Montfort, figured and described in the same place, and specifically designated as the type. Because at the same time he cited one of Lamarck's Clavatulae, the latter has been mistaken as the type. An unjustified attempt to reject *Clavus* on account of the perfectly distinct prior name of *Clava* Martyn, has been made, but Tryon correctly preserved the genus for smooth Turritidae with a short last whorl, long spire, nodulous shoulder, no spiral sculpture, a wide, deep anal sulcus adjacent to the suture and, in the completely adult, a marked subsutural callus on the body. Such species as *Pleurotoma crenularis* Reeve (Conch. Iconica, fig. 54 (not of Weinkauff), 1845; *P. lanceolata* Reeve (fig. 182), *P. maculosa* Reeve (fig. 45); and *P. echinata* Reeve (fig. 48) appear to be properly located in the genus *Clavus*.

Genus TURRICULA Schumacher, 1817.

The next to be considered is the genus *Turricula* Schumacher, 1817, based on *T. flammea* Schumacher, founded on figures 1337 and 1338, volume 4, of Martini's Conchylien Cabinet. This shell is *Turris javanus* Bolten, but not *Murex javanus* of Linnaeus and Gmelin. It is the *Murex tornatus* of Dillwyn, 1817, but not of Bolten, 1798. It is not *Clavatula flammea* Hinds, 1843.

The type of *Turricula* is an almost perfectly smooth shell of the kind ordinarily called *Surcula* H. and A. Adams, 1853, of which the type is *Murex javanus* Linnaeus and Gmelin, not Bolten. The only distinction between *Turricula* and *Surcula* is the rough sculpture of the latter. *Surcula*, if based on the adjacency of the anal sinus to the suture can only be maintained as a minor section of *Turricula*. A futile attempt has been made to reject *Turricula* on account of the use of that name in the worthless polynomial system of Klein, but that is quite inadmissible on any genuine nomenclatorial basis. The *Turricula* of Herrman, 1783, was not used in a generic sense. The *Turricula* of the Museum Calonnianum has been rejected by the International Committee on Nomenclature. The use of the name by Fabricius, 1822, and Beck, 1837, being later than Schumacher's date, need not be further considered.

Surgula Weinkauff, 1875, is a Germanized rendering of *Surcula*, but whether due to author or compositor is uncertain.

Genus MANGILIA Risso, 1826.

The next name to be considered is *Mangelia* Risso, 1826. The first species is *M. costulata* Risso, which is identical with or merely a variety of *nebula* Montagu. Risso named no type, but *costulata* was selected by Bellardi in 1847, Kobelt in 1905, and Dall in 1908. The selection of other types by authors subsequent to Bellardi has created a good deal of confusion, since Risso's group of species was not homogeneous. As has been already shown by Iredale[1] Gray, in the Proceedings of the Zoological Society of London for 1847, selected as the type of Leach's manuscript genus *Bela* this same *Murex nebula* of Montagu which makes *Bela* an exact synonym of *Mangelia*, this being the first valid publication of *Bela*. *Mangelia ginnania* Risso (fig. 130) to which Gray in 1847 referred the manuscript name of *Ishnula* Clark, is apparently identical with *Mangelia* s. s., though Monterosato proposed a sectional name *Ginnania* for it in 1884. *Raphitoma* Bellardi, 1844, was a heterogeneous group. Later in his preliminary synopsis of 1875, he divides the group into two sections: I, typified by *R. vulpecula* Brocchi, and II, by *R. harpula* Brocchi. In his subsequent monograph of the Pleurotomidæ he specifies (p. 323) *vulpecula* as the type of the genus. The latter is a typical *Mangelia* and *Raphitoma* therefore becomes a synonym of *Mangelia*. Other authors disregarding Bellardi's selection of a type have made extraordinary confusion of the relations of this genus.

Its chief characteristics are the absence of an operculum; the entire, hardly thickened, and nonvaricose outer lip; the unarmed pillar; and shallow anal sinus near the suture. The shell is usually axially ribbed and spirally minutely sculptured. The fact that the author intended to be honored was named Mangili led Lovèn and many subsequent writers to correct the spelling to *Mangilia*, which, as it hardly affects the location of the name in indices, though a little irregular

[1] Proc. Mal. Soc., London, vol. 11, p. 299, 1915.

from a nomenclatorial standpoint, may without too much reprehension be accepted.

Genus DRILLIA Gray, 1838.

The name *Drillia* was proposed in 1838 for a peculiar African species (*umbilicata* Gray) by J. E. Gray. What is probably the same species *Brachytoma castanea* Swainson, 1840, was one of the two types of Swainson's *Brachytoma* (not *Brachystoma*, as mispelled by several authors) and both of them probably may turn out to be Clavatulae. At any rate the shells which have been commonly called *Drillia* have to take another name.

The small blackish Drillias so common in Panamic waters, of which *Pleurotoma bottae* Valenciennes is the type, will take the name of *Crassispira* Swainson, 1840.

The light-colored species, with an oily gloss, thin shells, and prominent riblets usually crossed by rather widely spaced spiral striations, will take the new name of *Elaeocyma* Dall. This group appears to be peculiar to the Pacific coast of America. *Drillia empyrosia* Dall may be taken as type and *D. unimaculata* Sowerby, *hemphilli* Stearns, and several others belong to it.

Cymatosyrinx Dall, 1889, based on *Pleurotoma lunata* Lea, will cover the thin-shelled light-colored species of its type.

For the generally brown or brownish clathrate species a few of which are found in nearly every fauna, and of which *Pleurotoma gibbosa* Reeve may be specified as a typical example, the new name of *Clathrodrillia* Dall may be used. *Drillia ostrearum* Stearns is an American example.

Genus MELATOMA Swainson, 1840.

Swainson in 1840 described and figured under the name of *Melatoma costata* a shell which he supposed to be fluviatile but which really belonged to the Turritidae. Seven years later Gray gave the name of *Clionella* (*sinuatum* Born) to a species of the same conchological type. This group which by its dentition and operculum is related to the Clavatulae must take the earlier name.

There is a group of species typified by *Pleurotoma penicillata* Carpenter which in sculpture and periostracum closely resemble the African *Melatoma*, but their operculum has an apical nucleus and is long and narrow. They may be called *Pseudomelatoma*. *Melatoma* Anthony, 1847, is quite a different thing.

Genus MONILIOPSIS Conrad, 1865.

This name was applied in 1865 to a very beautifully sculptured species (*M. elaborata* Conrad) from the Eocene. The West American species formerly called *Surcula cancellata* Carpenter, *inermis* Carpenter, etc., though with much less elaborate ornamentation appear to be related to the Eocene fossil and may tentatively be referred to the same group. At all events they can not be comprised in *Surcula* as properly restricted. I may note that Conrad's species was very insufficiently figured by him.

Genus ANCISTROSYRINX Dall, 1881.

This group, which has a wholly superficial resemblance to *Columbarium*, is an evident development from *Cochlespira* Conrad, 1865, of the Eocene. It should be stated, however, that some wholly incongruous species have been referred to this section by authors unfamiliar with the original type, *A. elegans*, which is figured in Dr. A. Agassiz' Three Voyages of the *Blake* (vol. 2, p. 66, fig. 282, 1888). The distinctions which may serve to retain *Ancistrosyrinx* as a section of *Cochlespira* are recorded in Bulletin Museum of Comparative Zoology (vol. 43, p. 257, 1908). *Candelabrum* Dall, MS. not of Blainville, is a synonym.

Genus GEMMULA Weinkauff, 1876.

This section of *Turris* with short canal and beaded or rugose anal fasciole was named without a designated type, but, in 1896, Cossmann selected *Pleurotoma gemmata* Hinds. The section *Hemipleurotoma* Cossmann, is regarded as synonymous by Casey.

There is a numerous group of abyssal Turritidae with a sculpture somewhat like that of *Gemmula* but covered with a greenish periostracum, the shell of a chalky consistency, the outer lip thin and simple instead of internally thickened and lirate as in *Pl. gemmata*. These differences seem to be of at least sectional value and the group may be named *Cryptogemma* with *Gemmula benthina* Dall, 1908, as type. The aspect of these shells suggests relationship with *Antiplanes*, but these features may be due to similar influences of the deep-water environment. The universal erosion, even in the youngest living specimens, prevents us from knowing the nuclear characters.

Genus BELA (Leach MS.) Gray, 1847.

Iredale reviewed this genus in 1915 in the Proceedings of the Malacological Society of London, and as the type of *Bela* selected by Gray himself is the same species as the type of *Mangelia* Risso, there is no question but that the name must be abandoned.

The next name in order is *Lora* Gistel, 1848, type *Tritonium viridulum* O. Fabricius (probably=*Bela exarata* Möller). This is followed by *Oenopota* of Mörch, 1852, who designated no type. *Onopota*, H. and A. Adams, 1858, is synonymous.

Genus BATHYTOMA Harris and Burrows, 1891.

Dolichotoma Bellardi, 1875 (*Doligotoma* Weinkauff, 1876), is preoccupied by *Dolichotoma* Hope, 1839. The type is *Pleurotoma cataphracta* Brocchi, which automatically becomes the type of *Bathytoma.* This species is more or less sculptured. Casey proposed in 1904 the name of *Megasurcula* for the smoother West American species. But von Koenen in 1867[1] proposed for the *Pleurotoma filosa* of Lamarck the name *Cryptoconus;* and a comparison of it with the smaller Californian species (*stearnsiana* Raymond) shows only specific differences between them. *Cryptoconus* thus supersedes *Bathytoma* for the West American forms, whether it be accepted for the more emphatically sculptured European and West Indian species or not, and I can see no important characters to separate them.

Genus AFORIA Dall, 1889.

This name was applied by me to *Pleurotoma circinata* Dall, on the mistaken statement of Jeffreys that it possessed no operculum. Better material enabled the diagnosis to be corrected and the species would have been referred to *Leucosyrinx* were it not for the fact that a portion of the shells (males?) show in the adult a deep notch or sinus in the anterior part of the outer lip between the canal and the periphery, somewhat analogous to the sinus for the eye pedicels in *Strombus.* Whether this is a sexual character remains to be determined, but it occurs in so many specimens that it can not be regarded as abnormal.

Genus BORSONELLA Dall, 1908.

It seems entirely probable that true *Borsonia* and *Cordieria* do not exist on the Pacific coast, and that the relations between *Antiplanes* and *Borsonella* are more intimate than those with any of the European forms, notwithstanding the plait on the pillar in *Borsonella.* With Casey I think that this is a feature which may occur sporadically in a portion of any large group of Turritidae.

Genus CYTHARA Schumacher, 1817.

Cossmann states (Essais, vol. 2, p. 121) that this name was used before Schumacher, but he gives no reference and a careful search has not revealed any binomial use of it, so I am obliged to regard the statement as a mistake. *Eucythara* Fischer is a synonym. Schumacher's type, *C. striata* Schumacher, is said by several authors to be identical with *Cancellaria citharella* Lamarck, 1822. Both authors refer to the same figure of Chemnitz (1330), which represents a shell corresponding to the generally accepted type of *Cythara.*

[1] Zittel, Traité, de Pal., vol. 2, p. 284 (Barrois translation), gives 1840 the date of von Koenen's name, but I have not been able to verify this.

Some authors have confounded with this figure two adjacent figures of immature Strombi and concluded that *Cythara* was a synonym of *Strombus*, but this conclusion has no valid basis.

The typical *Cythara* is a relatively large tropical shell with short spire and narrow, elongated aperture, plentifully supplied in adults with denticulations or striated callus on both body, pillar, and outer lip. It appears to be entirely distinct from the relatively small shells, mostly with unarmed apertures, from the temperate faunas, which authors, including the writer, have been accustomed to refer to this genus. The name which we shall adopt for the small forms referred to is difficult to determine, since some of them were included in Risso's *Mangelia*, and Reeve included all he knew in his monograph of the Mangelias along with *Cythara* proper. Other authors, ignoring the real type of *Mangelia*, have applied the latter name to these species, while still others have proposed a considerable number of new names for the various species of this group. True *Cythara* appears to bear much such a conchological relation to these shells as *Glyphostoma* does to the small shells we have been accustomed to call *Clathurella*.

Cossmann in 1889 calls them *Mangilia*, following Reeve; Bellardi in 1875 had called them *Ditoma*, but this name was preoccupied by Illiger in 1807. Bellardi's type species was *Pleurotoma angusta* Jan. This is a form with a thickened outer lip, spiral striation, and conspicuous short anal sinus. Cossmann in 1889 substituted *Agathotoma*, the type, of course, remaining automatically the same; but in 1875 Monterosato had proposed for *Pleurotoma bertrandi* Payraudeau the name *Cytharella*. This covers the smooth group exactly. *Haedropleura* Monterosato, 1882, type *Murex septangularis* Montagu, would provide for the more elevated forms with few axial ribs, but the type is said to be operculate, which the true Cytharellae are not. The forms with shouldered whorls and numerous axial ribs like *angusta* Jan must take Cossmann's name, unless some anterior designation can be found. *Zetekia* is a small form recalling *Mitromorpha*, with predominantly spiral sculpture and coarse lirations on both sides of the aperture and the anal sulcus inconspicuous. The type (U. S. Nat. Mus., No. 274109) is about six millimeters long, with a smooth nucleus of about three whorls and four subsequent whorls, with the suture obscure and the color purplish brown. It was collected at Panama and I have called it *Z. denticulata*.

Genus CLATHURELLA Carpenter, 1857.

This was a new name for *Defrancia* Millet, not Bronn, 1825. In 1908[1] I discussed the synonymy of *Clathurella*, for which a species

[1] Bull. Mus. Comp. Zool., vol. 43, No. 6, p. 250. On p. 261, under *Bellardiella*, the statement as to the nucleus is inaccurate and should be eliminated. The correct description is given on p. 260, line 7 *et seq.*

not included in Millet's original list has been usually but erroneously taken as the type. As neither Millet nor Carpenter named a type, and Carpenter's name automatically takes as type the designated species of *Defrancia* Millet (*D. pagoda*, selected by the writer in 1908), *Clathurella* must be reserved for species having the character of *D. pagoda* Millet. However, Iredale has shown that Bronn in 1831 proposed the name *Pleurotomoides* for the preoccupied *Defrancia* of Millet, which must take precedence of *Clathurella* with the same typical species. Beck proposed *Pleurotomina* as a substitute for *Defrancia* in 1847, but it had been used by Gray in 1838 as a subfamily name. This leaves the species placed in *Clathurella* by Cossmann, 1896, type *C. rava* Hinds, without a name, and among the numerous names for small Turritidae one must be sought. The earliest which seems available appears to be *Philbertia* Monterosato, 1884. The curious succession of synonyms is as follows, noting first that Bellardi did not (as has been erroneously stated) propose a name *Heterotoma*, and if he had it was preoccupied by Hartmann in 1844. Then follows *Bellardia* Bucquoy, Dautzenberg, and Dollfus, 1882, not of Mayer, 1870; *Bellardiella* Fischer, 1883 (new name for *Bellardia*), not of Tapparone Canefri earlier in 1883; *Philbertia* Monterosato (p. 132, 1884); *Cormarmondia* Monterosato (p. 135, 1884) (new name for *Bellardiella*); *Otitoma* Jousseaume, 1898; and lastly *Clathurina* Melvill (April, 1917) (new name for *Clathurella*).

As far as the data are accessible to me *Philbertia* (from which the later *Comarmondia* does not materially differ) is the earliest available name for the group included by *Clathurella* Cossmann not Carpenter, and typified by *Pleurotoma bicolor* Risso=*P. purpurea* (Montagu), variety *bicolor* Bucquoy, Dautzenberg, and Dollfus+*P. philberti* Michelotti, fide Monterosato. *Philbertia* has the outer lip thickened or varicose, lirate or dentate within when adult, the pillar usually smooth, the nucleus acute, smooth, and rather elevated; the species are small and the sculpture more or less clathrate or sculptured both axially and spirally.

The nearest group to it is *Glyphostoma*, which is large, with a more brilliant surface, a more fusiform profile, more contracted and emphatically armed aperture and different nucleus. *Philbertia* abounds in shallow temperate waters, while *Glyphostoma*, receding to the Eocene in time, apparently prefers tropical waters and even considerable depths.

Genus CALLIOTECTUM Dall, 1889.

A dissection of a better preserved specimen of *C. vernicosum*, the type of this genus, has revealed a minute radula with teeth of the Volutoid type, and the long esophageal caecum characteristic of the

Volutidae, to which family it must be referred as one of the degenerate abyssal forms which have lost their columellar plaits. A magnificent species related to *Calliotectum*, named *Prodallia dalli* and figured by Bartsch in 1915, was dredged in very deep water among the Philippines.

The other named groups among the Turritidae of the Pacific coast are not involved in synonymic difficulties and therefore need not be discussed here.

Preliminary list of names heretofore applied to divisions of the Turritidae with references and notes.

Acamptogenotia ROVERETO, 1899, see *Pseudotoma* Bellardi not Stephens.

Aforia DALL, 1889, Bull. Mus. Comp. Zool., vol. 18, p. 99. Type, *Pl. circinata* Dall.

Agathotoma COSSMANN, Rev. Crit. Pal., 3me Année, p. 1, 1889. New name for *Ditoma* Bellardi 1875, not Illiger, 1807. See Essais, vol. 3, p. 192, 1899.

? **Aliceia** DAUTZENBERG and FISCHER, Mém. Soc. Zool. de France, vol. 10, p. 182, 1897. Type, *A. aenigmatica* Dautzenberg and Fischer, Mém. Soc. Zool. de France, vol. 10, p. 182, 1897, Azores. Nepionic shell, perhaps the young of a *Clavatula*.

Amblyacrum COSSMANN, 1889, Cat. Ill., p. 295. Essais, vol. 2, p. 137. Type, *Pl. rugosa* Deshayes. This is a *Surcula* with short canal, moderate anal sulcus and Drillia-like sculpture. No varix behind outer lip.

Ancistrosyrinx DALL, 1881, Bull. Mus. Comp. Zool., vol. 9, p. 53. Type, *A. elegans* Dall. ?=*Cochlespira* Conrad, 1865, Amer. Journ. Conch., vol. 1, p. 20.

Anna RISSO, 1826, Eur. Mér., p. 214, fig. 68. Type, *A. massena* Risso, Eur. Mér., p. 214=*Buccinum scacchianum* Philippi. Referred to Pleurotomidae by various authors but really a *Cantharus*.

Antiplanes DALL, Proc. U. S. Nat. Mus., vol. 24, No. 1264, p. 513, 1902. Type, *Surcula perversa* Gabb, 1865.

Aphanitoma BELLARDI, Mon. Pl., 1875, p. 241. Type, *Turbinella labellum* (Bonelli), Bellardi and Michaud. Fischer, Man., p. 594, 1883, names as example *A. pecchiolii* Bellardi. Resembles a small *Genota* with two plications on the pillar. Zittel, Man. (French ed.), p. 286, 1887, accepts the type as *Pl. labellum*. Not *Aphanitoma* Cossmann. 1883.

Apiotoma COSSMANN, 1889, Cat. Illustr., p. 263. Essais Pal., vol. 2, p. 73, 1896. Type, *Pl. pirulata* Deshayes. Eocene. Slender *Genota*-like shell.

Asthenotoma HARRIS and BURROWS. Eocene and Olig. Paris, 1891, p. 113. New name for *Oligotoma* Bellardi, 1875, not of Westwood, 1836. Type, *Pl. basterotii* Desmoulins, 1842. Shell small, like small *Drillia* without varices, lirate outer lip, simple sinuate pillar. Sculpture of spiral cords. Miocene.

Atoma BELLARDI, Mon. Pl., 1875, p. 324. Type, *A. hypothetica* Bellardi, Mon. Pl., 1875, p. 324 (1847). Not of Latreille 1796 (Arachn.)=*Enatoma* Rovereto, Syn. 1899, p. 3.

Awateria SUTER, New Zealand Geol. Surv., Pal. Bull. No. 5, pt. 1, p. 57, 1917. Type, *A. streptophora* Suter; Pliocene, New Zealand.

Bathybela KOBELT, Icon. Eur., vol. 3, p. 276, 1905. Type, *Thesbia nudator* Locard.

Bathyclionella KOBELT, Icon. Eur., vol. 3, p. 279. Type, *Pl. quadruplex* Watson; abyssal. Apparently not related to *Clionella*.

Bathytoma HARRIS and BURROWS, Eocene and Olig. Paris, 1891, p. 113, new name for *Dolichotoma* Bellardi, not Hope, 1839. Cf. *Megasurcula* Casey, and *Cryptoconus* v. Koenen.

Beisselia HOLTZAPFEL, 1889. (Not seen.) Type, *Koenenia speciosa* Holtzapfel, Senonian; new name for *Koenenia* Holtzapfel, 1888, not of Beushausen; nor of Grassi, 1885. This is a pleurotomoid resembling a very large coarse *Fusinus*.

Bela GRAY, 1847. Ann. Mag. Nat. Hist., vol. 20, p. 276. No type selected, includes *Pl. nebula*, Proc. Zool. Soc., 1847, p. 134, *nebula* selected by Gray as type. H. and A. Adams, 1853, cite *Ishnula* Clark MS. as a synonym of *Bela*, but Gray, Ann. Mag. Nat. Hist., vol. 20, p. 134, had already referred it to *Mangilia* Risso as synonym. *Bela* equals *Oenopota* Mörch, Yoldi Cat., pt. 1, p. 73, 1852, and *Lora*, Gistel, 1848.

Bellardia
Bellardiella } see *Philbertia*.

Bellaspira CONRAD, 1867. Amer. Journ. Conch., vol. 3, p. 261. Type, *Mangelia virginiana* Conrad. Yorktown Miocene.

Belomitra FISCHER, 1882. Man., p. 592. Journ. de Conchyl., vol. 30, p. 275. Type, *B. paradoxa* Fischer. Abyssal. Resembles *Bela* but has plicate pillar.

Borsonella DALL., 1908. Mus. Comp. Zool. Bull., vol. 43, p. 258. Type, *Borsonia dalli* Arnold.

Borsonia BELLARDI, 1838. Bull. Soc. Géol. de France, p. 30, vol. 10.

2nd sect. Type, *B. prima* Bell. (2 plaits).

1st sect. Type, *B. bicoronata* Bell. (1 plait).

3rd sect. Type, *B. uniplicata* Nyst. (1 plait).

Brachytoma SWAINSON. Man., 1840, p. 314. Types, *Pl. stromboides* Sowerby, Man., fig. 381, and *B. castanea* Swainson, after Chemnitz. Both these species are *Drillia* Auct. and both are probably *Clavatulas*. *B. castanea* is, perhaps, identical with Gray's type (*umbilicata*) of *Drillia*.

Buchozia BAYAN. (Not seen.) Type, *Auricula citharella* Lamarck. Eocene. +*Etallonia* Deshayes, 1862, not Oppel, 1861,+*Zafra* Cossmann, 1892, not of A. Adams, 1860. Very like *Bela* but somewhat heavier.

Calvatula PRESTON, Zool. Record, vol. 49, 1912, Moll., p. 61. Err. typogr. for *Clavatula*.

Candelabrum DALL, 1878, Bull. Mus. Comp. Zool., vol. 5, p. 61, not of Blainville, 1830. See *Ancistrosyrinx* Dall, 1881.

Catenotoma COSSMANN and PISSARO, Bull. Soc. Géol. Normand., vol. 19, p. 39, 1900. Type, *Surcula catenata* Lamarck. Eocene.

Chauvetia MONTEROSATO, Nom. Conch. Medit., 1884, p. 137, new name for *Nesaea* Risso, 1826, not Lamarck, 1812–16. Type is stated to be *Buccinum candidissimum* Philippi. This species appears to be a cancellate *Anachis*. Cossmann refers it to *Donovania* but the type is not of that genus. In 1890 Monterosato refers it to the group of *Raphitoma vulpecula*.

Cirillia MONTEROSATO, 1884. Nom. Conch. Medit., p. 133. Type, *Pl. linearis* Montagu;+*Leufroyia* Monterosato, p. 134 (type, *Pl. leufroyi* Michaud). ?=*Anna* Risso, Eur. Mér., p. 126 (*A. massena* Risso). *Anna* equals *Cantharus* sp. Nucleus short, the last whorl unicarinate; the surface roughly sculptured, outer lip thickened, not lirate, pillar simple.

Citharopsis PEASE, Amer. Journ. Conch., vol. 4, p. 97, 1868, 1st sp. *Cithara ornata* Pease, Amer. Journ. Conch., vol. 4, p. 97, 1868. Small Indopacific *Anachis*; not *Cytharopsis* A. Adams, 1865.

Clathrodrillia DALL, 1918. Type, *Pl. gibbosa* Reeve.

Clathromangilia MONTEROSATO, Nom. Conch. Medit., p. 131, 1884. Monotype *Pl. granum* Philippi, 1844. Coarsely clathrate, small; varicose outer lip.

Clathurella CARPENTER, Maz. Cat., 1857, p. 399. New name for *Defrancia* Millet, 1827, not Bronn (1825). Type, *Defrancia pagoda* Millet, selected by Dall, Mus. Comp. Zool. Bull., vol. 43, p. 259, 1908, no type having previously been designated. For species commonly referred to *Clathurella*, see under *Philbertia* Monterosato. Not *Clathurella* Cossmann, 1896 (*C. rava* Hinds) nor of Bucquoy, Dautzenberg and Dollfus, 1882. Type, *C. purpurea* Montagu (=*philberti*+*purpurea*+*corbis* Monterosato, 1884.)

Clathurina MELVILL, Apr., 1917, Trans. Mal. Soc., p. 185. Type, *Pl. foraminata* Reeve. See *Philbertia*.

Clavatula LAMARCK, Syst., 1801, p. 84. Type, *C. coronata* Lamarck, Syst., 1801, p. 84, not of Swainson, Man., 1840, p. 314 (*sulcata* Swainson, Man., 1840, p. 314). < *Pleurotoma* Lamarck, 1822. +*Clavicantha* Swainson, 1840, Man., p. 314. ?+*Drillia* Gray, 1838, Ann., vol. 1, p. 28. Type, *D. umbilicata* Gray. Not *Drillia* Auct. +*Brachytoma* Swainson, 1840, Man., p. 314; (*castanea* Swainson).

Clavatula SWAINSON, 1840. Man., p. 314. Type, *C. sulcata* Swainson, Man., p. 314, 1840,=*Murex gibbosus* Born, Index, 1778; Test. Mus. Vind., 1780, p. 321; +*Pl. flavidula* Lamarck var., Kiener, Icon., p. 31, 1839;=*Drillia* Auct., not *Clavatula* Lamarck, 1801.

Clavicantha SWAINSON, 1840, Man., p. 314;=*Clavatula* Lamarck, 1801, not Swainson, 1840.

Clavosurcula SCHEPMAN, *Siboga* Exp., livr. 64, Mon. 49′ e, p. 429, 1913. Type, *C. sibogae* Schepman. Resembles *Steiraxis*.

Clavus MONTFORT, Conch., p. 434, 1810. Type, *C. flammulatus* Montfort, Conch., vol. 2, p. 434, 1810, not *Clava* Martyn et al. <*Drillia* Auct. A smooth species with depressed anal fasciole and tubercles on the shoulder, spire slender, last whorl short, with subsutural callus, sharp outer lip and plain columella.

Clinura BELLARDI, Mon. Pl., 1875, p. 204. Type, 1st sect. *Pl. calliope* Brocchi, 1814. (short spire.) 2nd sect. *Pl. elegantissima* Forbes. (long spire.)

Clionella GRAY, Proc. Zool. Soc., 1847, p. 153. Type. *Buccinum sinuatum* Born, 1778;=*Melatoma* Swainson, 1840, not Anthony, 1847.

Cochlespira CONRAD, 1865, Amer. Journ. Conch., vol. 1, p. 20. Type, *Pl. cristata* Conrad. Oligocene.

Cochlespirella CASEY, Proc. Acad. Nat. Sci. Phila., 1903, p. 279. Type, *Fusus nanus* Lea, Eocene, and includes *Pl. insignifica* Heilprin. Cossmann, Essais, p. 221, 1906, on the basis of *insignifica* refers this to *Peratotoma*.

Cochlespiropsis CASEY, Trans. St. Louis Acad., vol. 14, 1904, p. 143, 1st sp. *Pl. engonata* Conrad, Eocene. Cossmann, Essais, p. 221, 1906, unites this with *Rouaultia*.

Columbarium v. MARTENS, Conch. Mitt., vol. 2, p. 105, 1881. Type, *Pleurotoma* (*Col.*) *spinicincta* v. Martens, Conch., Mitt., vol. 2, p. 105, 1881.

Comarmondia see *Philbertia*.

Conopleura HINDS, Voy. Sulph., Moll., 1844, p. 24. Type, *C. striata* Hinds, Voy. Sulph., Moll., p. 24.

Cordieria ROUAULT, 1848, Bull. Soc. Géol. de France, sér. 2, vol. 5, p. 207. Type not indicated. Tryon, Struct. Conch., 1883, cites *Pl. pyrenaica* Rouault. Cossmann, Essais, vol. 2, p. 98, 1906, names *C. iberica* Rouault. Not *Cordieria* Monterosato, 1884. Two plaits on the pillar as restricted.

Cordieria MONTEROSATO, Nom. Conch. Medit., 1884, p. 131. 1st sp. *Pl. reticulata* (Renieri) Brocchi; 2nd Pl. *cordieri* Payraudeau, the latter cited as type in Moll. Roussillon, vol. 2, p. 767, 1908. Not *Cordieria* Rouault, 1848. Close to *Philbertia* Monterosato.

Coronia GREGORIO, Mon. Claib., 1890, p. 23. 1st sp. *Pl. acutirostra* Conrad;=*Gemmula* Weinkauff, 1875, not *Coronia* Ehrenberg, 1840.

Crassispira SWAINSON, Man., 1840, p. 313. Type, *Pleurotoma bottae* Valenciennes in Kiener, 1839+*fasciata* Swainson, Man., 1840, p. 313.

Crassopleura MONTEROSATO, Nom. Conch. Medit., 1884, p. 127; monotype *Pl. maravignae* Bivona, 1838,+*P. incisa* Reeve, 1843.

Crossopleura MONTEROSATO, Journ. de Conchyl., 1879, p. 117, 1890. Monotype, *Pl. maravignae* Bivona.

Cryptoconus v. KOENEN, 1867. Type, *Pl. filosa* Lamarck. Ueber *Conorbis* und *Crytoconus* v. Koenen, 1867, p. 11, fig. 8 (not seen); cf. Arch. Naturg., vol. 2, p. 211, 1880. +*Megasurcula* Casey, 1904.

Cryptogemma DALL, 1918. Type, *Gemmula benthina* Dall.

Cymatosyrinx DALL, 1889, Bull. Mus. Comp. Zool., vol. 18, p. 95. Type, *Pl. lunata* Lea.

Cythara SCHUMACHER, Essais, p. 245, 1817. Type, *C. striata* Schumacher=*Cancellaria citharella* Lamarck 1822. This includes the species with short spire, denticulate outer lip and striated pillar, the aperture narrow. Cossmann states this name was used before Schumacher binomially (Essais, p. 121), but this appears to be erroneous.

Cytharella MONTEROSATO, Bull. Mal. Ital., 1875, p. 6. Type, *Pleurotoma bertrandi* Payraudeau. Cf. *Ditoma* Bellardi, 1875. =*Mangilia* Cossmann, not Risso. These are the small species with thickened but not lirate or denticulate outer lip and pillar; the spire usually shorter than the aperture, the surface longitudinally ribbed, smooth, or spirally minutely sculptured; nucleus small, smooth. Not *Cytherella* Rupert Jones, 1849, Crustacea, from *Cythere*.

Cytharopsis A. ADAMS, 1865, Ann. Mag. Nat. Hist., vol. 15, p. 323. Type, *Mangilia cancellata* A. Adams. Not *Citharopsis* Pease, Oct., 1868.

Daphnella HINDS, Voy. Sulph., Moll., 1844, p. 25. Type, *D. limnaeiformis* Kiener.

Daphnellopsis SCHEPMAN, *Siboga* Exp. livr. 64, Mon. 49′ e., p. 449, 1913. Type, *D. lamellosa* Schepman, *Siboga* Exp. livr. 64, p. 449, 1913. Like *Daphnella* but with heavily callous lips.

Daphnobela COSSMANN, 1896, Essais, p. 93. Type, *Buccinum junceum* Sowerby. Eocene. Shell extremely like *Aesopus*.

Defrancia MILLET, see *Clathurella* Carpenter.

Diaugasma MELVILL, Proc. Mal. Soc. London, 1917, p. 141. Type, *Daphnella epicharta* Melvill and Standen.

Diploconus SANDBERGER. (Not seen.) Not *Diploconus* Haeckel (Protista), 1860; nor of Candèze (Coleoptera) 1860, nor of Zittel, Cephalopoda, 1868 (not seen).

Ditoma BELLARDI, 1875, Mon. Pleur., p. 295. Not *Ditoma* Illiger, 1807, Coleoptera. Type, *Mangilia angusta* Jan. ?+*Cytharella* Monterosato, *q. v.*=*Agathotoma* Cossmann, Rev. Crit. Pal., 1889, vol. 3, p. 45. Also Essais, vol. 3, p. 192.

Dolichotoma BELLARDI, Mon. terz. Piem., p. 229, 1875. Monotype, *Pl. cataphracta* Brocchi. Not *Dolichotoma* Hope, 1839. =*Bathytoma* Harris and Burrows, 1891, new name (not needed). =*Cryptoconus* v. Koenen (1840, *fide* Zittel). 1867 *fide* Fischer. +Megasurcula Casey, 1904;=*Doligotoma* Weinkauff, 1876, Jahrb. Mal. Ges., p. 8.

Doligotoma WEINKAUFF, 1876, Jahrb. Mal. Ges., p. 8,=*Dolichotoma* Bellardi not Hope.

Donovania BUCQUOY, DAUTZENBERG, and DOLLFUS, 1882, Moll. Roussillon, vol. 1, p. 112. Type, *D. minima* Montagu=*brunneum* Donovan, 1804. *Buccinum minimum* Montagu, 1803, is preoccupied by *B. minimum* Turton, 1802, *fide* Iredale. 1915. +*Lachesis* Risso, 1826, not Daudin, 1804;+*Nesaea* Risso, 1826, not Lamarck, 1816.

Drillia GRAY, see *Clavatula* Lamarck and *Clavus* Montfort. Also *Crassispira* Swainson, and *Clavatula* Swainson not Lamarck. *Drillia* Gray, Ann. Nat. Hist., vol. 1, 1838, p. 28. Type, *D. umbilicata* Gray. *Brachytoma* Swainson, 1840 (*eastanea*), is synonymous. *Brachitoma* (*strombiformis* Sowerby) is also a *Drillia*.

Drilliola (MONTEROSATO, MS.) COSSMANN, 1903, Essais, vol. 5, p. 188. Type, *D. emendata* Monterosato, Medit. Cossmann states that it goes between (his)

Eucithara and *Clathurella* and has a flattened later spirally sculptured protoconch.

Elaeocyma DALL, 1918. Type. *Drillia empyrosia* Dall.

Enatoma ROVERETO, 1899, see *Atoma*.

Endiatoma COSSMANN, 1896, Essais, p. 106. Type, *Oligotoma quadricincta* Cossmann;=*Aphanitoma* Cossmann, 1883, not Bellardi, 1875. Eocene.

Eoclathurella CASEY, Trans. St. Louis Acad., vol. 14, 1904, p. 166, 1st sp. *E. jacksonica* Casey, Trans. St. Louis Acad., vol. 14, 1904, p. 166. Eocene. He also refers to this group *Mangilia meridionalis* O. Meyer. Upper Claibornian. Cossmann, 1906, Essais, p. 223. suspends judgment on account of unfigured type.

Eodrillia CASEY, Trans. St. Louis Acad., vol. 14, 1904, p. 159, "Among the typical species" are *depygis* Conrad, *lonsdalii* Lea, *surculopsis* Gregorio, and *texana* Conrad (Casey). Cossmann, 1906, Essais, p. 223, unites this with *Eopleurotoma*.

Eopleurotoma COSSMANN, 1889, Cat. Illustr., p. 269. Type, *Pl. multicostata* Deshayes. Eocene. Casey refers *Pl. nupera* Conrad, *gemmata* Conrad, *hoeninghausi* Lea, and *properugosa* Gregorio to this group (1904). Cossmann, 1906, Essais, p. 223, refers *Eodrillia* Casey, to this section.

Eosurcula CASEY, Trans. St. Louis Acad., vol. 14, 1904, p. 145, 1st sp. *Pl. moorei* Gabb. Eocene. Cossmann, Essais, p. 222, 1906, admits this as section of *Surcula* s. s. on the ground of a narrower protoconch.

Epalxis COSSMANN, 1889, Cat. Ill., p. 254. 1896, Essais, vol. 2, p. 103, type named *Pleur. crenulata* Lamarck. Eocene. Small, obscure plait on pillar, shell in general recalling some of the Mangilias.

Etallonia DESHAYES, 1862. Paris basin, vol. 2, p. 605. Type, *E. prisca* Deshayes. Eocene. Of the two species one is an *Actæon* or related Opisthobranch, the second a pleurotomoid recalling *Gymnobela*. =*Buchozia* Bayan, 1873, new name. Not *Etallonia* Oppel, 1861.

Eubela DALL, 1889, Bull. Mus. Comp. Zool., vol. 18, pp. 102–6. Type, *Daphnella limacina* Dall.

Eucheilodon GABB, Journ. Acad. Nat. Sci. Phila., vol. 4, 1860, p. 379. Type, *E. reticulata* Gabb, Journ. Acad. Nat. Sci. Phila., vol. 4, pl. 667, fig. 18. Shell much like *Glyphostoma* but attenuated in front, outer lip not expanded, the aperture narrow and columella denticulate in the adult. Cossmann spells this *Euchilodon*, ascribes the genus to Heilprin, cites *E. crenocarinatus* Heilprin, 1880, as type! Essais, vol. 3, p. 189, Apr., 1889.

Eucithara FISCHER, 1883, Man., p. 593. New name for *Cythara* Schumacher, 1817, not Klein! Klein being nonbinomial this name is useless. The type-mentioned by Fischer is *Mangilia stromboides* Reeve.

Eucyclotoma BOETTGER, 1895, Nachrbl. d. Mal. Ges., p. 55. Type, *Clathurella bicarinata* Reeve, *fide* Cossmann. (Should be Pease, not Reeve.) Indopacific. Shell with two very prominent carinae, beaded, with Clathurelloid aperture. Cossmann names *bicarinata* as type. Boettger gives (1) *tricarinata* Reeve, and (2) *bicarinata* Pease, but does not designate either as type.

Exilia CONRAD, Journ. Acad. Nat. Sci. Phila., ser. 2, vol. 4, p. 291, pl. 47, fig. 34, 1860. Type, *E. pergracilis* Conrad. Referred by Conrad to Pleurotomidae but really Chrysodomoid.

Folineaea MONTEROSATO, Nom. Conch. Medit., 1884, p. 136. Type, *Buccinum lefebvrii* Maravigna, 1840,+*B. folineaea* Philippi, Moll. Sic., vol. 2, pl. 27, fig. 10. Hardly differs from *Clathromangilia* and is placed as a synonym of *Donovania* by Cossmann. In 1890 Monterosato spells it *Folinia*. Not *Folinia* Crosse, 1868.

Fusitoma CASEY, Trans. St. Louis Acad., vol. 14, 1904, p. 163. Type, *F. sipho* Casey (ex Aldrich), Trans. St. Louis Acad., vol. 14, 1904, p. 163. Cossmann, 1906, Essais, p. 223, suspends judgment for want of data.

Gemmula WEINKAUFF, 1875, Jahrb. d. Deutsche Mal. Ges., vol. 2, p. 287. Type, *Pl. gemmata* Hinds. No type selected in 1875. Cossmann, 1896, selects *gem-*

mata. +*Hemipleurotoma* Cossmann, *fide* Casey, 1904. Cossmann, 1906, holds to the division. Not *Gemmula* Deshayes (in Dall) 1902.

Genota H. and A. ADAMS, Gen. vol. 1, p. 89, 1853. +*Genotia* Tryon, Fischer, etc. em. Type, *Pl. mitriformis* Wood, first of two species.

Ginnania MONTEROSATO, Nom. Conch. Medit., 1884, p. 127, 1st sp. *Pl. fuscata* Philippi; 2nd *Pl. laevigatum* Philippi. The last is selected as type in Moll. Roussillon, vol. 2, p. 766, 1908. =*Mangilia* (*nebula* type) s. s.

Glyphostoma GABB, Proc. Acad. Nat. Sci. Phila., 1872, p. 270; type, *G. dentifera* Gabb. *Mangiliinae.* ?+*Lienardia* Jousseaume, 1884, *Cl. rubida* Hinds. For relations seé *Philbertia* and *Clathurella* Cossmann not Carpenter.

Glyptotoma CASEY, Trans. St. Louis Acad., vol. 14, 1904, p. 140, 1st sp. *Pl. crassiplicata* Gabb. Eocene. Two or three plaits on the pillar, median sinus with nodulous fasciole.

Gosavia STOLICZKA, 1865. Volutoid placed with Pleurotomidae by Cossmann.

Gymnobela VERRILL, 1884, Trans. Conn. Acad., vol. 6, p. 157. Type, *G. engonia* Verrill, fixed by Cossmann, 1896. No type selected by Verrill. Inoperculate, Bela-form, or swollen; nucleus cancellate; abyssal. Verrill's first species is *G. engonia*, his second and figured species is *curta.*

Haedropleura (MONTEROSATO) Bucquoy, Dautzenberg, and Dollfus, Moll. Roussillon, 1882, p. 110. Type, *Murex septangularis* Montagu, 1808. Resembles a *Cytharella* with elevated spire. Operculate.

Helenella CASEY, Trans. St. Louis Acad., vol. 4, 1904, p. 167. Type (1st of two sp.) *Pl. multigranosa* E. A. Smith, St. Helena. Two plaits on the pillar. Recalls *Mitromorpha;* very small shells.

Hemilienardia BOETTGER, Nachrbl. d. Deutsche Mal. Ges., 1895, p. 52. Type, *Clathurella malleti* Recluz. Very short, stumpy, inflated, strongly cross-sculptured, bright-colored, small shells.

Hemipleurotoma COSSMANN, 1889, Cat. Ill., p. 264. Type, *Pl. archimedis* Bellardi. In Essais Pal., 1896, p. 78, Cossmann proposes another type, *Pl. denticula* Basterot. He regards *Coronia* Gregorio as synonymous.

Hemisurcula CASEY, Trans. St. Louis Acad., vol. 14, 1904, p. 150. Type, *Pl. silicata* Aldrich. Gregg's Landing Eocene. Cossmann, 1906, Essais, p. 222, rejects this on the ground of insufficient characters.

Heterotoma Auct. after *Heterotomatae* of Bellardi, Moll. Piem. Mon. Pleur., 1847, p. 7. Not *Heterotoma* Latreille, 1829. Bellardi did not propose a genus *Heterotoma* but named a group in the plural number. In any case, the name was more than once preoccupied.

Homotoma BELLARDI, 1875, Mon. Pl., p. 296. No type selected. Fischer, Man., p. 593, 1883, selects *H. textilis* Brocchi. Bellardi's species are heterogeneous. *Textilis* resembles very much a small *Fusinus.* Equals *Peratotoma* Harris and Burrows, 1891. Not *Homotoma* Guerin-Méneville, 1829. In his preliminary synopsis, 1875, Bellardi divides *Homotoma* into Sect. I, Type, *H. reticulata* Renieri, and Sect. II, Type, *H. semicostata* Bellardi.

Irenosyrinx DALL, 1908, Mus. Comp. Zool. Bull., vol. 43, p. 257. Type, *Pleurotomella goodei* Dall.

Ishnula (Clark MS.), GRAY, Proc. Zool. Soc., 1847, p. 134. Not *Ischnula* Mörch, Mem. Soc. Mal. Belg., vol. 4, 1869, p. 21, type *Pl. impressa* Mörch (=*Bela*).

? Kenyonia BRAZIER, Proc. Linn. Soc. N. S. Wales, vol. 21, p. 346, 1896 (not seen). Type, *K. pulcherrima* Brazier, Proc. Linn. Soc., N. S. Wales, vol. 21, 1896, p. 347. New Hebrides.

Koenenia HOLTZAPFEL 1888, Paleontographica, vol. 34, Moll. der Sachsener Kreide, 1st abth., p. 91. Type, *K. speciosa* Holtzapfel. Cretaceous. Not *Koenenia* Grassi, 1885. Equals *Beisselia* Holtzapfel, 1889.

Kylix DALL, 1918. Type, *K. alcyone* Dall.

Leptosurcula Casey, Trans. St. Louis Acad., vol. 14, 1904, p. 157. Type, *Pl. beadata* Harris. Eocene. Cossmann, 1906, Essais, p. 223, judgment suspended.

Leucosyrinx Dall, 1889, Mus. Comp. Zool. Bull., vol. 18, p. 75. Type, *Pl. verrilli* Dall.

Leufroyia Monterosato, 1884. Nom. Conch. Medit., p. 134. Type, *Pl. leufroyi* Michaud.

Lienardia Jousseaume, Bull. Soc. Zool. de France, vol. 8, p. xl, 1884. Type, *Clathurella rubida* Hinds, Indopacific. Also, Bull. Soc. Zool. de France, vol. 9, p. 184, 1884. Cf. *Glyphostoma* Gabb.

Lophiotoma Casey, Trans. St. Louis Acad., vol. 14, 1904, p. 130. 1st sp. *Pl. tigrina* Lamarck. Recent. Cossmann, Essais, 1906, p. 220, refers this to *Pleurotoma* s. s.

Lora Gistel, Naturg., 1848, p. ix, sole example *Tritonium viridulum* Fabricius, which is a *Bela*, probably *B. exarata* Möller, according to the type-specimen.

Lyromangilia Monterosato, 1917, Bull. Soc. Zool. Ital., ser. 3, vol. 4, (separate copies, p. 25). Type, *Pl. taeniata* Deshayes, Mediterranean.

Lyrosurcula Casey, Trans. St. Louis Acad., vol. 14, 1904, p. 156. 1st sp. *L. elegans* Casey, Claibornian. Cossmann, 1906, Essais, p. 222, expresses no opinion as type is not figured.

Mangelia Risso, Eur. Mér., 1826, vol. 4, p. 219; no type mentioned. 1st sp. *M. costulata* Risso, equals *nebula* Montagu, taken as type by Bellardi, 1847; Kobelt, 1905; Dall, 1908; etc. +*Raphitoma* Weinkauff, Conch. Cab., 1876, types *nebula* Montagu and *harpula* Brocchi, not *Raphitoma* Bellardi, 1847, but Bellardi, in 1875, p. 323, states that *M. vulpecula* Brocchi is typical *Mangilia*. Shell elevated, spire longer than the aperture, longitudinally ribbed, spirally minutely sculptured; pillar smooth, outer lip thin, simple, notch at the suture, nucleus smooth, short, last turn finely cancellate, no operculum. Cossmann substitutes a new type (Essais, p. 114, 1896) *Pl. vauquelini* Payraudeau for *Mangilia* and unites with it *Clathromangilia* Monterosato, 1884; *Cytharella* Monterosato, 1875; *Pseudoraphitoma* Boettger, 1895; and *Paraclathurella* Boettger, 1895. Thus Cossmann's group = *Cytharella*. *Bela* (Leach) Gray, 1847, is a synonym of *Mangelia* with the same type.

Mangiliella Bucquoy, Dautzenberg, and Dollfus, Moll. Roussillon, p. 108, 1882. Type, *Mangilia multilineolata* Deshayes. Like *Haedropleura* but more slender and not operculate.

Megasurcula Casey, Trans. St. Louis Acad., vol. 14, 1904, p. 147 Founded on the recent *Surcula carpenteriana* and *tryoni* of Gabb. No type designated. Recent, California. +*Megalosurcula* Cossmann, 1906, Essais, p. 222. =*Cryptoconus* v. Koenen, 1867. Cossmann, Essais, p. 222, refers it to *Bathytoma*.

Melatoma Swainson, Mal., 1840, p. 342. Type, *M. costata* Swainson, Mal., 1840, p. 342, fig. 104. +*Clionella* Gray, Proc. Zool. Soc., 1847, p. 153. Not *Melatoma* Anthony, 1847.

Mesochilotoma Seeley, Ann. Mag. Nat. Hist., ser. 3, vol. 7, p. 284, 1861. Monotype *M. striata* Seeley, Ann. Mag. Nat. Hist., ser. 3, vol. 7, p. 284, 1861. Cretaceous. Equals *Surculites* Conrad, 1865, q. v.

Microdrillia Casey, Proc. Acad. Nat. Sci. Phila., 1903, p. 276. 1st sp. *Pl. cossmanni* O. Meyer (=*meyeri* Cossmann) Eocene. Cossmann, 1906, Essais, pp. 223–4, admits this as a section of *Asthenotoma*.

Microsurcula Casey, Trans. St. Louis Acad., vol. 14, 1904, p. 154. Type, *M. nucleola* Casey. Includes *Pl. georgei* Harris. (Woods Bluff.) Cossmann, Essais, p. 222, 1906, expresses no opinion as the type is unfigured.

Mitromorpha A. Adams, Ann. Mag. Nat. Hist., ser. 3, 1865, vol. 15, pp. 182 and 322. Type, *M. filosa* Carpenter, Ann. Mag. Nat. Hist., ser. 3, vol. 15, 1865, p. 182. Position doubtful, usually classed near the *Mitras*. See Iredale, Proc. Mal. Soc., vol. 12, p. 328, 1917.

Moniliopsis CONRAD, 1865, Amer. Journ. Conch., vol. 1, p. 143. Type, *Pl. elaborata* Conrad, 1832, Fos. Sh. Tert. form. 1, p. 52, pl. 17, fig. 19. Recalls *Surcula inermis* Carpenter but has a sutural band and much more emphatic and elegant sculpture. Conrad's figure is very inadequate.

Nannodiella DALL, 1918. Type, *N. nana* Dall.

Nicolia GREGORIO (not seen). Not *Nicolia* Malmgren, Verm. 1865.

Oenopota MÖRCH, Yoldi Cat., vol. 1, p. 78, 1852. 1st sp. *Pl. pleurotomaria* Couthouy. +*Onopota* H. and A. Adams, 1858, Gen., p. 654. + *Bela* auct. not (Leach MS.) Gray, 1847. =*Lora* Gistel, 1848.

Oligotoma BELLARDI, 1875, p. 235. Type, *O. meneghinii* Mayer. ?=*Pl. basteroti* Desmoulins, 1842. Not *Oligotoma* Westwood, 1836. See *Asthenotoma* Harris and Burrows, Eoc. and Olig. Paris, 1897, p. 48, new name for *Oligotoma* Bellardi preoccupied.

Onopota. See *Oenopota* Mörch.

Orthosurcula CASEY, Trans. St. Louis Acad., vol. 14, 1904, p. 151. Types named are *Pl. longiforma* Aldrich (Red Bluff) and *Surcula transversaria* Lamarck. Cossmann, 1906, Essais, p. 222, refers this to *Surcula* s. s.

? **Otitoma** JOUSSEAUME, 1898, Le Naturaliste, p. 106. Type, *O. otitoma* Jousseaume, Le Naturaliste, 1898, p. 106. Red Sea (not seen). ?=*Philbertia* Monterosato, 1884.

Otocheilus CONRAD, Amer. Journ. Conch., vol. 1, 1865, p. 24. Type, *Fulgoraria mississippiensis* Conrad, 1848. Eocene. Cited by Tryon Man., p. 159. This is placed by Tryon in Pleurotomidae but is really a synonym or section of *Lyria* in the Volutidae where Conrad placed it.

Oxyacrum COSSMANN, 1889, Cat. Illustr., p. 274; 1896, Essais Pal., p. 82. Type *Pl. obliterata* Deshayes. Eocene.

Paraclathurella BOETTGER, 1895, Nachrbl. d. Deutsche Mal. Ges., pp. 52, 56. Type, *Pl. gracilenta* Reeve,+*Pl. fusoides* Reeve. Philippines. Small slender Indopacific Clathurellas in the usually accepted sense.

Peratotoma HARRIS and BURROWS, 1891, Eoc. and Olig. Paris. p. 113, new name for *Homotoma* Bellardi, 1875, not Guerin-Méněville, 1829–38.

Perrona SCHUMACHER, Essai, p. 218, 1817. Type, *Murex perron* Chemnitz, Conch. Cab., vol. 10, figs. 1573–4, +*Perronia* Gray, Syn., 1842. +*Perronium* Blainville, Dict. Sci., 1825, vol. 38, p. 528. The type equals *P. tritonum* Schumacher, Essai, p. 218, 1817,+*Pleurotoma perronii* Reeve, 1843,+ *Murex perron* Gmelin, 1792.

Phandella CASEY, Proc. Acad. Nat. Sci. Phila., 1903, p. 272. Monotype, *P. nepionica* Casey, Proc. Acad. Nat. Sci. Phila., 1903, p. 272. Upper Vicksburgian. Cossmann, 1906, Essais, p. 223, suspends judgment for want of data.

Philbertia MONTEROSATO, Sin. Medit. 1884, p. 132. Type, *Pleurotoma bicolor* Risso.+*philberti* Michaud,+*purpurea* (Montagu) Bucquoy, Dautzenberg, and Dollfus, var. *bicolor*. *Heterotomatae* Bellardi, 1847, not *Heterotoma* Hartmann, 1844;+*Bellardia* Bucquoy, Dautzenberg, and Dollfus, 1882, not of Mayer, 1870; +*Bellardiella* Fischer, Man., Dec. 1883 (n. n. for *Bellardia*), not Tapp. Canefri, July, 1883, type, *Pl. gracilis*;+*Comarmondia* Monterosato, 1884, n. n. (p. 135) for *Bellardiella*;+*Clathurina* Melvill, Apr. 1917, type, *Pleurotoma foraminata* Reeve;+*Heterostoma* Cossmann, 1896, not of Bellardi, 1847. Group equivalent to *Clathurella* Auct. not Defrance. Mangiliinae. *Philbertia* has the outer lip thickened, lirate or dentate within when adult, pillar smooth, nucleus smooth, rather elevated and acute. Differs from *Glyphostoma* by smaller size, less brilliant surface, less fusiform profile, less contracted mouth and different nucleus.

Phlyctaenia COSSMANN, Cat. Illustr., 1889, p. 245. Type indicated *Borsonia nodularis* Deshayes. Eocene of Paris. Not *Phlyctaenia* Hübner, 1816. Lepidoptera. +*Phlyctis* Harris and Burrows, 1881, new name. Equals *Cordieria* Rouault, 1849.

Phlyctis Harris and Burrows, 1881, Eoc. & Olig. Paris, p. 113. New name for *Phlyctaenia* Cossmann, 1889, not Hübner, 1816. Equals *Cordieria* Rouault, 1849.

Pholidotoma Cossmann, 1896, Essais, pt. 2, p. 111. Type, *Fusus subheptagonus* Orbigny. This belongs to the Volutidae, near *Volutoderma* et al., though placed in Pleurotomidae by Cossmann.

Phymorhynchus Dall, 1908, Mus. Comp. Zool. Bull., vol. 43, p. 258. Type, *Pleurotomella castanea* Dall.

Pleurobela Kobelt, 1904, Icon. Eur., vol. 3, p. 301. Sect. of *Belomitra* for *B. spelta* (Monterosato) Locard. =*Pleurobela* Monterosato MS.

Pleurofusia Gregorio, Mon. Claib., p. 33, 1890. Type, *Pl. longirostropis* Gregorio, Mon. Claib., p. 33, 1890, a variety of *Pl. servata* Conrad. Species resemble a coarsely spirally sculptured *Fusinus*. Cossmann makes it a synonym of *Surcula* (*javana* type).

Pleuroliria Gregorio, Mon. Claib., p. 38, 1890. Type, *Pl. supramirifica* Gregorio, Mon. Claib., p. 38, 1890,=*Pl. cochlearis* Conrad, var. A *Pleurotoma*, type of *albida* Perry, but smaller, the nucleus multispiral and acute (Casey).

Pleurotoma Lamarck, Prodrome, 1799, p. 73. Monotype, *Murex babylonius* Linnaeus, Amboyna. +*Pleurotome* Link, Rostock Samml., 1807, p. 118. Same type.

Pleurotomella Verrill, 1873, Amer. Journ. Sci., ser. 3, vol. 5, p. 15. Type, *P. packardi* Verrill.

Pleurotomina Beck, Amtl. Ber. Nat., Kiel, 1846 (1847), p. 115; new name for *Defrancia* Millet not Bronn. *Bela impressa* Mörch, sole species.

Pleurotomoides Bronn, Ital. Tert. Geb., 1831; Lethaea Geogn., vol. 2, 1838, pp. 1062, 1064; new name for *Defrancia* Millet not Bronn.

Pontiothauma E. A. Smith, Ann. Mag. Nat. Hist., vol. 16, p. 2, 1894. 1st species, *P. mirabile* Smith. Malabar coast, 1,250 fathoms. Report on anatomy see S. Pace, Journ. Linn. Soc., Zool., vol. 28, p. 455, 1903.

Protosurcula Casey, Trans. St. Louis Acad., vol. 14, 1904, p. 144. Type, *Pl. gabbi* Conrad. Eocene, Texas. Cossmann, Essais, p. 221, 1906, unites this with *Surcula* (*javana*) s. s.

Pseudodaphnella Boettger, 1895, Nachrbl. d. Deutsche Mal. Ges., p. 58. Type, *Clathurella philippinensis* Reeve. Shell a good deal like an *Amphissa*.

Pseudomata v. Martens, Sitzb. d. Ges. für Naturf. Freunde zu Berlin, p. 19, 1901. Type, *Pl. chuni* v. Martens.

Pseudomelatoma Dall, 1918. Type, *Pl. penicillata* Carpenter.

Pseudoraphitoma Boettger, 1895, Nachrbl. d. Deutsche Mal. Ges., p. 56. Sole type, *Clathurella fairbanki* Nevill. A *Clathurella* with *Gemmula* sculpture and *Drillia*-like outer lip.

Pseudotoma Bellardi, Mon. Pl. 1875, p. 209. No type selected. 1st sp. *P. laevis* Bellardi, which is mentioned by Fischer, Man., 1883, p. 589. Dall, 1908, adopted *Pleurotoma intorta* Brocchi as type. In Bellardi's preliminary synopsis of Pleurotomidae, 1875, he mentions *Pl. intorta* as the type and it is the sole species given. Not *Pseudotomia* Stephens, 1852. Lepidoptera. Equals *Acamptogenotia* Rovereto, 1899, Syn., p. 3.

Pusionella Gray, Proc. Zool. Soc., 1847, p. 137. Type, *Murex pusio* Born, 1778. +*Netrum* Philippi, Abb., 1850, p. 118. *Fusus nifat* Adanson.

Raphitoma Bellardi (1847) Mon. Pleur., pp. 10, 84 (1875) no type fixed. Not *Raphitoma* Bellardi, 1878, Mon. Pleur., p. 323. where *vulpecula* Brocchi, which is a typical *Mangilia*, is cited by Bellardi as the type of the genus making it a synonym of *Mangilia*. *Raphitoma*, as first established, was very heterogeneous. In his preliminary synopsis Bellardi (1875) divides this group into two sections, I, type *R. vulpecula* Brocchi, and II, type *R. harpula* Brocchi. G. O. Sars, Norv., 1878, p. 218, tries to restrict *Raphitoma* (Bellardi) to spirally sculptured species. Type, *R. anceps* (Eichwald),=*Pl. boreale* Lovèn+*Defrancia teres* Forbes. The cancellate species he would leave in *Clathurella*. Cf. *Teres* Bucquoy, Dautzenberg, and Dollfus, also with *R. anceps* as type.

Rissomangilia MONTEROSATO, 1917, Bull. Soc. Zool. Ital., ser. 3, vol. 4, (separate copies, p. 24). Type, *Pl. bertrandi* Payraudeau. Mediterranean. =*Cytharella* Monterosato, 1875.

Rouaultia BELLARDI, 1877, Mon. Pl., pt. 2, p. 223. Type *Pl. subterebralis* Bellardi and Sismonda. 1 feeble plait on pillar, otherwise resembling *Gemmula*. This is *Cochlespira* Cossmann, 1896, not of Conrad. Cossmann, 1906, Essais, p. 221, unites *Cochlespiropsis* Casey (*engonata* Conrad) with *Rouaultia*.

Ruscula CASEY, Trans. St. Louis Acad., vol. 14, 1904, p. 161. 1st sp. *Pl. plicata* Lea, Claibornian. Cossmann, 1906, Essais, p. 223, suspends judgment in default of data.

Savatieria ROCHBRUNE and MABILLE, 1885, Bull. Soc. Phil. Paris, ser. 7, vol. 9, p. 101. Type, *S. frigida*, Rochbrune and Mabille; also Moll. Cap Horn., page II, 65, pl. 2, fig. 5, 1889. This, though referred to Pleurotimidae (sic), is obviously an *Anachis*. Not all the species referred to this genus by Strebel, Zool. Jahrb., 1905, are congeneric with the original type.

Scobinella CONRAD, Journ. Acad. Nat. Sci. Phila., ser. 2, vol. 1, p. 120, Aug., 1848. Type, *S. coelata* Conrad, pl. 12, figs. 8, 9. Vicksburg. +*Zelia* Gregorio, 1890, not Desvoidy, 1830. Shell with four or five plaits, more like a slender *Mitra* than a *Pleurotoma*.

Sinistrella O. MEYER, 1887, Senckenb. Ber., p. 18. Cossmann, Essais, pt. 2, p. 110. Type, "*Triforis*" *americanus* Aldrich. Eocene. Small, sinistral; spirally beaded. Cossmann (Essais, vol. 5, p. 120) regards it as a sinistral form of his *Trypanotoma*, 1893.

Sistenope COSSMANN, 1889, Cat. Illustr., p. 293. Essais, vol. 2, p. 133, 1896. Type, *Raphitoma polycolpa* Cossmann. Equals *Pleurotomella* Verrill, 1873, *fide* Cossmann, 1896.

Smithia, MONTEROSATO, Nom. Conch. Medit., 1884, p. 128. Monotype, *Pl. smithii* Forbes,=*striolata* Scacchi. +*Smithiella* Monterosato, 1890,=*Bela* s. s. Not *Smithia* Maltzan, 1883, nor of Edwards and Haime, 1851.

Smithiellia MONTEROSATO in Moll. Roussillon, vol. 2, p. 766, (1890?) 1908. New name for *Smithia* Monterosato, not Maltzan, 1883. Spelled *Smithiella* in Kobelt, Icon, Eur., vol. 3, p. 381, 1905.

Spergo DALL, Proc. U. S. Nat. Mus., vol. 17, p. 680, 1895. Type, *S. glandiniformis* Dall. Hawaii.

Spirotropis G. O. SARS, 1878, Moll. Reg. Arct. Norv., p. 242. Type, *S. carinata* Philippi.

Steiraxis DALL, 1895, Proc. U. S. Nat. Mus., 1895, p. 15. Type, *Pl.* (*St.*) *aulaca* Dall. Paucispiral operculum.

Strombina GREGORIO, 1890 (not of Bronn, 1849). Mon. Claib., p. 25. 1st sp. *Pl. stromboides* Lamarck. Equals *Gemmula* Weinkauff.

Suavodrillia DALL, 1918; type, *Drillia kennicottii* Dall. Alaska.

Subulata VON MARTENS, Sitzb. Ges. Naturf. Freunde zu Berlin, 1901, p. 17. *Pl. bisinuata* v. Martens. Off East Africa. Martens refers this to Anton, 1839, but Anton did not use the word in a nomenclatorial sense.

Surcula, see *Turricula*.

Surculina DALL, 1908, Mus. Comp. Zool., Bull., vol. 43, p. 260. Type, *S. blanda* Dall.

Surculites CONRAD, Amer. Journ. Conch., vol. 1, p. 213, 1865. Type, *S. annosa* Conrad, Amer. Journ. Conch., vol. 1, 1865, pl. 20, fig. 9, Shark River, N. J. Eocene. Doubtful shell; aperture characters not known, sharp angle at shoulder, sutural band, sculpture feeble.

Surculoma CASEY, Trans. St. Louis Acad., vol. 14, 1904, p. 153. Type, *Pl. tabulata* Conrad (+*coelata* Lea). Claibornian. Cossmann, Essais, p. 222, 1906, makes this a section of *Amblyacrum* with wider sinus, bent canal and siphonal fasciole with umbilical chink.

Taranis JEFFREYS, 1870, Ann. Mag. Nat. Hist., 4th ser., vol. 5, p. 447. Type, *T. mörchi* Malm.

Teleochilus HARRIS, Austr. Tert. Moll., 1897, p. 64. Type, *Daphnella gracillima* Tenison Woods, 1876. Tertiary of Australia. No sulcus. Shell somewhat like a thin *Dibaphus*.

Terebritoma COSSMANN, 1892, Annuaire Géologique. Type, *Mangelia solitaria* Whitfield. Cretaceous of Syria. Small, short canal, spirally corded.

Teres BUCQUOY, DAUTZENBERG, and DOLLFUS, Moll. Roussillon, vol. 1, p. 86, 1882. Type, *Pl. anceps* Eichwald. +*Teretia* Norman, new name, 1888. ?+*Tomopleura* Casey, 1904.

Thesbia JEFFREYS, 1867, Brit. Conch., vol. 4, p. 359. Type, *T. nana* Jeffreys ex Lovèn. *Tritonium ? nanum* Lovèn, Ind. Moll. Scand., p. 12. *Mangelia nana* Forbes and Hanley, vol. 3, p. 461, pl. 112, fig. 8. Shell columbelloid, resembling *C. rosacea* Gould, radula pleurotomoid.

Thetidos HEDLEY, Funafuti Moll. Mem. Austr. Mus., vol. 3 ,pt. 7, p. 473, 1899. Type, *T. morsura* Hedley, Funafuti Island.

Tomella SWAINSON, Man., p. 314, 1840. Type, *Pl. lineata* Lamarck.

Tomopleura CASEY, St. Louis Acad., 1904, p. 138. Type, *Pl. nivea* Philippi, 1851. =*Teres* Bucquoy, Dautzenberg, and Dollfus, 1882, p. 86, *Pl. anceps* Eichwald. +*Teretia* Norman, 1888, as emendation. *P. nivea* is unfigured, from the description it should resemble *albida* Perry, *virgo* Lamarck and similar species in sculpture but with a shorter canal, smaller size and more posterior notch. Cossmann, 1906, Essais, p. 220, refers this to *Drillia* s. s.

Trachelochetus COSSMANN, Cat. Illustr., p. 254 (1890 *fide* Zool. Record). Essais Pal., vol. 2. 1896. Type, *Pl. desmia* Edwards. Eocene. Equals *Gemmula* Weinkauff, 1875.

Tripia GREGORIO, Mon. Claib., p. 37, 1890. Type, *Pl. anteatripla* Gregorio, Mon. Claib., 1890, p. 38. Type, a small *Surcula*, feebly sculptured. In 1896, Cossmann refers it to *Crassispira* Swainson as synonym. Cossmann restores it to good standing, Essais, vol. 5, p. 188, 1903.

Tritonimangilia K. MARTIN, 1914, Leiden Samml. Geol. Reichmus., vol. 2, p. 126. Type, ————, Upper Oligocene, Java. (Not seen.)

Tropisurcula CASEY, Trans. St. Louis Acad., vol. 14, 1904, p. 153. 1st sp. *Drillia caseyi* Aldrich. (Red Bluff.) +*Tropidosurcula* Cossmann, em. Essais, 1906, p. 222. Cossmann expresses no opinion for want of data.

Trypanotoma COSSMANN (1893?) Essais, p. 109, 1896. Type, *Pl. terebriformis* O. Meyer, Eocene. Differs from *Oligotoma* (equals *Asthenotoma*) only by faint axial sculpture.

Turricula SCHUMACHER, Essai, p. 217, 1817. Type, *T. flammea* Schumacher.+ *tornatus* Dillwyn, 1817, not of Bolten, 1798. (Not *Clavatula flammea* Hinds, 1844.) +*Surcula* H. & A. Adams, Gen., 1853, vol. 1, p. 88. Type, *Murex javanus* Linnaeus. +*Surgula* Weinkauff, Conch. Cab., p. 7, 1875.

Turris BOLTEN, 1798, Mus. Bolt., p. 123. Type, *T. babylonius* Linnaeus. Not *Turris* Montfort, Conch., 1810. +*Pleurotoma* Lamarck, 1799, Prodr., p. 73. same type. +*Lophiotoma* Casey, 1904, p. 130, no type selected; 1st sp. *Pl. tigrina* Lamarck. +*Tomopleura* Casey, Trans. St. Louis Acad., 1904, p. 138, *P. nivea* Philippi.

Tylotia MELVILL, Proc. Mal. Soc., vol. 12, p. 160, 1917; type, *Pleurotoma auriculifera* Lamarck; new name for *Clavus* Auct., not of Montfort.

Typhlomangelia (M. Sars MS.) G. O. SARS. Moll. Norv., p. 241, 1878. Type, *Pl. nivalis* Lovèn. Pleurotominae.

Varicobela CASEY, Trans. St. Louis Acad., vol. 14, 1904, p. 162. Type, *Strombus smithi* Aldrich. (Red Bluff.) Cossmann, 1906, Essais, p. 223, suspends judgment for want of data.

Veprecula MELVILL, Proc. Mal. Soc., vol. 12, p. 141, 1917. No type mentioned; p. 188, type cited, *V. sykesii* Melvill and Standen.

Vielliersia MONTEROSATO, Nom. Conch., Medit., 1884, p. 128. Type, *Murex attenuata* Montagu, *Pl. viellicrsi* Michaud, 1829. (Typographical error for *Villiersia.*) Equals *Villiersiellia* Monterosato in Journ. de Conchyl., 1879, p. 117, 1890. Hardly differs from typical Mangilia. Not *Villiersia* Orbigny, 1837.

Villiersiella MONTEROSATO in Kobelt, Icon. Eur., vol. 3, p. 380, 1905. New name for *Viellicrsia* Monterosato, 1884, not of Orbigny, 1837. (*Villiersia.*)

Zafra A. ADAMS, 1860, Ann. Mag. Nat. Hist., vol. 6, p. 331. Not *Zafra* Cossmann, 1892. Type, *Z. mitraeformis* A. Adams. Columbella-like small forms. Cf. also *Teleochilus* Harris. The *Zafrae* seem to be ribbed, the *Teleochili* smooth or nearly so, recalling *Bela laevigata.*

Zelia GREGORIO, Mon. Claib., p. 44, 1890. Type, *Borsonia* (*Zelia*) *sativa* Gregorio. Pillar triplicate, outer lip internally lirate, exterior elegantly sculptured. Not *Zelia* Desvoidy, 1830.

Zetekia DALL, 1918; type, *Z. denticulata* Dall. Panama.

The following changes of names have been found necessary:

Pleurotoma sello new name for *biscriata* E. A. Smith, 1882, not of Conrad, 1834.

Pleurotoma aesara new name for *asperulata* E. A. Smith, 1882, not of Lamarck, 1822.

Pleurotoma aglaia new name for *crassa* E. A. Smith, 1888, not of Edwards, 1856.

Pleurotoma agatho new name for *flexuosa* E. A. Smith, 1882, not of Munster, 1835.

Pleurotoma alcippe new name for *parilis* E. A. Smith, 1888, not of Edwards, 1860.

Pleurotoma amymone new name for *parva* E. A. Smith, 1888, not of Conrad, 1830.

Pleurotoma antiope new name for *recta* E. A. Smith, 1888, not of Anton, 1839.

Pleurotoma arethusa new name for *reticulosa* E. A. Smith, 1882, not of Edwards, 1860.

Pleurotoma roseotincta new name for *roseobasis* Pilsbry, 1902, not of E. A. Smith, 1888.

Pleurotoma berenice new name for *spinosa* E. A. Smith, 1882, not of Defrance, 1826.

Pleurotoma clymene new name for *tenella* E. A. Smith, 1882, not of Mayer, 1858.

Pleurotoma enna new name for *unifasciata* E. A. Smith, 1888, not of Deshayes, 1833.

Pleurotoma glauce new name for *ventricosa* E. A. Smith, 1888, not of Deshayes, 1833.

DESCRIPTIONS OF NEW LEPIDOPTERA FROM MEXICO.

By Harrison G. Dyar,

Custodian of Lepidoptera, United States National Museum.

This is the sixth paper describing new species of Lepidoptera from Mexico.[1] Most of the material is from that sent for determination by Mr. Roberto Müller, of Mexico City, through the Bureau of Entomology, United States Department of Agriculture. A few species were left over from the previous donations of Mr. William Schaus and Mr. B. Preston Clark, referred to in my fifth paper.

The present paper comprises 117 new species, 12 new genera, 1 synoptic table, and 1 reference to synonymy.

Superfamily PAPILIONOIDEA.

Family RIODINIDAE.

Genus CHARIS Hübner.

CHARIS CRASPEDIODONTA, new species.

Fore wing with the margin incised between all the veins; hind wing with the incisions deeper, the veins forming points, with groups of spatulate scales lengthening them. Above, black; base of fringe white on both wings; hind wing with a little red at anal angle. Beneath, basal fourth of fore wing with red lines forming rings filled by black spots; then a gray space, irrorate with white scales; a median band of black, edged on both sides with red, touching two black, red-bordered spots at end of cell, with some blue scales between and beyond them; a submarginal gray space, irrorate with white; margin and the veins preceding, red, with two rows of blue spots, the inner surrounded by black. Hind wing with the marbling of red lines separating black spots reaching to two-thirds, some of the black spots with metallic blue; a gray submarginal space; margin as on fore wing. The blue spot in interspace 3–4 on both wings is retracted. Expense, 19 mm.

Type.—Female, Cat. No. 21197, U.S.N.M.; Presidio, Mexico, May, 1913 (R. Müller).

[1] The fifth paper is in Proceedings United States National Museum, No. 2139, vol. 51, 1916, pp. 1–37, where reference to earlier papers is given.

Genus IPIDECLA Dyar.

IPIDECLA MONENOPTRON, new species.

Wings above dark gray, the fore wing with a patch of metallic blue occupying nearly the basal half. Beneath, pale gray; fore wing with a black shade on costal half to end of cell; hind wing with the veins black-lined. Expanse, 18 mm.

Type.—Male, Cat. No. 21198, U.S.N.M.; Sierra de Guerrero, Mexico, February, 1913 (R. Müller).

Family LYCAENIDAE.

Genus THECLA Fabricius.

THECLA BUNNIRAE, new species.

Fore wing blackish, shaded with fulvous on basal two-thirds below cell. Hind wing with light fulvous shading nearly to margin; a fulvous spot at anal angle; tail at vein 2 long, at vein 3 short. Below, wing gray, slightly yellowish tinted; fore wing with a straight white line from costa to vein 2, edged within by fulvous gray. Hind wing with a faint white line at end of cell; an outer angled white line edged within with red, bent at vein 7, dislocated inward at the interspace 3–4, forming a slight W thence to margin; a terminal black line preceded by white from veins 1–2; a black spot at tornus with red before it; a powdery gray space; a black spot with orange crescent before it in the interspace 2–3. Expanse, 21 mm.

Type.—Cat. No. 21199, U.S.N.M.; Sierra de Guerrero, Mexico, February, 1913 (R. Müller).

THECLA VIGGIA, new species.

Black above; fore wing with a dark-blue shade below cell to three-fourths; hind wing blue nearly to the margin; tail at vein 2 short, at vein 3 long, with a white tip. Below whitish gray; fore wing with a faint, narrow, dark ellipse at end of cell; immediately beyond, a curved gray band, edged within by fulvous, not attaining costa or margin; an outer blackish line, white-edged within, bent at vein 5; median space more whitish than base or margin. Hind wing with the cell mark and band as on fore wing, the band with more red, angled on the veins, produced downward along vein 1, without red thence to margin; a submarginal light-gray line, lunate between the veins, extruded between veins 4–6; margin with rounded dusky spots between the veins; a black spot nearly enclosed by red in the interspace 2–3; a small black dot at tornus, with a little red before; black specks in the interspace 1–2. Expanse, 19 mm.

Type.—Cat. No. 21200, U.S.N.M.; Santa Rosa, Vera Cruz, Mexico, May, 1906 (W. Schaus).

THECLA NIPPIA, new species.

Fore wing blackish, shaded with light blue on basal third below cell and in cell to its end. Hind wing blue to vein 6; fringe white; a black terminal line; tail at vein 2 long, white margined and tipped; tail on vein 3 short, white. Below, white; fore wing with faint whiter outer line, dislocated at the veins. Hind wing with the outer line slender, blackish, edged without by white, forming a shallow W from vein 3 to margin; a faint submarginal line; a red spot in the interspace 2–3 with outer black center; a black and red speck at tornus. Expanse, 25 mm.

Type.—Female, Cat. No. 21201, U.S.N.M.; Sierra de Guerrero, Mexico, January, 1911 (R. Müller).

THECLA JANTHODONIA, new species.

Fore wing black, shaded with dark metallic blue below cell for two-thirds. Hind wing blue almost to the margin; tail at vein 2 long, black; at vein 3, short. Below, dark slate-gray; fore wing with a bluish white line from vein 9 to 2 just beyond cell, broken on the veins, and a similar fainter submarginal one. Hind wing with a blue dash below vein 8, one-third out; outer and submarginal lines approximated, similar, of bluish, edged respectively within and without with black, broken into spots by the veins; the outer line forms a confused W from vein 3 to the margin, running into the submarginal line; a large black space with blue scales at tornus to above vein 3; a black spot and red crescent in interspace 2–3. Expanse, 25 mm.

Type.—Cat. No. 21202, U.S.N.M.; Santa Rosa, Vera Cruz, Mexico, August, 1906 (W. Schaus).

THECLA VEVENAE, new species.

Wings black above, with dark blue luster, which reaches to the margin according to the light. No tails, the anal angle a little hairy. Beneath, shining dark green; fore wing gray along inner margin; hind wing with traces of an outer broken white line with blackish inner edging; a terminal black line on both wings, the fringe gray. Expanse, 21 mm.

Type.—Cat. No. 21203, U.S.N.M.; Misantla, Vera Cruz, Mexico, June, 1910 (R. Müller).

Near *T. semones* Godman and Salvin.

THECLA MURIDOSCA, new species.

Wings black; fore wing violet blue in and below cell to two-thirds. Hind wing tinged with blue below cell; a large patch of rough scales nearly covering cell, around which the color is gray. No tails, the anal angle a little hairy. Below glaucous green; fore wing brown where covered by the hind wing; hind wing with an irregular outer line, black within, whitish without, faint above vein 4; whole wing irregularly sprinkled with black scales, forming patches outwardly between the veins, most distinct in interspace 2–3. Expanse, 20 mm.

Type.—Cat. No. 21201, U.S.N.M.; Jalapa, Mexico (Schaus collection).

Family HESPERIIDAE.

Genus EBRIETAS Godman and Salvin.

EBRIETAS LACHESIS, new species.

Fore wing brown, with sparse sprinkling of yellow atoms; a large round black discal spot, with tiny hyaline speck in its upper corner; a single hyaline spot subcostally in interspace 8–9; an inner black spot in interspace 1–2; an outer row, faint, excurved over cell; margin black shaded. Hind wing with basal, median and outer black macular bands and margin black. Below, fore wing with the two hyaline dots repeated, white; bands faintly indicated; a double small yellow patch above tornus. Hind wing with anal angle broadly yellow to one-third of wing, the yellow continuing as median and outer rows of spots faintly to costa; fringe brown. Expanse, 34 mm.

Type.—Male, Cat. No. 21210, U.S.N.M.; Teapa, Tabasco, Mexico, December, 1913 (R. Müller).

Genus BUTLERIA Kirby.

BUTLERIA PENAEA, new species.

Bronzy black; fore wing with small pale yellow spots; a rounded spot in end of cell and elongate one below it under median vein; a spot in line beyond this in interspace 2–3, one outward in interspace 3–4 and two subapical. Hind wing with an elongate spot in cell and a curved row of three close together about middle of wing. Beneath fore wing with the spots repeated, a little enlarged. Hind wing with rather dense yellow irroration, the spots more numerous, whitish; one in cell; a mesial row of five, nearly in line; an outer row of seven, more irregular and smaller. Expanse, 19 mm.

Type.—Cat. No. 21211, U.S.N.M.; Sierra de Guerrero, Mexico, July, 1915 (R. Müller).

Genus CATIA Godman.

CATIA JOBREA, new species.

Fore wing bronzy black; costa broadly fulvous to two-thirds, just touching the three subapical fulvous spots; a cuneiform spot in interspace 3–4 and a small one as part of it in interspace 2–3. Male stigma large, from vein 1 to median, followed by rough scales from vein 1 to middle of interspace 1–2. Hind wing fulvous shaded over the disk, with traces of outer spots between veins 3 and 5. Below, fore wing fulvous above vein 2, the spots repeated; inner margin broadly blackish. Hind wing fulvous over yellow, with faint outer pale band on center of wing. Expanse, 23 mm.

Type.—Male, Cat. No. 21212, U.S.N.M.; Sierra de Guerrero, Mexico, May, 1913 (R. Müller).

The female lacks the fulvous costal shade and stigma.

Genus PRENES Scudder.

PRENES HEMIZONA, new species.

Black with bluish reflection; fore wing elongate, outer margin produced to vein 2; fringe from vein 2 to tornus, white; white spots as follows: A large cuneiform one in base of interspace 2–3; a quadrate one above it in cell; a curved row of five beyond cell, the one in interspace 3–4 quadrate, in 4–5 elongate. Hind wing with a white band with rounded ends between veins 3 and 7, yellowish at the ends; fringe white from vein 5 to tornus. Below, as above. Expanse, 40 mm.

Type.—Cat. No. 21213, U.S.N.M.; Mexico (R. Müller).

An old specimen, without exact data.

Genus THESPIEUS Godman.

THESPIEUS GAYRA, new species.

Brown-black, the spots dull yellow-hyaline; fore wing with two obliquely placed in end of cell; a row of three subapical ones, close together; an oblique row of four large ones, above vein 1, in interspace 2–3, very large, in 3–4 and 4–5. Hind wing with a diffused spot in cell; an outer row of four closely placed spots in a straight line; fringe pale yellowish. Below, fore wing as above, the spot in interspace 1–2 diffused. Hind wing purplish shaded, the spots repeated; a brown band at middle of wing between veins 1 and 8 and an outer band between 1 and 7, the tornal area dark brown. Expanse, 40 mm.

Type.—Cat. No. 21214, U.S.N.M.; Naranjo, Guerrero, Mexico, 3,000 feet, August, 1906 (W. Schaus).

A second specimen from Mr. Müller, without data, but presumably from Sierra de Guerrero.

Genus LEREMA Scudder.

LEREMA HYPOZONA, new species.

Bronzy black; fore wing with a row of pale yellow spots; one above vein 1, one in interspace 2–3 quadrate, in 3–4, two beyond cell, small and extruded, three small subapical. Hind wing yellowish over the disk. Below, washed with whitish; fore wing with the spots repeated, except that above vein 1. Hind wing much washed with whitish, except toward apex; a broad, median, curved, whitish band between veins 2 and 8. Expanse, 24 mm.

Type.—Cat. No. 21216, U.S.N.M.; Sierra de Guerrero, Mexico, February, 1916 (R. Müller).

Genus PADRAONA Moore.

PADRAONA SOPHISTES, new species.

Brownish black, marked with fulvous; fore wing with a band along costa to end of cell, forming a bar in upper half of cell, obliquely cut at its end by the radial nervules; a band along inner margin to two-thirds, joining the outer band that narrows above, is indented at end of cell and ends at vein 7; fringe fulvous. Hind wing with the inner area broadly fulvous, joining a broad outer band that ends at vein 7; fringe fulvous. Below, fore wing shaded with fulvous at apex, marks repeated. Hind wing all fulvous, the dark parts above showing by transparency. Expanse, 24 mm.

Type.—Cat. No. 21217, U.S.N.M.; Misantla, Vera Cruz, Mexico, November, 1908 (R. Müller).

PADRAONA INCULTA, new species.

Black, fringe touched with fulvous; fore wing with a fulvous shading along costa; an outer oblique band, cut by the veins, curved over cell and dissolved into spots, leaving a subapical row of three. Hind wing with a discal band between veins 2 and 6, and slight fulvous shading on inner area. Below, washed with yellow; fore wing with a large yellow discal spot; costa yellow; a black discal dot; inner margin black, running up into the cell on basal half. Hind wing yellow, the veins yellow; a dusky marginal band, outlining an enlarged repetition of the discal band above, yellow. Expanse, 27 mm.

Type.—Cat. No. 21218, U.S.N.M.; Mexico (R. Müller).

A specimen without exact data.

Superfamily BOMBYCOIDEA.

Family SYNTOMIDAE.

Genus ICHORIA Butler.

ICHORIA LEUCOPUS, new species.

Fore wing hyaline, the veins and margins black, a little broader at apex; a large black discal spot. Hind wing hyaline with black veins and narrow margin. Body black; a crimson spot at base of patagia and narrow band at base of abdomen above; feet black, the hind tarsi white above. Expanse, 21 mm.

Type.—Female, Cat. 21219, U.S.N.M.; (R. Müller).

A specimen without exact data.

Family ARCTIIDAE.

Genus PERICALLIA Hübner.

PERICALLIA PANNYCHA, new species.

Fore wing slaty black; hind wing deep blue-black. Body blue-black, some crimson scales as bases of tegulae and behind the eyes. Expanse, 41 mm.

Type.—Female, Cat. No. 21220, U.S.N.M.; Mexico (R. Müller). A specimen without exact locality.

With *hodeva* Druce, this represents the large old world genus *Pericallia;* but they are not in the least like them in appearance.

Family AGARISTIDAE.

MELANCHROIOPSIS, new genus.

Fore wing with vein 2 arising beyond two-thirds of the cell, 3–5 near its end, 6 from the upper angle, 7–10 stalked from the end of accessory cell, 11 on accessory cell. Hind wing with vein 2 before end of cell, 3–4 at the end, 5 from middle of cross vein, 6–7 at apex of cell, 8 anastomosing very shortly near base.

Type of the genus.—*Melanchroiopsis acroleuca*, new species.

MELANCHROIOPSIS ACROLEUCA, new species.

Black; pectus, long hairs on second joint of palpi, border about front, occiput, border to tegulae and tip of abdomen orange-brown; fore wing bluish black, the veins slaty black; apex white. Hind wing blue-black with white fringe. Beneath, a whitish ray on submedian fold of fore wing and on submedian and discal folds of hind wing. Expanse, 45 mm.

Type.—Male, Cat. No. 21221, U.S.N.M.; Sierra de Guerrero, Mexico, June, 1915 (R. Müller).

Family NOCTUIDAE.

Subfamily AGROTINAE.

Genus MESEMBREUXOA Hampson.

MESEMBREUXOA MELANOPIS, new species.

Head, thorax, and fore wing soft light gray; marks slender, blackish; inner line slight, coarsely wavy; claviform narrow, touching the inner line, neatly outlined; orbicular an ellipse with central black dot; reniform very large, elliptical, excavate without, with black lunate central line and some dark suffusion in lower part; outer line crenulate-dentate, with black and whitish points on the veins; no subterminal line; a terminal black line, broken on the veins. Hind wing sordid whitish, slightly fuscous shaded; veins dark. Expanse, 35 mm.

Type.—Male, Cat. No. 21222, U.S.N.M.; Mexico (R. Müller).

A specimen without exact locality.

Genus EUXOA Hübner.

EUXOA DISCILINEA, new species.

Light gray; fore wing with the reniform separated into two cusps, the inner more angled and forming part of a distinct median blackish shaded line across wing; orbicular round, vague, whitish; traces only of inner and faint outer line, blackish, the outer crenulate; blackish shadings separated by gray along the inner third of wing; a dark narrow crenulate terminal line. Hind wing gray, fringe white. Expanse, 35 mm.

Type.—Female, Cat. No. 21223, U.S.N.M.; Mexico City, Mexico, September, 1915 (R. Müller).

EUXOA PARSIMONIA, new species.

Dark brown; fore wing slightly violaceous; a creamy brown costal band between the lines, involving the subcostal vein; two creamy lines on costa near base; inner line double, black, dentate on the veins; claviform a black blur; orbicular a creamy ringlet; reniform creamy, filled with brown; outer line black, crenulate, retreating on costa and shortly angled; a pale dentate subterminal line close to margin. Hind wing brownish, veins and margins broadly dark. Expanse, 35 mm.

Type.—Male, Cat. No. 21224, U.S.N.M.; Zacualpan, Mexico, October, 1915 (R. Müller).

Subfamily HADENINAE.

Genus NEPHELESTIS Hampson.

NEPHELESTIS SABATTA, new species.

Fore wing dark brown, a little purplish, shading to bronzy on the darker markings; inner and outer lines purplish, paler than the ground, straight but not rigid, the outer slightly outflexed at cell; median space dark-filled; reniform and orbicular large, narrowly confluent, pale-ringed, filled with dark purplish, the orbicular oblique, the reniform kidney-shaped; marginal area dark purple; subterminal line bronzy brown, broad, forming a projection at vein 3, not attaining costa. Hind wing sordid pale, shaded with dark fuscous on the veins, discal dot and margin. Expanse, 27 mm.

Type.—Female, Cat. No. 21225, U.S.N.M.; Zacualpan, Mexico, September, 1914 (R. Müller).

EUMÜLLERIA, new genus.

Eyes large, round, hairy, not overhung by long cilia; tibiae and tarsi unarmed; front full, without prominence; tegulae not ridge-like; tongue well developed; vestiture of the thorax wholly of narrow scales; abdomen without dorsal crests.

Type of the genus.—Eumülleria cliopis, new species.

EUMÜLLERIA CLIOPIS, new species.

Fore wing dark purplish, rather evenly mottled with blackish spots, which are the fragments of the ordinary lines; a pale dot at base of costa, an angle representing the inner line, a dot for outer line and three subapical dots; claviform small, black; orbicular circular, black, outlined in olive-yellow; reniform large, flat without, black, outlined in olive-yellow; an olive-yellow subterminal line, distinct, angled inwardly subcostally and on discal and submedian folds. Hind wing brownish gray, with faint discal dot. Expanse, 29 mm.

Type.—Male, Cat. No. 21226, U.S.N.M.; Mexico (R. Müller).

A specimen without exact locality.

Genus TIRACOLA Moore.

TIRACOLA NONCONFORMENS, new species.

Fore wing dark brown, finely sprinkled with minute white scales; reniform small, circular, yellow-brown; subterminal line pale, near margin, darker edged outwardly, slightly flexuous, widened subcostally; other lines illegible, except the outer on its lower portion, forming an arc of dark brown between veins 1 and 2. Hind wing dark brown, almost as dark as fore wing except over base and fringe where pale brownish appears. Anal tuft of male partly of dull ocherous hairs. Expanse, 31 mm.

Type.—Male, Cat. No. 21227, U.S.N.M.; Mexico (R. Müller).

A specimen without exact locality.

Genus HYDROECIODES Hampson.

HYDROECIODES ASPASTA, new species.

Light creamy brown; fore wing with the stigmata large, full, pale filled, with narrow obscure brown outlines, all similar; inner and outer lines single, dark, nearly straight, dentate on vein 1; a dark median shade line; margin dark, preceded by a vague pale irregular subterminal line; a terminal black line. Hind wing translucent pale grayish, with discal dot and terminal line. Expanse, 29 mm.

Type.—Female, Cat. No. 21228, U.S.N.M.; Chiapas, Tabasco, Mexico, May, 1915 (R. Müller).

HYDROECIODES POTHEN, new species.

Thorax and fore wing reddish brown, the basal half of fore wing more reddish; lines obscure, the inner and median as dark shades; outer preceded by a dark shade, itself whitish, obscurely crenulate on the veins; terminal space dark, preceded by a broken yellowish subterminal line; scattered white scales over wings, forming four dots on terminal half of costa and points at the ends of the veins; reniform an indefinite powdery white area. Hind wing translucent pale grayish, with dark veins, discal dot and terminal line; anal area gray; costa yellowish. Expanse, 27 mm.

Type.—Male, Cat. No. 21229, U.S.N.M.; Mexico (R. Müller).

The specimen without exact locality.

Genus CHABUATA Walker.

CHABUATA SYGCLETA, new species.

Clayey brown, shaded with red-brown, leaving the costa and fillings of the lines paler; terminal space narrowly blackish, as is the fringe; reniform narrow, elliptical, black-ringed and black-centered, white outwardly and sending a white spur close to vein 5; a black dash at base; orbicular pale, with black central spot; lines indistinct, doubled, the wing mottled with brown; many short black dashes along costa. Hind wing sordid whitish over the disk; veins and apex broadly blackish; fringe with pale basal interline. Expanse, 24 mm.

Type.—Male, Cat. No. 21230, U.S.N.M.; Zacualpan, Mexico, September, 1914 (R. Müller).

CHABUATA IOTA, new species.

Brown, rather dark; lines not contrasted; inner line single, angled on median vein; claviform a slight angle; orbicular large, round. slightly more reddish; a faint median dark shade, bent in cell; reniform elliptical, slightly paler filled, leaving a narrow line of bright white and two dots on its outer edge and a dot on the inner angle; outer line slender, dark, excurved over cell; subterminal space slightly more reddish; terminal space the darkest part of wing, bordered by a slender, slightly irregular subterminal dark line. Hind wing dark gray, a little lighter over disk, with faint discal spot. Expanse, 26 mm.

Type.—Female, Cat. No. 21231, U.S.N.M.; Zaculapan, Mexico, September, 1914 (R. Müller).

Genus ERIOPYGA Guenée.

ERIOPYGA CONSTANS, new species.

Light gray; fore wing with orbicular and reniform large, full, filled with dark gray, pale-outlined; lines obscure in male, more distinct in female, double, pale-filled; inner forming little arcs between the veins; outer resolved into a series of black points along the veins, distinct only on costa; subterminal line pale, irregular, preceded by a dark shade; terminal space slightly darker-shaded. Hind wing overspread with dark gray, the disk lighter, especially in the male; fringe whitish; discal spot dark. Expanse, 29 mm.

Type.—Male, Cat. No. 21232, U.S.N.M.; Mexico (R. Müller).

Also a male and female, all without definite locality, the female labelled in Schaus's writing: "*Eriopyga melanopis* Hps. Subsp.;" but I think it is distinct.

ERIOPYGA PHANEROZONA, new species.

Fore wing gray, irrorate with black; lines distinct, straightened, without crenulation, of pale luteous with powdery dark edges; inner upright, curved only at costa, far out, touching the orbicular; outer line curving over cell; subterminal line similar to the others, nearly straight; orbicular and reniform scarcely darker than the ground, pale-outlined. Hind wing soiled whitish, gray shaded on the margin, veins and discal dot; fringe white. Expanse, 27 mm.

Type.—Female, Cat. No. 21233, U.S.N.M.; Tehuacan, Mexico, June, 1910 (R. Müller).

Labelled in Hampson's writing: "*Eriopyga melanopis* Hmpsn. ♀ Subsp. 1;" but I think it is distinct.

ERIOPYGA PANSAPHA, new species.

Light purplish gray; fore wing smooth, with sparse black irrorations; lines double, blackish, filled by the ground color, appearing as double rows of spots dots, the outer distinctly resolved into dots, the inner showing the crenulations; claviform invisible; orbicular of the ground color, dotted-outlined in black; reniform similar, but with little white specks in the outer edge; subterminal line lost. Hind wing subhyaline sordid, veins and margin narrowly brown-gray. Expanse, 28 mm.

Type.—Male, Cat. No. 21234, U.S.N.M.; Mexico (R. Müller).

ERIOPYGA CACOEONA, new species.

Dark gray; fore wing with a black line at base, forked at its tip; inner line coarsely angled, double, dark, paler-filled; claviform a black streak; orbicular pale, dark edged; a black median shade-line, angled in cell; reniform quadrate, black-edged, especially inwardly, paler-filled, but a little blackish-clouded and with a black mark on vein 3; outer line pale, the black inner edge distinct, a little wavy, running in on costa; subterminal space concolorous in the male, darker in the female; subterminal line black, irregular and rather sharply toothed; a terminal black line, followed by pale dots on the fringe at the ends of the veins. Hind wing dark fuscous, broadly pale on the disk in the male; fringe with the outer half whitish. Expanse, male 27 mm.; female, 24 mm.

Type.—Male, allotype, female, Cat. No. 21235, U.S.N.M.; Mexico City, Mexico (R. Müller).

Genus LOPHOCERAMICA Dyar.

LOPHOCERAMICA SIMPLICIFACTA, new species.

Thorax and fore wing dark purplish brown, sprinkled with a few white scales, most thickly toward margin; lines indistinct broad dark brown shades, the inner and outer showing traces of crenulations, the median broader; stigmata lost, the reniform faintly indicated in pale; a row of white terminal points at the ends of the veins. Hind wing brown, dark, lighter at base, especially in the male; a faint discal dot in the male; a pale line in base of fringe. Expanse, male, 31 mm.; female, 34 mm.

Type.—Male, allotype, female, Cat. No. 21236, U.S.N.M.; Orizaba, Mexico, October, 1913, and November, 1907 (R. Müller).

Subfamily ACRONYCTINAE.

Genus ACRONYCTA Ochsenheimer.

ACRONYCTA YBASIS, new species.

Whitish gray; a purple-brown shade in subterminal space as far up as vein 5; a strong black bar in base on submedian space, forked at end; a dash on submedian and discal folds across subterminal and terminal spaces; inner line indistinct and confused, much waved; orbicular and reniform large, pale, black-ringed, and black-centered; a median line, distinct and double on the costa; outer line black, double, the parts well separated, strongly excurved over cell; a row of terminal black dots between the veins. Hind wing white, washed with dark fuscous; discal dot, traces of outer line and terminal shade dark; terminal dots as on fore wing. Expanse, 29 mm.

Type.—Female, Cat. No. 21237, U.S.N.M.; Mexico (R. Müller).

ACRONYCTA FUMEOLA, new species.

Purplish gray, banded with blackish; bands subbasal, median and subterminal; ordinary lines narrow, black, between the dark shades; inner line dentate, dislocated in cell; outer line excurved over the reniform, touching it below, suffused with whitish irroration; reniform large, black-ringed, with whitish scales edging the ring within; a terminal black line; fringe mixed with pale scales. Hind wing soiled fuscous, shaded darker at the margin; fringe pale. Expanse 23 mm.

Type.—Female, Cat. No. 21238, U.S.N.M.; Mexico (R. Müller).

FOTOPSIS, new genus.

Fore wing without accessory cell; veins 7–10 stalked; front conically produced, rounded; abdomen without crests; palpi obliquely upturned; fore wing with the apex pointed.

Type of the genus.—Fotopsis sparganiotis, new species.

FOTOPSIS SPARGANIOTIS, new species.

Fore wing gray with a brownish ocher shade through cell, running out to subterminal area between veins 3–5; many black dots, the veins black-lined terminally; inner line broken into scattered dots, with dots along subcostal and median veins; a dot far out for orbicular; reniform small, yellowish outlined, brown filled; outer lines resolved into black dashes on the veins; white points at projection of brown area; black terminal marks between the veins: Hind wing pale at base, gray-brown outwardly; veins and terminal line dark. Expanse, 25 mm.

Type.—Male, Cat. No. 21239, U.S.N.M.; Sierra de Guerrero, Mexico, June, 1913 (R. Müller).

BOUDA, new genus.

Fore wing with accessory cell; tongue absent; legs unarmed; front without prominence; abdomen without crests; thoracic vestiture chiefly of scales; hind wing with vein 8 anastomosing with cell near base only; thorax without crests; palpi oblique, the third joint porrect or upturned; veins 3–4 of hind wings separate, 5 somewhat below the middle of the cross-vein.

Type of the genus.—Bouda pallipars, new species.

BOUDA PALLIPARS, new species.

Fore wing gray, the subbasal space broadly and conspicuously pale, with greenish tint; basal line black, indenting the pale space on submedian fold; inner line black, also dented on submedian fold; a dark shade beyond it; a white point at end of the obsolete claviform; one white point with black edge for orbicular, two points for reniform, with a black patch beyond; outer line black, denticulate, excurved over cell; a shaded irregular subterminal line; fringe checkered black and white. Hind wing dark gray. Expanse, 20 mm.

Type.—Male, Cat. No. 21240, U.S.N.M.; Mexico City, Mexico (R. Müller).

Another specimen bears the date April, 1914.

BOUDA HIDALGONIS, new species.

Fore wing pale green; marks black, rather coarse; subbasal line angular; inner line black, dentate on submedian space, the thick solid claviform adhering to it; orbicular a black spot; reniform large, clouded, with two white specks at its inner edge, filling out the angle of the outer line, which is angled below on submedian fold; an irregular subterminal line; terminal black dashes, followed by pale green dashes in the fringe. Hind wing dark gray. Expanse, 21 mm.

Type.—Male, Cat. No. 21241, U.S.N.M.; Guerrero Mill, Hidalgo, Mexico, altitude 9,000 feet (Mann and Skewes, gift of B. Preston Clark).

PUMORA, new genus.

Fore wing with an accessory cell; fore tibia with large stout claw on the inner side; front with corneous process with raised edges and central process, the process touching the edge below, which is drawn in somewhat heart-shaped; proboscis long; eyes large; thorax roughly scaled, but apparently not crested, the patagia not curled.

Type of the genus.—*Pumora hyperion*, new species.

PUMORA HYPERION, new species.

Head and thorax orange yellow; abdomen brown dorsally, dark orange at base, tip and venter. Fore wing bronzy black; a broad orange-yellow central band, cut by the black costal edge, widening below, its inner edge more oblique than the outer. Hind wing bronzy black. Beneath, bronzy black. Expanse, 19 mm.

Type.—Female, Cat. No. 21242, U.S.N.M.; Cuernavaca, Mexico, September, 1914 (R. Müller).

Genus CHALCOPASTA Hampson.

CHALCOPASTA CHALCOPHANIS, new species.

Male antennae serrate; frontal process sessile; wings rather broad. Fore wing greenish metallic golden; costa brown, widening beyond cell and cream color there, a narrow projection at basal third of cell; reniform brown, confluent with costal area, with kidney-shaped brown line; a brown patch at base on inner margin; fringe brown and cream color; a row of faint brown submarginal spots between the veins. Hind wing pale cream color. Expanse, 34 mm.

Type.—Male, Cat. No. 21243, U.S.N.M.; Mexico City, Mexico, August, 1909 (R. Müller).

CHALCOPASTA ANOPIS, new species.

Male antennae serrate; frontal process produced; wings rather narrow. Fore wing greenish metallic golden; costa cream color with brown scales, widening a little beyond cell, a toothlike projection at basal third of cell; reniform cream color and brown, confluent with costal area; a cream-color and brown patch at base on inner margin; fringe brown and cream color, a row of faint brown submarginal spots between the veins. Hind wing creamy white. Expanse, 30 mm.

Type.—Male, Cat. No. 21244, U.S.N.M.; Cuernavaca, Mexico, September, 1914 (R. Müller).

This species and *chalcophanis* differ from *territans* Hy. Edwards in the absence of any gold in the reniform. The two here described are closely allied but seem distinct in the details of structure cited.

Genus NOCLOA Smith.

NOCLOA LAMIOTA, new species.

Fore wing bright yellow; a shade of dark brown at base on costal half, running out obliquely below orbicular to touch outer line at submedian fold; inner line brown, double, strongly dentate on vein 1 and median vein; orbicular and reniform large, irregularly circular, outlined in brown; outer line excurved gently above, brown, single, dentate on vein 1; wing irrorate with red-brown, densest marginally, defining faintly a subterminal line; a dark brown line in base of fringe. Hind wing whitish, with terminal brown line; fringe faintly brown. Expanse, 23 mm.

Type.—Male, Cat. No. 21245, U.S.N.M.; Cuernavaca, Mexico, November, 1914 (R. Müller).

NOCLOA BEATA, new species.

Fore wing white, irrorate with brown; markings in chocolate brown; base brown on costa and submedian space; inner line forming three arcs, enclosing two oval white spaces, cut by a fine brown line; a broad bar for claviform between inner and outer lines; orbicular and reniform large, full, brown outlined, and with duplicating central rings; median line from reniform to inner margin; outer line crenulate, excurved over cell, defining a white lunule in interspace 1–2, followed by a faint duplication; subterminal line fine, dentate; a terminal line; fringe spotted. Hind wing white, with brown terminal line. Expanse, 30 mm.

Type.—Male, Cat. No. 21246, U.S.N.M.; Zacualpan, Mexico, October, 1915 (R. Müller).

Genus STIRIA Grote.

STIRIA INTERMIXTA, new species.

Head and collar yellow; thorax purple and gray. Fore wing yellow, with gray-brown markings; an oval patch at base of vein 1; a small square patch on middle of inner margin; a terminal border, wide in the middle and including the fringe; traces of broken outlines of orbicular and reniform; a narrow outer line, not reaching costa, and superposed spots before tornus below vein 2. Hind wing whitish over the disk, the costa and outer margin with broad gray-brown border; fringe pale, with brown interline. Expanse, 37 mm.

Type.—Male, Cat. No. 21247, U.S.N.M.; Zaculapan, Mexico, August, 1915 (R. Müller).

Allied to *S. ischune* Dyar, but differing in the color of the hind wings and size of the spot on inner margin of fore wing.

NEOPHAEUS, new genus.

Fore wing with accessory cell; fore tibia with a large claw on inner side; head with a corneous plate with raised edges and central process, not on the front, but on the anterior part of vertex; tongue well developed; eyes large, round; thorax with rough scales; palpi sharply upturned, much exceeding the vertex.

Type of the genus.—*Neophaeus chalcospilans*, new species.

NEOPHAEUS CHALCOSPILANS, new species.

Fore wing with the apex pointed; outer margin concave above; bronzy brown, irrorate with white; a single outer line, slender, brown, bent at right angles on vein 7. Hind wing silky whitish; costal half and outer border shaded with light brown. Expanse, 31 mm.

Type.—Female, Cat. No. 21298, U.S.N.M.; Mexico (R. Müller).

Genus ANTAPLAGA Grote.

ANTAPLAGA VARRARA, new species.

Thorax and fore wing greenish yellow with slight fuscous tint. Hind wing uniform dark fuscous. Expanse, 24 mm.

Type.—Male, Cat. No. 21248, U.S.N.M.; Tehuacan, Mexico, September, 1913 (R. Müller).

ANTAPLAGA ALESAEA, new species.

Fore wing and thorax white. Hind wing sordid white; a faint fuscous outer border. Below, fore wing dark fuscous, except costa. Hind wing sordid white. Expanse, 20 mm.

Type.—Female, Cat. No. 21249, U.S.N.M.; Guerrero, Mexico, August, 1916 (R. Müller).

The following table will separate the species of *Antaplaga* which have the fore wings without markings:

- Thorax orange.
  - Smaller; no fuscons suffusion ---------- *thoracica* Hy. Edwards.
  - Larger; with fuscous suffusion ---------- *suffumosa* Dyar.
- Thorax concolorous with fore wing.
  - Fore wing orange or greenish.
    - Hind wing pale; disk slightly dusky.
      - Cilia orange ---------- *salacon* Druce.
      - Cilia pale ---------- *composita* Hy. Edwards.
    - Hind wing fuscous except on costa.
      - Fore wing yellow; hind wing of male pale on disk ---------- *dulcita* Schaus.
      - Fore wing greenish yellow; hind wing all fuscous ---------- *varrara* Dyar.
  - Fore wing white.
    - Hind wing black-brown ---------- *pyronaca* Druce.
    - Hind wing white, the edge gray ---------- *alesaea* Dyar.

Subfamily ERASTRIINAE.

Genus COBUBATHA Walker.

COBUBATHA RUSTICA, new species.

Fore wing pinkish brown, shaded with gray; subbasal line faint, whitish; inner line similar, more distinct; space between these plumbeous gray; outer line white, nearly straight, shaded with plumbeous beyond; middle space dark red-brown, with a little patch of this color just beyond the outer line, representing the reniform; subterminal line whitish, dentate irregularly, preceded by a little plumbeous. Hind wing pale at base, dark gray outwardly; fringe pale. Expanse, 16 mm.

Type.—Female, Cat. No. 21250, U.S.N.M.; Cuernavaca, Mexico, January, 1915 (R. Müller).

Genus OZARBA Walker.

OZARBA IMPLORA, new species.

Fore wing blackish brown; subbasal line showing a white point on costa; inner line with two white points on costa, else broken and nearly obsolete; outer line with two strong teeth opposite cell, white, even; a slender black median line, coarsely angled; reniform outlined in white within, powdery without; some black beyond teeth of outer line in submarginal space, and three white dots on costa; a slender white irregularly angled subterminal line; small terminal black dashes. Hind wing blackish fuscous, with narrow black terminal line. Expanse, 17 mm.

Type.—Male, Cat. No. 21251, U.S.N.M.; Zacualpan, Mexico, August, 1915 (R. Müller).

OZARBA SQUAMICORNIS, new species.

Antennae of male thickened with black scales above to three-fourths. Fore wing olive, shaded with red-brown on costa, margin and fringe; an oval green discal spot without margins, inside the reniform, which shows as a black speck; inner, median and outer lines slender, brown, wavy, the outer doubled above and excurved somewhat over cell; a faint subterminal shaded dark line; fringe with black specks, especially one just below apex and at anal angle. Expanse, 20 mm.

Type.—Male, Cat. No. 21252, U.S.N.M.; Mexico (R. Müller).

Genus LITHACODIA Hübner.

LITHACODIA SUBSTELLATA, new species.

Fore wing yellowish white, thickly irrorate with brown; lines pale, only the outer legible, wavy, excurved over the cell; reniform of two white points, lower larger and distinct; a broken brown terminal line; base of fringe yellowish with brown interline. Hind wing slightly paler than fore wing, evenly irrorate; fringe as on fore wing. Expanse, 22 mm.

Type.—Female, Cat. No. 21253, U.S.N.M.; Zacualpan, Mexico, August, 1915, (R. Müller).

Near *L. albidula* Guenée.

Genus EUSTROTIA Hübner.

EUSTROTIA DELTOIDALIS, new species.

Fore wing dark brown, irregularly faintly shaded with red, most distinctly subapically; lines black; inner line angled; median line straight, shaded; outer line excurved over cell; orbicular round, reniform elliptical, both solid, black; a shaded subterminal line close to margin; terminal line fine, black, crenulate, with whitish points in the incisions. Hind wing fuscous, pale at base; an outer dark line on inner half; terminal line as on fore wing; fringe reddish. Expanse, 19 mm.

Type.—Male, Cat. No. 21254, U.S.N.M.; Zacualpan, Mexico, March, 1915 (R. Müller).

Genus DIASTEMA Guenée.

DIASTEMA DOSCELES, new species.

Fore wing with a broad creamy area from base, shading to blackish on costa, cut by dark median vein and vein 1 outwardly, ending in two arcs, of the large rounded claviform and orbicular; inner line pale, double, of three arcs, crossing the pale basal area near its end; median space narrow, filled with olive and black; reniform large, cream-color, with an inner brown concentric ring, and dark shading on its inner half; a narrow creamy area before the outer line, which is double, slender, black, excurved over reniform and running inward subcostally; subterminal line a black shade, wide on costal third and forming an outward projection at vein 7; a broken black terminal line; fringe with pale interline; hind wing creamy yellowish, with dark outer shade-line, widest at apex. Expanse, 27 mm.

Type.—Male, Cat. No. 21255, U.S.N.M.; Zacualpan, Mexico, June, 1915 (R. Müller).

Subfamily HYPENINAE.

Genus MARGIZA Schaus.

MARGIZA PARTITALIS, new species.

Fore wing creamy brown for two-thirds, the terminal third dark purplish brown; inner and outer lines slender, black, coarsely crenulate, broken into dots; a pale point for orbicular; reniform a trace;

a black subapical spot in the purple border, with a little light color above it. Hind wing sordid whitish at base, with broad purple outer border; traces of an outer dark line; black terminal dots between the veins on both wings. Expanse, 22 mm.

Type.—Female, Cat. No. 21256, U.S.N.M.; Coatepec, Mexico, May, 1914 (R. Müller).

MARZIGETTA, new genus.

Fore wing without accessory cell; veins 8–10 stalked, 11 free; apex of fore wing acute; palpi of female obliquely ascending, the end joint porrect, about two times the length of head.

Type of the genus.—*Marzigetta obliqua*, new species.

MARZIGETTA OBLIQUA, new species.

Fore wing brown, irrorate with black; a red shade in median space; lines pale, followed by blackish shades; inner line straight, oblique, from inner third of inner margin to outer third of costa; submarginal line parallel to outer margin, a little wavy; terminal space dark; a row of black dots between the veins. Hind wing dark fuscous, pale at base. Expanse, 18 mm.

Type.—Female, Cat. No. 21257, U.S.N.M.; Mexico (R. Müller).

Genus MASTIGOPHORUS Poey.

MASTIGOPHORUS ASYNETALIS, new species.

Fore wing dark brown, shading to reddish just before subterminal line; terminal space narrow, leaden black filled, with a black spot just before apex and black terminal line; ordinary lines faint; inner black, diffused, forming a spot in cell; discal dot black, small, with some whitish scales; outer line blackish, dentate, irregular; subterminal line pale, waved. Hind wing gray-brown, darker on margin, with blackish discal dot and traces of outer line. Expense, 19 mm.

Type.—Female, Cat. No. 21258, U.S.N.M.; Misantla, Mexico, July, 1914 (R. Müller).

ALESUA, new genus.

Fore wing with accessory cell; veins 7–9 stalked from accessory cell, vein 10 arising from it, 11 free, but close to 10; palpi obliquely ascending, the third joint smooth, oblique; fore wing of male without vesicle; anal angle of hind wing not lobed; outer margin of fore wing evenly rounded.

Type of the genus.—*Alesua etialis*, new species.

ALESUA ETIALIS, new species.

Fore wing gray, shaded with reddish brown along inner margin and outer margin nearly to apex; reniform a thick black ellipse with dash proceeding from it inwardly; orbicular a dot; lines indistinct, wavy-crenulate, brown; subterminal line blackish, coarsely wavy; a row of terminal white dots, preceded by black dashes; fringe dark. Hind wing blackish, with spotted white fringe. Expanse, 22 mm.

Type.—Male, Cat. No. 21259, U.S.N.M.; Mexico (R. Müller).

Genus SCOPIFERA Herrich-Schäffer.

SCOPIFERA INSURRECTA, new species.

Much as in *S. lycagusalis* Walker; smaller, the pale shade beyond reniform less extended and less conspicuous; subterminal line a row of pale dots without accompanying dark line. Expanse, 30 mm.

Type.—Male, Cat. No. 21260, U.S.N.M.; Mexico (R. Müller).

This may prove to be a subspecies when the locality is known.

Genus TAPHONIA Schaus.

TAPHONIA TESTACEALIS, new species.

Fore wing brown, shading to straw color at apex and in a small triangular spot on costa at outer third; a dark brown shade along costa and in upper fourth of subterminal space; discal dot a brown ellipse, shaded with reddish; lines obscure, the subterminal most distinct, wavy, dark; a terminal crenulate brown line. Hind wing with faint outer line, followed by pale; margin as on fore wing. Expanse 28 mm.

Type.—Male, Cat. No. 21261, U.S.N.M.; Mexico (R. Müller).

Genus BOMOLOCHA Hübner.

BOMOLOCHA DICIALIS, new species.

Fore wing dark bronzy brown, irrorated with black; inner line lost; orbicular a black dot; reniform a small cusp, over which the outer line makes a narrow loop, slender, black, a little grayish without; subterminal line blackish, narrow, irregular; a terminal crenulate black line with faint whitish points at ends of veins. Hind wing dark gray-brown, a little bronzy. Expanse, 39 mm.

Type.—Male, Cat. No. 21262, U.S.N.M.; Cuernavaca, Mexico, June, 1914 (R. Müller).

Subfamily NOCTUINAE.

Genus OSTHA Walker.

OSTHA MEMORIA, new species.

Wings dark reddish brown, marked with light purplish gray in diffused bands; some scattered gray at base; orbicular a thick ring; reniform narrow; a broad spotted band obliquely from costa at outer fourth to middle of inner margin; a patch at apex, followed by traces of subterminal line; white specks in base of fringe at ends of veins. Hind wing with a small discal bar; two outer parallel approximate bands consisting of irregularly lunate spots; termen as on fore wing. Expanse, 21 mm.

Type.—Male, Cat. No. 21263, U.S.N.M.; Chiapas, Mexico, May, 1915 (R. Müller).

Genus PLEONECTYPTERA Grote.

PLEONECTYPTERA TRILINEOSA, new species.

Dark purplish gray; lines straight, rather broad, orange-yellow; inner line with reddish outer edge, not attaining costa; reniform an obscure dark ellipse; outer line a little oblique, from costa at five-sixths to inner margin at two-thirds; subterminal line pale, faint, wavy; terminal space filled with red; a broken crenulate black terminal line. Hind wing with an outer yellow half line from vein 5 to above anal angle. Expanse, 27 mm.

Type.—Female, Cat. No. 21264, U.S.N.M.; Zacualpan, Mexico, June, 1914 (R. Müller).

Genus PARACHABORA Warren.

PARACHABORA PSEUDANAETIA, new species.

Fore wing purplish brown, shaded with blackish on the costal half; orbicular and reniform large, full, of the pale color, indistinctly outlined; only traces of ordinary lines; subterminal line marked by a yellowish shading, distinct at apex; a row of terminal dashes, not quite on the margin. Hind wing white, with narrow dark fuscous border, staining the veins for a short distance; fringe white. Expanse, 27 mm.

Type.—Male, Cat. No. 21265, U.S.N.M.; Orizaba, Mexico, June, 1912 (R. Müller).

Family LASIOCAMPIDAE.

Genus GLOVERIA Packard.

GLOVERIA CONCINNA, new species.

Dark brown; fore wing densely irrorate with pale yellow hairs; lines brown, approximate; a white discal dot just beyond the inner line; outer line with whitish outer border; subterminal line brown, irregular below, smooth and waved above. Fringe of both wings dark brown, with pale outer edge. Expanse, 67 mm.

Type.—Female, Cat. No. 21266, U.S.N.M.; Zacualpan, Mexico, August, 1909 (R. Müller).

GLOVERIA RUBICUNDENS, new species.

As in *concinna*, but the lines wide apart, normal. Expanse 66 mm.

Type.—Female, Cat. No. 21267, U.S.N.M.; Mexico (Schaus collection).

This may not be a distinct species from *concinna*.

GLOVERIA OBSOLETA, new species.

Very dark brown, with whitish irrorations on fore wing; lines dark, obscure, the outer traceable; a faint whitish discal dot. Fringe on both wings white-tipped. Expanse, 78 mm.

Type.—Female, Cat. No. 21268, U.S.N.M.; Guerrero Mill, Hidalgo, Mexico, 9,000 feet (Mann and Skewes, gift of B. Preston Clark).

GLOVERIA SODOM, new species.

Dark brown, irrorate with white hairs, relieving two broad dark bands, well separated, the outer curved; discal spot white, diffused; subterminal line dark, irregular, inbent at veins 2 and 5; edge of fringe white. Expanse, 66 mm.

Type.—Female, Cat. No. 21269, U.S.N.M.; Guerrero Mill, Hidalgo, Mexico, 9,000 feet (Mann and Skewes, gift of B. Preston Clark).

GLOVERIA LATIPENNIS, new species.

Chocolate brown, irrorate with white, except in the upper three-fourths of median space, which forms a dark band, in which is the round white contrasting discal spot; subterminal line a waved series of brown spots between the veins. Hind wing dark brown, with yellowish white-tipped fringe. Expanse, 63 mm.

Type.—Female, Cat. No. 21270, U.S.N.M.; Jalapa, Mexico (Schaus collection).

Family NOTODONTIDAE.

Genus LEPASTA Möschler.

LEPASTA CONCORDENS, new species.

Similar to *L. conspicua* Butler, but the wing more elongate, the markings less oblique; the subcostal area is pinkish throughout, the white band below it broken; submarginal band pinkish in the main, its white edge indicated only; this band runs inward on submedian fold and meets the basal band obliquely, not at a right angle, as in *conspicua;* it is cut off from the band by a narrow line of ground color. Expanse, 37 mm. (*Conspicua*, male, 30–33 mm.)

Type.—Male, Cat. No. 21271, U.S.N.M.; Sixola River, Costa Rica, March 29, 1909 (W. Schaus).

Another specimen, Chiapas, Mexico, May, 1915 (R. Müller), has not been made the type, as it was unfortunately damaged on the setting board.

Genus SYMMERISTA Hübner.

SYMMERISTA ODONTOMYS, new species.

Dark purplish gray; head, collar, and center of thorax wood-brown; fore wing with a yellow-white costal stripe from apex to outer third of cell, the veins in it white, and sending a white tooth just beyond reniform; an angle on vein 7 and a slight one on vein 8; lines obscure, blackish, double; subterminal line most distinct, coarsely dentate, single; reniform a brown dash in a pale cloud; some brown effusion beyond cell. Hind wing and abdomen dark gray-brown. Expanse, 42 mm.

Type.—Female, Cat. No. 21272, U.S.N.M.; Zacualpan, Mexico, September, 1915 (R. Müller).

POSTANITA, new genus.

Hind wing with vein 5 very weak, nearly absent; fore wing with accessory cell; male antennae pectinated but not to the tips, of female, simple; vein 8 of hind wing diverging from subcostal near end of cell.

If vein 5 be counted as present, the genus falls near *Litodonta* Harvey; but that has vein 5 stronger, female antennae pectinate, and fore wing below with long, downturned hair in both sexes.

Type of the genus.—*Postanita decurrens*, new species.

POSTANITA DECURRENS, new species.

Male.—Basal area wood-brown, narrow, limited by the subbasal line, which is broken into dots and has a pale outer border; inner space filled with dark purple-brown, running out obliquely on costa and curving out along submedian fold, but resolved into a dotted area along inner margin to outer margin at vein 2; outer field yellowish wood-brown; a small fuscous discal dot; a gray shading from cell to margin in a streak along vein 5 and patch above; some dark brown subapical marks on costa. Hind wing whitish wood-brown, costa and margin grayish; some brown marks at anal angle. Expanse, 27 mm.

Type.—Male, Cat. No. 21273, U.S.N.M.; Mexico (R. Müller).

Female.—Basal area of fore wing as in male, but the subbasal line and a central arc of the inner line distinct, limiting the purple area, the former line dentate on subcostal and vein 1; discal dot very large, round, black-brown; a wedge-shaped dark brown patch, beginning on vein 5 beyond the cell and widening to subterminal line, where it is diffusely cut off; subterminal line indicated below; a brown dash at vein 2 on margin; clear area of wing more irrorate with brown than in the male. Hind wing solidly chocolate brown. Expanse, 31 mm.

Type.—Female, Cat. No. 21273, U.S.N.M.; Misantla, Mexico, June 1912 (R. Müller).

Genus PSILACRON Felder.

PSILACRON EUGRAPHICA, new species.

Violaceous gray, shaded with yellowish (green when fresh), especially in a spot in fork of veins 3–4; inner line oblique, double, straight, distinct between median vein and margin; a rounded black patch in basal space; a dark shade in cell; discal dot brown, rounded, lunate, in a narrow pale space; outer line dark brown, single, excurved over base of 3–4; subterminal line a distinct dark brown dentate band costa to vein 6, lost below except a small patch on vein 2; termen light violaceous, fringe with dark dashes at ends of veins. Hind wing pale gray, anal area broadly dark brown; veins and apex also brown; a double pale outer mark on costa separated by the inception of a brown line. Expanse 37 mm.

Type.—Female, Cat. No. 21274, U.S.N.M.; Mexico (R. Müller).

PSILACRON MONOSTIGMA, new species.

Male antennae pectinated nearly to tip, but the last six joints simple. Fore wing light greenish gray, perhaps green when fresh; a white spot at base of costa and submedian fold, somewhat tufted; an inner area of black irrorations; discal mark a curved line, black and brown, followed by a clouded patch; outer line indicated in brown, crenulate and irregular, not curved; subterminal line a trace; veins outwardly with black scales in uneven dashes, cutting the fringe. Hind wing dark gray-brown, with darker broken terminal line. Expanse, 40 mm.

Type.—Male, Cat. No. 21275, U.S.N.M.; Guerrero Mill, Hidalgo, Mexico, 9,000 feet (Mann and Skewes, gift of B. Preston Clark).

Genus SALLUCA Schaus.

SALLUCA AMATHYNTA, new species.

Fore wing soft light gray, shaded with olive green in a patch on costa near base and subapically; lines very indistinct, brown, double, scarcely legible; subterminal line distinct, a row of rounded brown spots between the veins, yellowish-edged without and with white suffusion within, the line incurved a little opposite cell; a row of terminal brown dashes. Hind wing whitish gray, darker on margin; fringe white; inception of a brown outer line shows on costa. Expanse, 37 mm.

Type.—Female, Cat. No. 21276, U.S.N.M.; "probably State of Vera Cruz," Mexico (R. Müller).

Two other females bear data, respectively: Misantla, Vera Cruz, Mexico, June, 1909 (R. Müller); Paso San Juan, Vera Cruz, Mexico (Schaus collection). The latter is also labelled: "*S. gramina* Schs. ♀;" but the association seems clearly an error.

Genus DICENTRIA Herrich-Schäffer.

DICENTRIA OBLIGATA, new species.

Fore wing gray, blackish-shaded, almost solidly for basal two-thirds, the discal bar in an oval clear space; veins outwardly black-lined; a brown line in interspace 4–5; outer line pale, shaded, straight, curving toward costa and obsolete above vein 6; a gray patch at apex; lines on veins widened in fringe. Hind wing white, veins dark-lined; costa and outer margin narrowly gray; inner area brown; a blackish patch at anal angle. Expanse, 42 mm.

Type.—Male, Cat. No. 21277, U.S.N.M.; Zacualpan, Mexico, September, 1915 (R. Müller).

Genus HEMICERAS Guenée.

HEMICERAS OBLIQUIPLAGA, new species.

Vertex of head white; thorax purple and brown, touched with white posteriorly. Fore wing with costal edge not white; bright red-brown, the median space more purplish, cut in a line from discal mark to above vein 1, the anal area purplish; lines dark, faint, picked out in specks of white scales on the veins, forming a line from vein 2 to margin, dentate on vein 1, and followed by red-brown; discal mark vague, purple, oblique. Hind wing brown, lighter between the veins. Expanse, 42 mm.

Type.—Female, Cat. No. 21278, U. S. N. M.; Mexico (R. Müller).

A pair, agreeing well, are before me from Juan Vinas, Costa Rica, January and November, 1909 (W. Schaus). The male has no stigma on hind wing and comes close to *H. muscosa* Schaus, described from Colombia, but extending to Costa Rica and Mexico.

Family EUPTEROTIDAE.

Genus CARTHARA Walker.

CARTHARA CRENULOSA, new species.

Fore wing gray, shaded with dark red about outer margin and in spots on costa; veins 3 and 4 dark red; inner line obsolete; discal black dots oblique, partly confluent; outer line purplish, double, crenulate from margin up to vein 4; inner branch from vein 4 to costa oblique; outer branch white, crenulate, preceded by olive patches in interspaces 4–5 and 5–6, then a gray shade to costa; followed by small rounded olive patches in 4–5, 5–6, 6–7 and 7–costa.

Hind wing all red, except yellowish hairs from anal area; outer line dark, faint, distinctly white-edged above tornus, preceded there by a black patch. Expanse, 33 mm.

Type.—Male, Cat. No. 21279, U.S.N.M.; Zacualpan, Mexico, November, 1915 (R. Müller).

Family GEOMETRIDAE.

Subfamily GEOMETRINAE.

Genus APICIA Guenée.

APICIA ABERRANS, new species.

Fore wing straw-color, thickly irrorated with brown, somewhat mottled in median space; inner line brown, faint, arcuate; discal dot round, blackish; outer line brown, distinct, irregularly flexuous, extruded subcostally, inbent a little above vein 2 and nearly straight thence to margin; no terminal line, the irrorations a little denser there. Hind wing similar; discal dot small; outer line ending at vein 7, less irregular than on fore wing. Expanse, 24 mm.

Type.—Male, Cat. No. 21280, U.S.N.M.; Sierra de Guerrero, Mexico, June, 1915 (R. Müller).

Genus BONATEA Druce.

BONATEA GRISEOLATA, new species.

Fore wing greenish gray, evenly colored, darker beyond the outer line; inner line faint, angled in cell and submedian fold; discal dot a black point; outer line forming an arc from costa to vein 7, with some powdery white and lilac scales beyond, then oblique and nearly straight to margin, purplish, and followed by white scales. Hind wing with median area paler; discal dot small; outer line stopping at vein 7; fringe concolorous. Expanse, 32 mm.

Type.—Male, Cat. No. 21282, U.S.N.M.; Mexico City, Mexico, October, 1914 (R. Müller).

Genus SICYA Guenée.

SICYA MEDANGULA, new species.

Creamy yellow, with pale gray strigae along costa and about anal area, where there is a faint brown cloud, staining distinctly the lower half of fringe; inner line faint, grayish, angled on median vein; a round, dark brown discal dot; outer line from costa before apex to outer third of inner margin, whitish, edged by gray within, smooth, a little inflexed below. Hind wing with a discal dot; a mesial dark line to vein 7; submarginal line dark, straight, from anal angle to vein 3. Expanse, 32 mm.

Type.—Female, Cat. No. 21283, U.S.N.M.; Cuernavaca, Mexico, January, 1915 (R. Müller).

Genus CARIPETA Walker.

CARIPETA HYPERYTHRATA, new species.

Fore wing violaceous brown, with broad red streaks on the veins beyond the outer line, separated by white and powdery black; lines white, edged by dark brown toward the center; inner line oblique with a blunt tooth on median vein; outer line angled at vein 6, incurved, projecting at vein 4, oblique inward to vein 2, thence outward to margin; discal dot dark brown, surrounded by white, with a brown shade following it; subterminal line represented by brown dashes between the veins. Hind wing translucent, pale at base, bright red outwardly; a brown discal dot; a faint outer line, angled a little at vein 2, white at inner margin, red-edged within. Expanse, 39 mm.

Type.—Male, Cat. No. 21284, U.S.N.M.; Mexico City, Mexico (R. Müller).

Genus SELENIA Hübner.

SELENIA GYNAECON, new species.

Fore wing olive-green in median space, with dense brown strigae, blotched and confluent; basal and terminal spaces solidly brown, except at outer margin below apex; inner line brown, curved, waved, lost in the concolorous strigae; discal mark slight, concolorous; outer line red-brown, narrow, from costa before apex to outer fourth of inner margin, bent a little at vein 2; some white scales subterminally, forming a double spot above tornus. Hind wing dark brown; a single outer line with a little green showing before it; wing narrowly strigose in darker, not contrasting. Expanse, 41 mm.

Type.—Female, Cat. No. 21285, U.S.N.M.; Misantla, Mexico, June, 1912 (R. Müller).

SELENIA EUCORE, new species.

Fore wing buff-yellow, shaded with brown, especially in median space; scattered brown strigae; inner line brown, curved, strigose-wavy; discal dot small, black, elliptical, slightly white centered; outer line brown, running out in a blunt point to subterminal area on vein 7, oblique inward to vein 3, curved, bluntly toothed on submedian fold; subterminal line even, regularly arcuate, light brown; a dark shade and strigae above anal angle. Hind wing with a brown median shade, crossing the black discal dot; outer line brown, even, gently curved; tornal area brown-shaded and strigose; subterminal line as on fore wing. Both wings with the margin scalloped between the veins; apex of fore wing falcate shortly. Expanse, 37 mm.

Type.—Female, Cat. No. 21286, U.S.N.M.; Cuernavaca, Mexico, June, 1914 (R. Müller).

SELENIA CACOCORE, new species.

Whitish, thickly irrorate with olive-brown, giving a sordid gray tint; inner line brown, faint, angled in cell; discal dot brown, with some reddish shading; a brown shade-line from middle of costa curves out below vein 6 to outer line; outer line angled at vein 7, inwardly oblique to vein 2, curved, a tooth on submedian fold; subterminal line even, arcuated; some purple and brown suffusion above anal angle. Hind wing similar, the outer line irregularly curved, not angled; subterminal area as on fore wing. Expanse, 40 mm.

Type.—Female, Cat. No. 21287, U.S.N.M.; Cuernavaca, Mexico, June, 1914 (R. Müller).

This may prove a dimorphic form of *S. eucore.*

Genus PHEROTESIA Schaus.

PHEROTESIA DENTATA, new species.

Fore wing light olive brown, densely irrorate with black, somewhat mottled; outer line only visible, black, sharply but irregularly dentate on the veins; discal dot small, black; a black cusp at origin of vein 2; black terminal cusps between the veins. Hind wing sordid yellowish at base; outer half mottled with brown-gray; forming a submarginal series of spots; discal dot small. Expanse, 29 mm.

Type.—Male, Cat. No. 21288, U.S.N.M.; Cuernavaca, Mexico, June, 1914 (R. Müller).

Genus NESALCIS Warren.

NESALCIS CEDIOPASA, new species.

Fore wing reddish gray, irrorate with black, a coppery reddish shade beyond outer line; inner line black, thick, curved, spotted on discal and submedian folds, its ends faint; discal dot round, black, large; outer line black, thick, spotted on the veins, extruded at veins 3–4, arched inward below vein 2; faint black dots for subterminal line; terminal line crenulate, forming black spots between the veins. Hind wing similar; no inner line; outer line less irregular. Expanse, 33 mm.

Type.—Male, Cat. No. 21289, U.S.N.M.; Zacualpan, Mexico, July, 1914 (R. Müller).

Subfamily HEMITHEINAE.

Genus RACHEOSPILA Guenée.

RACHEOSPILA CARA, new species.

Wings translucent, green, mottled with yellowish; fore wing with the costa dark purple rather broadly; a terminal red-purple line, dislocated on to the fringe at ends of veins; a straight outer line, purple, edged with yellow, dotted on the veins; a little purple along inner margin. Hind wing with the outer line curved, fainter than on fore wing; termen the same; a little red-purple on inner margin at the end of the line. Face purple, vertex white; three raised white spots on the abdomen. Expanse, 27 mm.

Type.—Male, Cat. No. 21295, U.S.N.M.; Zacualpan, Mexico, March, 1915 (R. Müller).

Near *R. mustela* Druce (Biol. Cent.-Am., Lep. Het., pl. 50, fig. 3), but I think distinct.

Subfamily LARENTIINAE.

Genus TEPHROCLYSTIA Hübner.

TEPHROCLYSTIA ANALIS, new species.

Fore wing rather pointed, dark gray, obscure; discal spot distinct, black, rounded; inner line wavy, double, whitish-filled on costa; outer line rather thick and black, broken, distinct only to vein 3; a subterminal broad shade, dentate roundedly and a little whitish beyond, also fading out below; a terminal broken black line. Hind wing pale, unmarked over disk, a small gray discal dot; anal area broadly irrorate with black, with traces of an outer line. Expanse, 19 mm.

Type.—Female, Cat. No. 21296, U.S.N.M.; Zacualpan, Mexico, September, 1913 (R. Müller).

Similar to *T. chrodna* Druce, but the hind wing very different.

TEPHROCLYSTIA CHIMERA, new species.

Large, dark gray, a lighter area emanating from discal mark, which is oval, black; lines faint; inner and outer double, blackish, the outer angled inwardly subapically and a little whitish-filled; inner angled in cell; subterminal line obsolete, marked only by some whitish scales; a terminal black line. Hind wing gray, nearly unmarked to median vein; anal area broadly black-scaled, showing a double outer pale band, which is continued faintly across wing; discal dot blackish. Expanse, 24 mm.

Type.—Female, Cat. No. 21297, U.S.N.M.; Zacualpan, Mexico, June, 1914 (R. Müller).

TEPHROCLYSTIA CAPITATA, new species.

Fore wing violaceous gray, reddish in median space; subbasal line black, angled subcostally; inner line oblique, straight, touching the discal dot with a sharp angle, then oblique to costa; discal dot round, black; outer line curving from costa, parallel to inner line to vein 2, then forming an outward angle on submedian fold; subterminal line slight, blackish, wavy, with inconspicuous white patches. Hind wing a little lighter than fore wing; a black streak along submedian fold; a thick black median bar from fold to margin; a faint outer double black line; a black terminal line as on fore wing. Expanse, 19 mm.

Type.—Female, Cat. No. 21299, U.S.N.M.; Zacualpan, Mexico, March, 1914 (R. Müller).

TEPHROCLYSTIA ENDONEPHELIA, new species.

Fore wing sordid wood-brown, irrorate with blackish, the costal area blackish to discal spot; lines whitish, double, nearly straight, the outer cutting the blackish costal shade; subterminal line obsolete; discal spot round, black; a terminal black line. Hind wing blackish, except costal area; a faint median whitish line across the black discal dot; a more distinct outer whitish line, with outward angle in the middle. Expanse, 14 mm.

Type.—Female, Cat. No. 21300, U.S.N.M.; Cuernavaca, Mexico, November, 1914 (R. Müller).

Near *T. seminigra* Warren.

TEPHROCLYSTIA MICROLEUCA, new species.

Pale gray, overspread with reddish, the cell remaining gray; subbasal, inner and outer lines black, irrorate and rather obscure, evenly curved; outer line obscurely double, forming a cream-colored patch on costa, followed by red; subterminal line dentate, near the margin, with small white patches. Hind wing gray on costal half, reddish on inner half; inner, median, outer and subterminal lines of black, shown on inner margin, the outer only continuing faintly across the wing; a small blackish discal dot. Expanse, 13 mm.

Type.—Female, Cat. No. 21301, U.S.N.M.; Cuernavaca, Mexico, November, 1914 (R. Müller).

TEPHROCLYSTIA SUPPORTA, new species.

Fore wing yellowish gray, thickly irrorate with black, leaving little lighter patches especially in interspaces 3–4 and 6–7 between outer and subterminal lines; inner line streaked, diffused, double, pale; median vein dotted with black; discal dot narrow, blackish; outer line double, pale, flatly crenulate, only a little curved; veins black-dotted between cell and subterminal line; subterminal line crenulate, whitish, forming spots in the interspaces 1–2 and 3–4; a broken terminal black line; fringe spotted with gray and blackish. Hind wing whitish to cell and unmarked, the inner three-fourths luteous gray, with subbasal, median, outer and subterminal lines of blackish, powdery, similar; fringe as on fore wing. Expanse 19 mm.

Type.—Female, Cat. No. 21302, U.S.N.M.; Guerrero Mill, Hidalgo, Mexico, 9,000 feet (Mann and Skewes, gift of B. Preston Clark).

TEPHROCLYSTIA ALOGISTA, new species.

Fore wing thin, dark, violaceous brown; a purple subapical costal patch; a round black discal dot; lines indistinct, wavy, blackish, appearing as irrorations or mottlings, the subterminal line picked out by a row of little white patches. Hind wing gray, unmarked, except along anal margin to median vein; gray there with five or six indistinct lines and a white spot at tornus. Expanse, 20 mm.

Type.—Female, Cat. No. 21303, U.S.N.M.; Mexico (R. Müller).

Another female has the same label; two other females are marked: Mexico City, Mexico, September, 1914 (R. Müller).

TEPHROCLYSTIA PERTACTA, new species.

Dark silvery gray, the markings black, distinct, sharply dentate; basal area discolored to yellowish and illegible in three females before me; a black discal dot in middle of cell and one in end; some fine lines across median space; outer line sharply dentate, incurved between veins 7 and 3; two subterminal lines, parallel, dentate, coming together at anal angle where there is a slight or large white dot; a terminal black line, cut by whitish on the veins; fringe spotted black and whitish, the black spots resting on the white specks of termen; a pale shade cutting through the subterminal lines from opposite end of cell to margin below apex. Hind wing with the costal half blackish gray; inner half yellowish in all three females, seeming discolored; three median and one crenulate submarginal evenly curved blackish lines; fringe scarcely spotted. Expanse, 19 mm.

Type.—Female, Cat. No. 21304, U.S.N.M.; Misantla, Mexico, November, 1914 (R. Müller).

Two other females labeled: Mexico and Orizaba, Mexico, August, 1913 (R. Müller).

Superfamily TINEOIDEA.

Family NOLIDAE.

Genus ROESELIA Hübner.

ROESELIA PSEUDERMANA, new species.

Fore wing silvery gray; a broad brown costal patch covering cell, except for a basal incision, cut off sharply at outer edge of reniform; orbicular and reniform large, with raised scales, concolorous; inner line an arc from between stigmata, curving in on submedian fold, then lost; outer line slender, black, whitish-lined without, inbent below vein 4 to vein 2, with a slight angle on vein 1; black lines on the veins beyond; subterminal line running across apex to margin; angled inward on vein 6 and lost below. Hind wing whitish gray; a slender gray outer line, excurved mesially. Expanse, 22 mm.

Type.—Female, Cat. No. 21305, U.S.N.M.; Chiapas, Mexico, May, 1915 (R. Müller).

Family COCHLIDIIDAE.

Genus SIBINE Clemens.

SIBINE PAUPER, new species.

Fore wing light violaceous brown, with shining dark streak along submedian fold and subterminally; a single yellow dot subapically.

Hind wing pale yellowish, costa and inner margin pinkish; a brown spot on tornus. Expanse, 28 mm.

Type.—Male, Cat. No. 21306, U.S.N.M.; Tabasco, Mexico, December (R. Müller).

Genus EUCLEA Hübner.

EUCLEA FUSCIPARS, new species.

Fore wing purplish brown, the outer area more purplish; a single curved brown line at outer third, outcurved a little below vein 1c; discal mark a faint cloud. Hind wing blackish. Expanse, 19 mm.

Type.—Female, Cat. No. 21307, U.S.N.M.; Mexico (R. Müller).

Near *Sisyrosea* (?) *assimilis* Dyar, but darker brown, the outer line thicker and bent at vein 1. The species classified as *Sisyrosea* (?)[1] belong to *Euclea*.

Family ZYGAENIDAE.

Genus TRIPROCRIS Grote.

TRIPROCRIS ROSETTA, new species.

Head and anterior two-thirds of thorax dark orange; remainder of insect blue black. Wings square and produced at apex, somewhat as in *Harrisina*, but not so extreme, the hind wing not reduced. Expanse, 23 mm.

Type.—Male, Cat. No. 21308, U.S.N.M.; Chiapas, Mexico, July, 1916 (R. Müller).

Genus PYROMORPHA Herrich-Schäffer.

PYROMORPHA AURORA, new species.

Fore wing with the basal two-thirds orange, shading to rose pink below median vein; outer third black; patagia orange. Hind wing black, a rose-pink ray on basal two-thirds of costa. Expanse, 23 mm.

Type.—Male, Cat. No. 21309, U.S.N.M.; Cuernavaca, Mexico, November, 1914 (R. Müller).

Genus GINGLA Walker.

GINGLA BEOVAVA, new species.

Black; fore wing bright red except the costa narrowly, inner margin more broadly and broad outer border, widening obliquely below. Hind wing red on costa from apex, covering cell, but cut short by black at submedian fold. Expanse, 22 mm.

Type.—Male, Cat. No. 21310, U.S.N.M.; Mexico (R. Müller).

Family COSSIDAE.

Genus PSYCHONOCTUA Grote.

PSYCHONOCTUA POAM, new species.

Fore wing white, reticulate with gray; discal mark small, lunate; inner line broadened on costa, but formed only of reticulations, not

[1] Proc. U. S. Nat. Mus., vol. 39, 1905, pp. 375–376.

a patch; an outer dark band of intensified reticulations, showing on costa and inner margin; margin darker. Hind wing soiled white, with a row of terminal dots in the fringe. Expanse, 42 mm.

Type.—Male, Cat. No. 21315, U.S.N.M.; Mexico (R. Müller).

Genus HYPOPTA Hübner.

HYPOPTA ACTILEUCA, new species.

Fore wing with the ground white; a broad dark gray-purplish shade, strigose, filled in and under the cell and around to costa, leaving the median vein and cross vein broadly white; costa with dark strigae and three white subapical patches; termen and outer angle of inner margin broadly pale, with purplish strigae; fringe white, mixed with gray. Hind wing whitish with large purplish mottlings, heaviest at end of cell and staining the bases of veins 2–5. Expanse, 25 mm.

Type.—Male, Cat. No. 21316, U.S.N.M.; Cuernavaca, Mexico, January, 1915 (R. Müller).

Family PYRALIDAE.

Subfamily PYRAUSTINAE.

PLATYGRAPHIS, new genus.

Palpi weakly upturned, the first and second joints thickly fringed with scales in front, the third naked and oblong, rather long; maxillary palpi invisible; median vein of hind wing not pectinated above; second joint of palpi about reaching vertex of head if turned up; fore wing with vein 7 straight and well separated from 8; antennae with the shaft not annulate, in the male unipectinate at base, the basal pectenation long and spatulate.

Near *Entrephia* Lederer, but the last joint of palpi is blunt.

Type of the genus.—Platygraphis isabella, new species.

PLATYGRAPHIS ISABELLA, new species.

Fore wing white; subbasal line brown, oblique; inner line oblique in reverse direction, straight; orbicular of two brown bars, from subcostal to submedian fold, filled with fulvous; reniform of two opposed arcs between subcostal and median veins, filled with fulvous, which color also occupies costa, terminal space and tornal region; a line from inner cusp of reniform obliquely to inner margin; a line from outer cusp of reniform, recurved above tornus and nearly perpendicular to costa; marginal line submacular. Hind wing white; median line forked on cell, filled with fulvous; outer line from costa to vein 2, forming a short hook; subterminal and marginal lines parallel to margin, filled with fulvous; fringe white, with brown interline. Expanse, 16 mm.

Type.—Male, Cat. No. 21317, U.S.N.M.; Sierra de Guerrero, Mexico, June, 1915 (R. Müller).

An old specimen in the Schaus collection from Jalapa, Mexico, is labeled: "*Bocchoris* sp." in Hampson's writing; but I can not make it fall in that genus.

Genus BOCCHORIS Moore.

BOCCHORIS CONTORTILINEALIS Hampson.

Bocchoris contortilinealis Hampson, Ann. Mag. Nat. Hist., ser. 6, vol. 16, p. 336.

Nacolcia verroniae Dyar, Ins. Ins., Menstr., vol. 5, 1917, p. 89.

I make this synonymy on the close general resemblance of the two forms. Hampson described *contortilinealis* from Grenada; I have it from Dominica, Jamaica and Cuba. *N. varroniae* I described from British Guiana. The difference between *Bocchoris* and *Nacoleia* Hampson gives as only "frons flat and oblique" in *Bocchoris* and "frons rounded" in *Nacoleia.* Now, in *contortilinealis*, the frons may well be described as "flat and oblique." The antennae set well back and there is a distinct flattening before them. In *N. verroniae*, however, there is no perceptible flattening, the frons is convex and the antennae seem normally placed. A structural difference, therefore, exists between the continental and insular forms, but I cannot consider it specific and, therefore, not generic.

Genus SYNGAMIA Guenée.

SYNGAMIA SUBNEBULOSALIS, new species.

Fore wing gray-brown; inner line blackish, angled on median vein; discal mark a bar, oblique, a little bent; outer line curved, from costa to vein 2, black, white-edged without, preceded by white between the radial nervules, dislocated to a point under reniform and continued obliquely to inner margin. Hind wing gray-brown; a thick black line from end of cell obliquely to inner margin, followed by white below vein 3; another outer bar from costa at outer third to anal angle, followed by white from costa to vein 3; terminal line black; fringe white, interlined with brown. Expanse, 16 mm.

Type.—Female, Cat. No. 21318, U.S.N.M.; Cuernavaca, Mexico. November, 1914 (R. Müller).

Genus LYGROPIA Lederer.

LYGROPIA FALSALIS, new species.

Fore wing pale subhyaline yellow; costa purple brown; a spot in base of cell, orbicular and reniform, fused to costa, each with a yellow center; outer margin broadly purple-brown at apex, narrowing below, widening again abruptly at vein 2 to inner margin; a faint outer line, straight from costa to vein 5, bent out and lost, faintly reappearing at outer third between vein 2 and inner margin. Hind wing with narrow purple brown border, a little widened at apex; a round black discal dot. Expanse, 19 mm.

Type.—Female, Cat. No. 21319, U.S.N.M.; Rascon, San Luis Potosi, Mexico, August, 1911 (R. Müller).

Subfamily NYMPHULINAE.

Genus STENIA Guenée.

STENIA MONONALIS, new species.

Pale straw color, fore wing darker at tip; costa brown-powdered to two-thirds; a dot on median vein at bast and on internal margin farther out; orbicular a ringlet fused to costa; a dot below on submedian fold; reniform of two opposed cusps, touching costal stripe; a waved line from it to inner margin; a black dot on costa at four-fifths, from which a straight brown line runs to anal angle, dislocated inward a little between subcostal and vein 4, angled on submedian fold; crenulate terminal line and fringe dark brown. Hind wing with a nearly straight line from discal dot to tornus; outer line from costa at three-fourths to discal fold, angled outward, thence to submedian fold, again angled outward and becoming terminal; fringe as on fore wing but mixed with pale. Expanse, 17 mm.

Type.—Female, Cat. No. 21320, U.S.N.M.; Chiapas, Mexico, May. 1915 (R. Müller).

Subfamily SCOPARIINAE.

Genus SCOPARIA Haworth.

SCOPARIA STEREOSTIGMA, new species.

Fore wing gray, irrorate with blackish; a dark mark at base; inner line whitish, angled on median vein and vein 1, followed by a broad blackish shade, sharply limited; discal spot round, black; costa narrowly dark, expanding beyond outer line; this whitish, narrowly black-lined within, crenulate and excurved over discal nervules; a dark shade from tornus; a whitish space subterminally, no distinct line; terminal line broken. Hind wing sordid whitish, darker on the edge. Expanse, 12 mm.

Type.—Female, Cat. No. 21344, U.S.N.M.; Jalapa, Mexico (Schaus collection). A worn female, apparently the same, Orizaba, Mexico. July, 1913 (R. Müller).

SCOPARIA ANADONTA, new species.

Gray, a little yellowish; fore wing irrorate with black; inner line bent on subcostal vein, a broad blackish shade, pale within; discal mark strongly constricted on outer side, reddish-filled, B-shaped, imperfectly closed below, joining costa by a shade; outer line whitish, distinct, black-edged within, incised subapically, oblique and nearly straight below; terminal space blackish-shaped, leaving a lighter subterminal shade, curving in a little centrally; a row of black spots in the fringe. Hind wing uniform soiled whitish. Expanse, 23 mm.

Type.—Male, Cat. No. 21345, U.S.N.M.; Real del Monte, Hidalgo, Mexico (Van Ostrand, gift of W. D. Kearfott).

SCOPARIA ANAGANTIS, new species.

Yellowish gray, pale; fore wing with a black dot on costa and one on submedian fold farther out; inner line represented by a black patch on costa, claviform-dash and mark on inner margin, joined by dull luteous; discal mark quadrate, with round luteous center, a projection at outer lower corner; a mark on costa above; outer line whitish, excurved mesially, marked by a double black spot on costa; a diffuse black shade subcostally and at tornus; a marginal powdery black line, thickened in the middle. Hind wing soiled whitish. Expanse, 18 mm.

Type.—Female, Cat. No. 21346, U.S.N.M.; Zacualpan, Mexico, March, 1915 (R. Müller).

SCOPARIA CYCLOPHORA, new species.

Fore wing purplish gray, irroate with black; discal mark a large black ring in a red-brown cloud, which reaches the outer line; a little red-brown in the basal space; a black mark at base subcostally; inner line narrow, black, oblique, angled on median vein slightly, edged within by pale; beyond, a broad black shade, ending in a claviform enlargement; outer line whitish, excurved on mesial third and edged by black dots within; a black shade at apex, tornus and center of outer margin, relieving a bent subterminal whitish shade. Hind wing translucent soiled whitish, darker on the edge. Expanse, 17 mm.

Type.—Female, No. 21347, U.S.N.M.; Zacualpan, Mexico, May, 1913 (R. Müller).

SCOPARIA FLEXUOSA, new species.

Size and color as in *S. sabura* Druce. Median area lighter gray, less suffused with brown; claviform round, not a dash; dark costal mark after inner line small, and sending a line along median vein to reniform, which is well defined; outer line more strongly excurved, the veins preceding it not dark lined; lower arm of subterminal line absent, the whole anal area black. Expanse, 24 mm.

Type.—Female, No. 21348, U.S.N.M.; Chiapas, Mexico, May, 1915 (R. Müller).

Subfamily SCHOENOBIINAE.

Genus DISMIDILA Dyar.

DISMIDILA TOCISTA, new species.

Close to *D. atoca* Dyar, of the same size and color. Fore wing with no white on costa; reniform with the following orange lunule and two white spots distinct, without succeeding dark shade; inner line black and thickened in the middle. Beneath, gray, the marks indefinitely repeated, without trace of the peculiar whitening of *D. atoca.*

Type.—Female, Cat. No. 21350, U.S.N.M.; Santa Rosa, Vera Cruz, Mexico, August, 1906 (W. Schaus).

The type of *D. atoca* is a male and this may be a case of sexual dimorphism.

Subfamily EPIPASCHIINAE.

ANARNATULA, new genus.

Palpi upturned; hind wing with vein 7 anastomosing with vein 8; veins 4–5 stalked; fore wing with vein 6 from the cell, 10 from the cell, 4 and 5 separate; palpi with the second joint very long, in the male containing a long pencil of pale hairs.

Type of the genus.—*Anarnatula hyporhoda*, new species.

ANARNATULA HYPORHODA, new species.

Fore wing brown; a broad white ray along median vein to outer line, spreading and cutting off little brown specks between the veins; two indentations above by the obsolete stigmata, which are marked by brown on the veins; outer line white, angled at vein 5, straight; a broken black terminal line. Hind wing orange red, apex and terminal line gray; fringe white. Expanse, 13 mm.

Type.—Male, Cat. No. 21351, U.S.N.M., Chiapas, Tabasco, Mexico, May, 1915 (R. Müller).

Greatly resembles Druce's figure, of *Pycnulia sylea* Druce,[1] but too small (*sylea*, 16 mm.). Both are males and the present species does not seem to vary in size. I have three females from French Guiana expanding about the same as the male (14 mm.).

Arnatula subflavida, which I described from Panama, is still larger (18 mm.). The three forms will be congeneric.

TAPINOLOPHA, new genus.

Palpi porrect, thickened in the middle, down-curved at tip, short; fore wing with veins 3 and 4 separate, 6 from the cell well below apex, 7–9 stalked, 10 and 11 on the cell; hind wing with veins 2, 3, and 4 well apart, 5 absent, 7 anastomosing with 8.

Type of the genus.—*Tapinolopha variegata*, new species.

[1] Biol. Cent.-Am., Lep. Het., pl. 101, fig. 24.

TAPINOLOPHA VARIEGATA, new species.

Fore wing elongate, narrow; carneous gray, sparsely black irrorate, dark gray over the cell to outer line; costa broadly blackish to middle; a black tuft in end of cell from which a narrow line crosses the wing, arcuate between discal and submedian folds; within this a broad, black band from discal fold to inner margin, incised in the middle; discal mark a black lunule in a small pale space; outer line blackish, diffused, broadly sinuate; subterminal line a row of dots between the veins, which are black lined, nearly parallel to outer margin; a terminal black line; fringe dark. Hind wing soiled whitish, with rounded dot on upper part of cross-vein; a terminal dark line. Expanse, 20 mm.

Type.—Male, Cat. No. 21352, U.S.N.M.; Zacualpan, Mexico, May, 1915 (R. Müller).

Subfamily PHYCITINAE.

Genus MOODNA Hulst.

MOODNA INANIMELLA, new species.

Dark reddish gray, the lines faint; inner line at middle of wing, blackish, rather broad, angled in the cell; discal dots conjoined; outer line blackish, dentate subcostally, a little extruded at veins 4–5, then oblique and obscurely dentate; a terminal broken black line. Hind wing translucent fuscous, whitish at base in the male. Expanse, male, 18 mm.; female, 20 mm.

Cotypes.—Male and female, Cat. No. 21353, U.S.N.M.; male, Zacualpan, Mexico, May, 1915 (R. Müller); female, Orizaba, Mexico (Schaus collection), labeled: "*Manhatta bisinuella* Hampson, type ♀," but I find it wrongly associated with the male of *Moodna bisinuella* Hampson,[1] which I consider the true type. It also resembles *M. lugubrella* Ragonot, but the inner line is only a black shade, narrow and angled.

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[1] Romanoff, Mem. sur. les Lép., vol. 8, 1901, p. 268.

NOTES ON MIMETITE, THAUMASITE, AND WAVELLITE.

By Edgar T. Wherry,

Of the Bureau of Chemistry, United States Department of Agriculture.[1]

The following brief papers are the results of studies made in the mineral collections of the United States National Museum.

MIMETITE FROM UTAH.

A specimen labeled "Penfieldite, Tintic District, Utah," in a United States Geological Survey collection, transmitted to the museum in 1902 (No. 85013), was examined by Mr. E. S. Larsen in the course of his optical study of all available minerals and found to be quite distinct from penfieldite in its optical properties.[2] It has therefore been further investigated, and proves to be mimetite in a rather unusual form—transparent, colorless, acicular crystals. Crystals from what is evidently the same occurrence have been described and figured by Farrington and Tillotson,[3] but very few forms were observed upon them. The crystals on the United States National Museum specimen being rich in forms, this account of them has seemed desirable.

The specimen is a 5 by 5 by 8 cm. mass of siliceous rock, containing numerous small cavities lined with drusy quartz, and on one face several imbedded galena crystals in an advanced state of alteration. The mimetite crystals occur in the cavities, being especially abundant on the galena-bearing side, and are subsequent to both galena and quartz.

The thinner crystals are colorless and transparent, with an adamantine luster; thicker ones have a faint yellowish hue and are more resinous. The mean index of refraction of one of the needles, measured on the goniometer by allowing sodium light to be refracted through faces lying 30° apart, proved to be 2.14±0.02. Mr. Larsen found by the immersion method in selenium-sulfur mixtures $\omega=2.14$, $\epsilon=2.13$, both ±0.02, agreeing essentially with the results given in the literature for mimetite.

[1] This paper was prepared while the writer held the position of Assistant Curator of the Division of Mineralogy and Petrology in the United States National Museum.

[2] American Mineralogist, vol. 2, 1917, p. 20.

[3] Field Columb. Mus. Publ. 129, Geol. Ser., vol. 3, No. 7, 1908, p. 150, pl. 50.

Two habits are represented among the crystals. The most abundant habit, shown in idealized diagram in figure 2, is acicular, the crystals averaging 0.1 mm. in diameter and 5 mm. in length. Two prisms are well developed, the second-order one being usually dominant, both showing slight curvature and vertical striation. These needles are mostly terminated simply by a basal plane, but occasionally pyramid faces are present. The other habit, represented by a very few crystals, is similar to that figured by Dana for the mineral, a single stout prism terminated by pyramids of the same order, the prism being horizontally striated like quartz, as shown in figure 1. It might be supposed that two different minerals are represented, but the angles of both types proved to be identical.[1]

As the average of a number of good measurements the ρ angle of the principal pyramid was found to be 40° 02′, the value adopted by Professor Goldschmidt in his "Winkeltabellen"; the figure of Haidinger (39° 50′), cited by Dana, being undoubtedly in error. This makes the axial ratio c=0.7275 in the orientation usually adopted for hexagonal minerals in this country (G_2), equivalent to c=1.260 in Professor Goldschmidt's (G_1) position. The angles of the other forms shown in the figures correspond to this ratio. Not only are all of the forms heretofore reported on this mineral present, but two new forms, which are named α (symbol $30\bar{3}2$) and z ($30\bar{3}1$) are also developed, the first on a crystal of the acicular habit, the other on a prismatic one:

ρ_α calculated, 51° 34′, observed 51° 20′±20′.
ρ_z calculated, 68° 45′, observed 69° 00′±20′.

It was thought best to confirm the optical and crystallographic identification of the mineral as mimetite by chemical tests. Removal of sufficient material for a complete and accurate analysis would have destroyed the specimen, but 0.0060 gram of acicular crystals were picked out of inconspicuous cavities and analyzed as fully as possible. The mineral is readily soluble in cold dilute nitric acid, and from such a solution the chlorine was precipitated by silver nitrate, and after removal of excess silver and evaporation the lead was precipitated by hydrochloric acid and alcohol, the precipitates being collected and weighed on a small Gooch crucible. Part of the arsenic was volatilized by the evaporation, but hydrogen sulfide precipitated the remainder, and after removal of the excess of the reagent and evaporation with nitric acid ammonium molybdate failed to yield a precipitate, showing the absence of phosphorus.

[1] The United States National Museum equipment not including a Goldschmidt two-circle goniometer, all measurements of crystal angles described in this paper have been made on the one in the Geophysical Laboratory of the Carnegie Institution, and thanks are herewith extended to Messrs. Wright and Merwin, of that laboratory, for their kindness in placing this instrument at the writer's disposal.

The results obtained were: Lead oxide 73.3, chlorine 2.5, arsenic pentoxide by difference 24.7 per cent, agreeing closely with the theory for mimetite.

This constitutes a good example of the value of optical study of rare or unsual minerals. Had Mr. Larsen not examined this specimen and discovered that its optical properties differed from those of penfieldite, it would in all probability have continued indefinitely to be treasured as a specimen of that rare mineral, which it certainly resembles in superficial aspect more than it does mimetite.

THAUMASITE.

CRYSTALLOGRAPHIC MEASUREMENTS OF THAUMASITE.

The first thaumasite discovered, from several localities in Sweden, was massive, but proved to be optically uniaxial, showing it to belong either to the tetragonal or hexagonal crystal system, and it is so classed by Dana.[1]

The material subsequently found at West Paterson, New Jersey, was described by Penfield and Pratt as forming a loose aggregate of hexagonal prismatic crystals.[2] A terminated crystal has been recently measured by Dr. W. T. Schaller;[3] it shows the base, 0001, a pyramid p, taken as the unit, $10\bar{1}1$, and a prism, m, of the same order as the pyramid, the symbol of which is accordingly $10\bar{1}1$. The angle ρ between the pyramid and the base averaged 51° 30′, whence Doctor Schaller calculated the axial ratio of the mineral to be $c=1.09$.

Early in 1916 Mr. James G. Manchester, president of the New York Mineralogical Club, sent the United States National Museum a number of minerals from New York and New Jersey in exchange, and among the lot was 25 grams of crystallized thaumasite, representing about 50,000 tiny crystals, mostly less than 1 mm. in length.

The vast majority of the crystals, though doubly terminated, show but two forms, the first order prism and the base, but three hours' search under a binocular microscope disclosed five crystals showing several distinct pyramidal faces and a few faces of the second order prism. These were submitted to crystallographic measurement, and a preliminary announcement of the results was made in August, 1917.[4]

Shortly after the appearance of this preliminary announcement there was received in this country from Stockholm, Sweden, the April, 1917, number of the Geologiska Föreningens Förhandlingar, in which Dr. Gust. Flink announced the discovery of measurable crystals of

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[1] System of Mineralogy, ed. 6, 1892, p. 698.

[2] On the occurrence of thaumasite at West Paterson, N. J. Amer. Jour. Sci., ser. 4, vol. 1, 1896, p. 229.

[3] The crystallography of thaumasite; in Mineralogical notes, Series 3; Bull. U. S. Geol. Surv. 610, 1916, p. 130.

[4] Amer. Mineralogist, vol. 2, 1917, p. 89.

thaumasite at Longbanshyttan.[1] A supplementary note calling attention to this was then published in the American Mineralogist.[2]

The crystals described by Doctor Flink are remarkably like those from West Paterson; they agree in size, habit, frequency of double termination by base, rarity of pyramid faces, dullness of base, etchings on prism faces, etc. He found two crystals with measurable pyramid faces, on one of which two angles, from pyramid to prism, proved to be 42° 24′ and 42° 26′; the corresponding angle with the base (ρ) is 47° 35′, whence the axial ratio c=0.9479. No other forms were observed.

Some uncertainty would naturally be attached to a ratio based on two measurements on a single crystal which was admittedly rather poorly developed. When compared with the results obtained by the writer on the New Jersey crystals, which are given in full below, it will be seen that the difference between the two sets of measurements is but 30′, and the corresponding difference in axial ratio 0.017; but since the writer's value is based on 26 measurements, on four forms, on five different crystals, it is believed to be nearer the true axial ratio for the species.

The crystals measured are from 0.5 to 1.5 mm. long and 0.3 to 0.7 mm. in diameter. The basal planes are dull, and yield only faint reflections; the pyramid faces are none too brilliant, and are mostly somewhat curved, so that they distort the image of the signal a little; the prism faces are the best of all, yielding brilliant images, although the existence of intergrowth with subparallel crystals makes itself evident in frequent multiplicity of images. None of the terminations is perfect, only from one to four of the possible six pyramid faces being developed; nor were any of the crystals found to be doubly terminated with pyramids; in every case the opposite end to that showing pyramid faces is terminated by the base alone. This suggests that the mineral is hemimorphic, but this could not be confirmed by etch-figures, since etching with dilute acids and with water containing carbon dioxid yielded nothing but narrow grooves without definite crystallographic features. The rather poor quality of the faces renders the measurements somewhat unsatisfactory, but the axial ratio of the mineral can certainly be regarded as established and the presence of several new forms proved.

One pyramid appears on all five crystals, yielding fairly good reflections in several instances, and its ρ was found to average 47° 5′±15′. This is evidently the same form observed by Doctor Schaller, the discrepancy in angles being due to the fact that he was unable to obtain definite signals with his crystal, and so was obliged to locate the pyramid by maximum illumination, a method incapable of yield-

[1] Geol. För. Förh., vol. 39, 1917, pp. 447–452.

[2] Vol. 2, 1917, p. 125.

ing accurate results. This pyramid is taken as the unit 101, and yields the axial ratio for thaumasite:

$$c=0.931\pm0.003.^{1}$$

Three other pyramids and the second order prism were also observed, making the total number of forms now known on the mineral 7. The results of the measurements of the angles of these forms, contrasted with the theoretical values, are given below, and an idealized combination of all the forms in figure 3. The zone of pyramids represents Professor Goldschmidt's harmonic series N_3, three members being absent:

Observed:	Form:	0001	....	$10\bar{1}2$	$20\bar{2}3$	$10\bar{1}1$	$30\bar{3}2$	....	....	$10\bar{1}0$
	$\frac{p}{q}$:	0	....	$\frac{1}{2}$	$\frac{2}{3}$	1	$\frac{3}{2}$	....	....	inf.
Theory:	N_3 :	0	$\frac{1}{3}$	$\frac{1}{2}$	$\frac{2}{3}$	1	$\frac{3}{2}$	3	2	inf.

The combination of forms on the separate crystals are:

Crystal No.	Forms.
1	c, a, m, e, p
2	c, m, p, q
3	c, m, p, q
4	c, m, p, q
5	c, a, m, f, p, q
Majority	c, m

Measured and calculated angles of thaumasite.

[New forms marked *.]

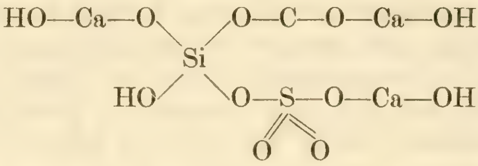
No.	Letter.	Symbol.	Number of crystals.	Number of measurements.	Measured. ϕ	Measured. ρ	Measured. $\pm$	Calculated. ϕ	Calculated. ρ
					° ′	° ′	′	° ′	° ′
1	c	0001	5	1	.. ..	0 10	30	.. ..	0 00
2	a*	$11\bar{2}0$	2	2	30 05	90 05	30	30 00	90 00
3	m	$10\bar{1}0$	5	28	0 00	90 00	60	0 00	90 00
4	e*	$10\bar{1}2$	1	4	0 00	30 00	120	0 00	28 16
5	f*	$20\bar{2}3$	1	2	0 00	38 00	120	0 00	35 38
6	p	$10\bar{1}1$	5	10	0 00	47 05	15	0 00	[47 05]
7	q*	$30\bar{3}2$	4	10	0 00	58 00	30	0 00	58 12

THE CHEMICAL CONSTITUTION OF THAUMASITE.

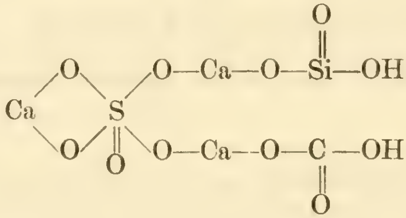
Thaumasite is one of the few minerals containing three different acid radicals, carbonate (CO_3), silicate (SiO_3), and sulfate (SO_4), as essential constituents; is it to be classed as a carbonate, a silicate,

[1] Axial ratios are often calculated to the fourth, fifth, or sixth decimal place, but when there is a variation of 3 units in the third place such extensions are without significance.

or a sulfate? Dana[1] placed it in a "concluding division" of silicates. Penfield and Pratt[2] not only accepted its interpretation as a silicate, but even wrote the following constitutional formula with silicon as linking element:



Now that it has been discovered that sulfates played an important rôle in the zeolite deposits of the Watchung Mountain region, which yield far more thaumasite than all other localities put together, the view suggests itself that this mineral is a sulfate, a derivative of anhydrite, as expressed in the structural formula below:



This formula agrees with the following facts:

1. Thaumasite is derived, in the Watchung Mountain region, by the action on anhydrite ($CaSO_4$), (or on the calcium sulfate portion of glauberite ($CaSO_4+Na_2SO_4$)), of solutions capable of depositing calcium carbonate (calcite) and silicates (zeolites).

2. It contains 15 molecules of water, but, as has been shown by Dr. H. E. Merwin,[3] 14 of these go off as the temperature is increased without a break in the dehydration curve, and must be regarded as "water of crystallization;" the last one is driven off only at red heat. The formula given shows that two hydroxyl (OH) groups are present, joined to different elements, which accounts for the high temperature needed to cause them to unite and liberate water (H_2O).

It is, of course, not to be inferred that in the crystalline mineral the atoms are actually arranged in the manner indicated, for from recent work in crystallography, especially the application of X-rays to the study of crystal structure, it is known that the atomic arrangement in crystals is based on geometrical rather than chemical relationships. Such a structural formula means, therefore, merely that

[1] System of Mineralogy, ed. 6, 1892, p. 698.
[2] Amer. Journ. Sci., ser. 4, vol. 1, 1896, p. 229.
[3] Journ. Wash. Acad. Sci., vol. 4, 1914, p. 496.

development of molecules of this structure in solutions led to the crystallization of the mineral in the first place.

Thaumasite is, accordingly, regarded as a sulfate, and it is recommended that it be described chemically as "di-hydroxy-tricalcium carbono-silico-sulfate, crystallizing with 14 molecules of water in the hexagonal system." It probably belongs in the same group as connellite and hanksite, which are similar in crystallization.

CRYSTALLOGRAPHIC MEASUREMENTS ON WAVELLITE FROM HELLERTOWN, PENNSYLVANIA.

In an abandoned iron mine 1 mile southeast of Hellertown, Northampton County, Pennsylvania, the locality of the beraunite described in an earlier paper in this series,[1] wavellite has long been known to occur, and in 1910 the writer found two specimens containing measurable crystals, which are rarely met with in this mineral.

The wavellite is in acicular crystals in divergent groups in cavities in ferruginous sandstone. These are very minute, rarely exceeding 0.1 mm. in diameter, but their faces are brilliant and yield fairly good reflections, although subparallel intergrowth renders the angles somewhat variable. The indices of refraction, measured by the immersion method, are $\alpha=1.525$, $\beta=1.535$, and $\gamma=1.550$, all ±0.005; the specific gravity is 2.325. The results of the crystallographic measurements are tabulated below. The form *p*, (121), is best developed, and gives reflections which can be read accurately to about 5′; but the results vary 30′ or more from one crystal to another, so that the axial ratio can not be determined beyond the third decimal place. The average angles for this form proved to be: $\varphi=41°\ 45'$; $\rho=47°\ 15'$, whence the ratios are: $a:b:c:=0.564:1:0.404$. In all 8 certain and several doubtful forms are present; one of their modes of combination is shown in figure 4; other crystals are like those figured by Dana.

The forms are:

b (010) well developed.
a (100) traces, in the midst of striations of prism zone.
l (430) traces, in the midst of striations of prism zone.
m (110) well developed.
n (340) traces, in striations.
p (101) prominently developed, but dull.
s (111) minute, though fairly bright.
o (121) fairly well developed, brilliant.

All the material which could be spared without destroying the specimens, amounting to 0.4 gram, was submitted to the firm of

[1] Proc. U. S. Nat. Mus., vol. 47, 1914, p. 507.

Booth, Garrett & Blair, of Philadelphia, for analysis, and the results, obtained by Mr. Frederick Wynkoop, of that firm, were:

Analysis of Wavellite from Hellertown, Pennsylvania.

	1	2	3
Al_2O_3	36.5	0.358	3.03
P_2O_5	33.4	0.236	2.00
F	0.8	0.040	13+
H_2O	28.6	1.580	
SiO_2	1.1	....	....
Total (less O=F 0.3)	100.1	....	....

1. Results of analysis; the fluorine figure is known to be too low, but the material available was insufficient for its accurate determination. 2 and 3, ratios.

This agrees exactly with the Groth formula for the mineral, $(Al(OH,F))_3(PO_4)_2+5H_2O$, which differs from that adopted by Dana in allowing for the fluorine and in recognizing the presence of an additional half molecule of water. Written in expanded form, this is $3Al_2O_3.2P_2O_5.13(H_2O, 2HF)$.

THE AXIAL RATIO OF WAVELLITE.

A number of occurrences of wavellite have been studied crystallographically, but the axial ratios obtained exhibit slight variation, as brought out in the following table, in which the determinations are arranged in chronological order:

Date.	Authors.	Source.	Axis *a*.	Axis *c*.	φ_m	$m \wedge m'''$
					° ′	° ′
1830	Senff (adopted by Dana and Goldschmidt).		0.5049	0.3751	63 13	53 35
1897	Cesaro	Belgium	0.5573	0.4084	60 52	58 16
1912	Ungemach	Pennsylvania [1]	0.5577	0.4057	60 51	58 18
1912	do	Montebras	0.5577	0.4057	60 51	58 18
1917	E. T. Wherry	Hellertown, Pa	0.5640	0.4040	60 35	58 50
Average (excluding Senff's)			0.559	0.405	60 47	58 25

[1] The locality was stated as "Cly, York Co., Pa.," but this is merely the site of the factory where the wavellite was used as a source of phosphorus; the mineral really came from Mount Holly Springs, Cumberland County.

This variation is undoubtedly due to the fact that the majority of the crystals measured have been very minute and imperfectly developed, subparallel intergrowth in particular being almost invariably present. There seems no good reason to assume that we know the axial ratio of wavellite with greater certainty than ±0.005, so the values should be stated only to the third decimal place; but the average values given are probably very close to those actually characteristic of the mineral.

EXPLANATION OF PLATE 56.

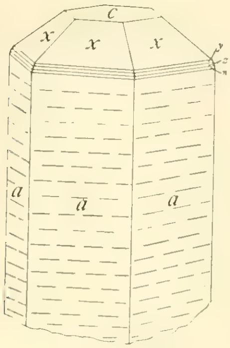
The figures are somewhat idealized diagrams of the crystals described. New forms are marked with an asterisk * below.

FIG. 1.—Mimetite, Tintic District, Utah; Prismatic habit; a combination of *c* (0001), *a* $(10\bar{1}0)$, *x* $(10\bar{1}1)$, *y* $(20\bar{2}1)$, *z** $(30\bar{3}1)$, and π $(40\bar{4}1)$.

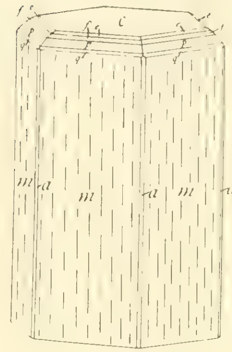
2.—Mimetite, same locality; acicular habit; *c* (0001), *a* $(10\bar{1}0)$, *b* $(11\bar{2}0)$, *h* $(21\bar{3}0)$, *x* $(10\bar{1}1)$, α* $(30\bar{3}2)$, *y* $(20\bar{2}1)$, *s* $(11\bar{2}1)$, and *m* $(21\bar{3}1)$.

3.—Thaumasite, West Paterson, New Jersey, showing all the forms observed; *c* (0001), *a** $(11\bar{2}0)$, *m* $(10\bar{1}0)$, *e** $(10\bar{1}2)$, *f** $(20\bar{2}3)$, *p* $(10\bar{1}1)$, and *q** $(30\bar{3}2)$.

4.—Wavellite, Hellertown, Pennsylvania; a combination of *b* (010), *a* (100), *l* (430), *m* (110), *n* (340), and *o* (121).



1



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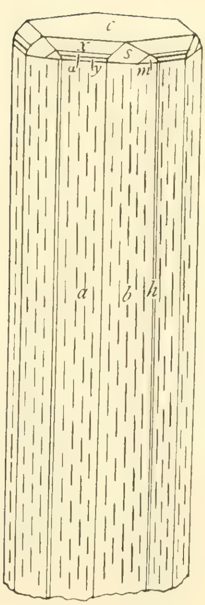

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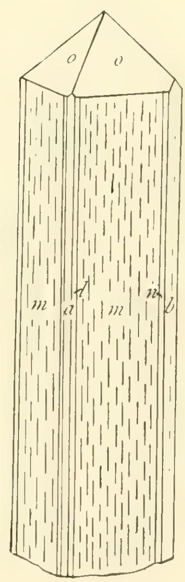

4

CRYSTALS OF MIMETITE, THAUMASITE, AND WAVELLITE

FOR EXPLANATION OF PLATE SEE PAGE 381

A NEWLY MOUNTED SKELETON OF THE ARMORED DINOSAUR, STEGOSAURUS STENOPS, IN THE UNITED STATES NATIONAL MUSEUM.

By Charles W. Gilmore,

Associate Curator of Paleontology, United States National Museum.

INTRODUCTION.

The Stegosaurs were by reason of their large size, and ornate dermal structure the more striking and characteristic of the large reptilia that inhabited the northern hemisphere in Morrison time. It should be said, however, that the family Stegosauridae is not confined exclusively to North America, for specimens have been found in England, France, and German East Africa that are but little unlike the American representatives. At this time the origin of the family is not known, though it is now generally believed that the Stegosaurs had a bipedal ancestry, and that increasing bulk and development of the dermal armor caused them to lose celerity of movement, thus becoming sluggish, slow-moving quadrupedal creatures of low mentality.

By the measurement of the brain cavity in the skull of *Stegosaurus* it is found that the brain displaces but 56 cubic centimeters of water and has an estimated weight of about 2½ ounces. This small organ directs the movements of a creature estimated to weigh several tons, while the average normal human brain has a capacity of 900 cubic centimeters in a creature weighing from 130 to 150 pounds.

The most remarkable feature of the nervous system of this great brute, however, is the enormous enlargement of the spinal cord in the sacral region, which has a mass of more than 20 times that of the puny brain. At best the intelligence of this animal was of the lowest order, hardly more than sufficient to direct the mere mechanical functions of life.

While the horned-dinosaurs, with skulls from 7 to 9 feet long, were the largest headed land vertebrates the world has ever known, the Stegosaurs are the smallest-headed when the great bulk of the body is taken into consideration. The jaws are provided with a dentition, made up of teeth so small and weak as to be always a source of wonder and conjecture as to the real character of their feeding habits. They would at least appear to indicate that their food consisted of the most succulent of terrestrial plants. The structure of the large, broad feet suggests they were land-haunting, doubtless of low, swampy regions rather than the upland, and such an environment would be the more natural place to find the soft plant life necessary for their sustenance. In addition to the small head, the great difference in the proportions of the fore and hind legs, the one most striking external feature of *Stegosaurus*, is the unusual development of the skin armor, consisting as it does of two parallel rows of erect alternating bony plates that extend from back of the skull on either side of the midline of the back nearly to the end of the tail; the tail being armed near the tip with two pairs of large bony spikes or spines. There is also a considerable number of small rounded bony ossicles that in life were held in the skin and probably formed a mail-like protection to the head and neck. The primary purpose of this armor must have been for defense, probably protective to the extent of giving the animal a most formidable appearance rather than actually useful as an offensive instrument.

While the fossil remains of these animals are not uncommon in our museums, they consist for the most part of the scattered and disarticulated bones of the skeleton. Only rarely have fairly complete skeletons been found and hitherto there has existed in our museums but one mounted skeleton, that of the Yale University Museum in New Haven, Connecticut, although now dismantled due to the tearing down of the old museum building preparatory to the erection of a new and more spacious institution.

THE MOUNTED SKELETON OF STEGOSAURUS STENOPS.

Thus the recent addition to the exhibition collection of the section of Vertebrate Paleontology in the United States National Museum of a mounted skeleton of *Stegosaurus stenops* makes it the only skeleton of *Stegosaurus* now on exhibition. Photographs as it appears in the exhibition hall are reproduced in plates 57–61.

The present specimen is a composite skeleton—that is, made up of the bones of more than one individual—but by following the type of the species (No. 4934, U.S.N.M.) the most perfect single skeleton known, as a guide, it is believed the mounted specimen gives a very accurate conception of the skeletal structure of this animal. It is based primarily on a specimen (No. 6531, U.S.N.M.) consisting of the nearly complete articulated tail, sacrum, the greater number of the dorsal vertebrae, pelvis, numerous ribs, and dermal plates. The other bones introduced are from individuals found in the same deposit of fossils, known to the collectors as "Quarry 13," located about 8 miles east of the famous Como Bluff in Albany County, Wyoming. None of the bones used in the mount were found more than 90 feet distant in the quarry from No. 6531, which forms the basis of the mount. It is quite possible that some of these bones may have originally belonged to that skeleton. A considerable number of elements for which bones of the proper size and proportions were not available have been restored. As is customary the restored portions were given a color sufficiently distinctive to make them easily recognized from the originals.

The skeleton as mounted measures 14 feet 9 inches in length between perpendicular uprights and 7 feet 11 inches high from the base to the top of the dermal plate above the hips. The Yale specimen is much larger, being 19 feet 5 inches long, and 11 feet 10½ inches from the base to the top of the highest plate. The much smaller size of the specimen in the United States National Museum may be attributed not only to its pertaining to a smaller species but also to the fact that the bones composing it were of individuals which had not reached their maximum development.

The actual articulation of the skeleton brings out some features in the proportions of the animal that would hardly be appreciated in a study of the individual bones. The wide hips (see pl. 60), necessitating a corresponding expansion of the posterior thoracic ribs, the flat-sided anterior half of the body (see pl. 59), the rapidly drooping tail, the pose being clearly indicated by the wedge-shaped centra of the anterior caudals. In the latter respect this mount is in striking contrast to the Yale specimen, which has the tail high above the ground. It was particularly gratifying to find that when the dermal plates were properly spaced above the backbone that the number required was in close agreement to an earlier expressed opinion [1] "that there are not more than 18 in the complete series of flat plates." In this specimen 19 were required to complete the two rows, and it would now appear that, allowing for some variation within the individual, there could not have been less than 18 or more than 20 plates in the complete series. The greatest uncertainty yet exists as to the exact number of cervical vertebrae. In the present mount the first 12 vertebrae are considered as belonging to the neck, thus leaving 15 of the 27 presacrals as pertaining to the thoracic region. While the type of *S. stenops* has a complete presacral series present, unfortunately those at the junction of the neck with the body are so crushed as to render them valueless for determining this important point. The cervical ribs are also partially unknown and it is not at all certain that as restored from scattered elements they represent the true shape or show the exact transition in form from the first to the last.

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[1] Gilmore, C. W., Proc. U. S. Nat. Mus., vol. 49, 1915, p. 355.

The other anatomical details of the skeleton of *Stegosaurus* have been so fully covered in an earlier paper[1] that no notice of them need be taken here except to mention that the digital formula of the forefeet is still in doubt. Following fragmentary evidence in the form of several incomplete feet in the collections, they were restored, as follows: Digit I, two phalanges; digit II, three phalanges; digit III, four phalanges; digit IV, three phalanges; and digit V, two phalanges. Digits I and II being terminated by broad, flat, hooflike unguals; the other three digits terminated by short but transversely expanded elements which in life were doubtless inclosed entirely within the muscular mass of the foot, thus giving but little, if any, external indication of their presence.

The fossil bones used in this mount were largely prepared by N. H. Boss, preparator in the section of vertebrate paleontology, who also modeled many of the missing parts. The actual mounting of the skeleton is the work of Thomas J. Horne, preparator in the same section, who is to be highly commended for the skill displayed in overcoming the many difficult mechanical problems presented. The inconspicuousness of the framework of iron necessary to support these fragile, though heavy bones shows for itself the highly skilled character of the work. For the pose of the skeleton and whatever anatomical discrepancies may be found I alone must be held responsible.

Many of the bones used in the mount are described and figured in Bulletin 89, United States National Museum, these being indicated in the appended list of bones used in the mount.

Measurements of skeleton.

Length between perpendiculars	14 feet 9 inches.
Length of tail between perpendiculars	8 feet.
Greatest width of hips	3 feet 2 inches.
Greatest height to top of highest plate	7 feet 11 inches.
Greatest width of shoulders	2 feet 10.5 inches.
Height of shoulders	2 feet 11 inches.
Height of elbow	1 foot 8 inches.
Height of hip	4 feet 10.5 inches.
Height of knee	2 feet 4 inches.

THE STEGOSAURUS EXHIBIT IN THE UNITED STATES NATIONAL MUSEUM.

In 1904 a natural size life restoration of *Stegosaurus stenops* Marsh (see pl. 62), formed a part of the United States National Museum exhibit at the World's Fair held in St. Louis during that year. At the close of the fair it was returned to Washington and there made a part of the exhibition series of the Section of Verte-

[1] Gilmore, C. W., Bull. 89, U. S. Nat. Mus., 1914.

brate Paleontology. This restoration was an enlargement to life-size of a small statuette modeled by Charles R. Knight, the well known artist and animal sculptor. Although according to our present knowledge of the skeletal anatomy it is now known to be inaccurate in some respects, taken all in all it presents a most striking picture of the supposed life appearance of this curious animal.

In 1913 the type-specimen of *Stegosaurus stenops* Marsh the most perfect skeleton known was prepared for exhibition. This skeleton as now displayed (see pl. 61), shows the precise relative position of every bone as originally found. Some important parts are missing, such as the distal half of the tail, hind feet, and some minor bones, yet it is by far the most perfect example of a *Stegosaurus* skeleton that has yet been discovered. The retention of the greater number of the dermal plates in their original relationship makes the specimen invaluable as a guide for the proper articulation of these puzzling elements in subsequently discovered specimens.

Although some bones are missing and others are slightly disarranged the position of the skeleton (see pl. 61) is that of an animal which died a natural death, for such disarrangement as exists can be attributed to the natural shifting of the bones rather than to their having been torn apart by any of the contemporary predatory carnivores.

This exhibit of Stegosaurian specimens is now made complete by the recent addition of the mounted skeleton previously described, and the arrangement in the exhibition hall of these important specimens as now displayed, is well shown in the reproduced photograph (pl. 61). The three specimens—i. e., the mounted skeleton, the skeleton in relief, and the life-sized restoration—constitute a most comprehensive and interesting exhibit of this curious dinosaur.

It is further supplemented by a small model (see pl. 63) restoracion which I prepared in 1915 of *S. stenops* one-twelfth natural size, based on the type of that species. In this model was incorporated all of the evidence relating to its external appearance, accumulated during several years study of a large series of Stegosaurian remains. It was particularly gratifying to find, after mounting the actual skeleton, that but slight changes were suggested as necessary either in the proportions or pose of the model.

When compared with the earlier restoration made by Knight (compare pls. 62 and 63), certain differences are to be observed. The most important of these is a shortening of the body, thus bringing the fore and hind limbs closer together; a reduction in the number of erect skin plates; the transposition of the largest plate of the series from above the hips to a point above the base of the tail; a reduction in the total length of the head, and the changing of its flat upper surface to a slightly convex contour which is more in conformity with the evidence furnished by several skulls of this animal now in the collections. Finally, the digits are represented as being terminated by flattened hoof-like nails rather than by elongated slightly curved claws as shown in plate 62.

The above corrections incorporated in this latest restoration (pl. 63) effect a considerable change in the proportions and general aspect of this reptile, and were only made possible by the discovery of better preserved specimens and the study of considerably greater number of individuals than were available at the time Knight made his restoration of this animal. It is to be expected that future discoveries will bring about still further modifications in our present conception of the life appearance of *Stegosaurus*.

List of bones used in the mounted skeleton of Stegosaurus stenops. No. 8612, U. S. N. M.

Bones used.	Catalogue numbers U.S.N.M.	Field numbers.	Diagram number.
Skull	4935	Sk 4 180	4
Right dentary	4935	Sk 4 180	4
Atlas	4935	Sk 4 180	4
*Axis	4935	Sk 4 180	4
*Tenth cervical vertebra	7348	123	4
*First dorsal vertebra	6531	59	13
Second dorsal vertebra	6531	60	13
*Third dorsal vertebra	6531	61	13
Fourth dorsal vertebra	6531		13
Sixth dorsal vertebra	6531		13
Seventh dorsal vertebra	6531		13
Eighth dorsal vertebra	6531		13
Ninth dorsal vertebra	6531	66	13
*Eleventh dorsal vertebra	6531		13
Twelfth dorsal vertebra	6531		13
Thirteenth dorsal vertebra	6531		13
Sacral vertebrae	6531	19	11
Fifth caudal vertebra	6531	17	11
Sixth caudal vertebra	6531	27	11
Seventh caudal vertebra	6531	28	11
Eighth caudal vertebra	6531	29	11
Ninth caudal vertebra	6531	30	11
Tenth caudal vertebra	6531	31	11
Eleventh caudal vertebra	6531	32	11
Twelfth caudal vertebra	6531	33	11
Thirteenth caudal vertebra	6531	34	11
Fourteenth caudal vertebra	6531	35	11
Fifteenth caudal vertebra	6531	36	11
Sixteenth caudal vertebra	6531	37	11
Seventeenth caudal vertebra	6531	38	11
Eighteenth caudal vertebra	6531	39	11
Nineteenth caudal vertebra	6531	40	11
Twentieth caudal vertebra	6531	41	11
Twenty-first caudal vertebra	6531	42	11
Twenty-second caudal vertebra	6531		11
Twenty-third caudal vertebra	6531		11
Twenty-fourth caudal vertebra	6531	45	11
Twenty-fifth caudal vertebra	6531	46	11
Twenty-sixth caudal vertebra	6531		13
Twenty-seventh caudal vertebra	6531		13
Twenty-eighth caudal vertebra	6531		13
Twenty-ninth caudal vertebra	6531		13
Thirtieth caudal vertebra	6531		13
Thirty-first caudal vertebra	6531		13
Thirty-second caudal vertebra	6531		13
Thirty-third caudal vertebra	6531		13
Thirty-fourth caudal vertebra	6531		13
Thirty-fifth caudal vertebra	6531		13
Thirty-sixth caudal vertebra	6531		13
Thirty-seventh caudal vertebra	6531		13
Thirty-eighth caudal vertebra	6531		13
Thirty-ninth caudal vertebra	6531		13
Fortieth caudal vertebra	6531		13
Forty-first caudal vertebra	6531		13

List of bones used in the mounted skeleton of Stegosaurus stenops. No. 8612, U. S. N. M.—Continued.

Bones used.	Catalogue numbers U.S.N.M.	Field numbers.	Diagram number.
Forty-second caudal vertebra	6531	....	13
Forty-third caudal vertebra	6531	....	13
Forty-fourth caudal vertebra	6531	....	13
Forty-fifth caudal vertebra	6531	14	13
Dermal plates:			
No. 1	7615	197	4
*No. 2	7615	196	4
No. 3	7383	47	7
*No. 4	7615	185	4
*No. 6	7584	211	4
No. 7	7584	212	4
*No. 8	7584	209	4
No. 9	7584	208	4
No. 10	7584	210	4
No. 11	7584	9	5
No. 12	7584	207	4
No. 13	4714	43	7
No. 15	6531	82	11
No. 16	6531	45	13
No. 17	6531	47	11
No. 18	6531	20	13
No. 19	6531	43	11
Dermal spines:			
Nos. 1 and 2	6531	18, 17	13
Nos. 3 and 4	6531	15, 16	13
Femur, right	7380	12	5
Femur, left	4929	216	4
Tibia, right	7380	75	5
Tibia, left	....	....	....
Fibula, right	7380	27	5
*Fibula, left	7389	161	7
Scapula, right	7361	96	5
*Scapula, left	4929	184	4
Coracoid, right	7361	96	5
Coracoid, left	2112	197	7
Humerus, right	4929	212	7
Humerus, left	4929	183	4
Ulna, right	4929	202	7
Ulna, left	4929	150	4
Radius, right	4929	16	8
Radius, left	4929	149	4
Ilium, right	6531	79	13
Ilium, left	6531	79	13
Pubes, right	6531	111	13
Pubes, left	6531	49	13
Ischium, right	6531	51	13
Ischium, left	6531	54	13
Calcaneum, right	7397	179	7
*Metatarsals I, II, and III, right foot	4280	77	5
Metatarsals I, II, and III, left foot	7349	....	....
*Proximal phalanx, digit I, right foot	4280	77	5
Proximal phalanx, digit I, left foot	7612	....	....
Ungual phalanx, digit I, right foot	7369	74	5
Ungual phalanx, digit I, left foot	7782	105	7
*Proximal phalangials, digits II and III, right foot	4280	77	5
*Proximal phalanx, digit II, left foot	7349	....	....
Ungual phalanx, digit II, right foot	7366	115	7
Ungual phalanx, digit II, left foot	7736	72	7
*Ungual phalanx, digit III, right foot	4280	77	5
Ulnare, left	4929	201	4
Metacarpals, I, IV, and V, left	4929	201	4
Metacarpal, I, right	7764	214	7
Proximal phalanx, digit I, left foot	736	3	5
Third cervical rib, left	....	....	....
First dorsal rib, left	7411	25	13
Second dorsal rib, right	7411	16	11
Second dorsal rib, left	6531	76	13
Third dorsal rib, left	7731	156	4
Fifth dorsal rib, right	7411	23	13
Sixth dorsal rib, left	7809	203	7
Sixth dorsal rib, right	6531	7	13
Seventh dorsal rib, right	6531	75	13
Seventh dorsal rib, left	6531	....	13
Eighth dorsal rib, left	6531	51	13
Eighth dorsal rib, right	7731	158	4
Ninth dorsal rib, left	7731	171	4
Fifteenth dorsal rib, right	6531	....	13
Sternal bone, right	6531	87	13

* Those elements marked with an asterisk indicate they were figured in Bulletin 89, U.S.N.M. 1914.

When numbers are missing in the above series of vertebrae, ribs, etc., it indicates that those bones were entirely restored.

The position of the bones as found in the quarry may be determined by referring to the quarry map published as plate 37 in Bulletin 89, U. S. National Museum 1914.

EXPLANATION OF PLATES.

Plate 57.

Mounted skeleton of *Stegosaurus stenops* Marsh. About 1/28 natural size. Viewed from the right side.

Plate 58.

Mounted skeleton of *Stegosaurus stenops* Marsh. About 1/20 natural size. Oblique view of right side.

Plate 59.

Mounted skeleton of *Stegosaurus stenops* Marsh. About 1/14 natural size. Viewed from the front.

Plate 60.

Mounted skeleton of *Stegosaurus stenops* Marsh. About 1/14 natural size. Viewed from the back.

Plate 61.

View of the Stegosaurus specimens as exhibited in the United States National Museum. 1. Mounted skeleton No. 8612. 2. Type of *Stegosaurus stenops* No. 4934, shown as found. 3. Life-sized restoration of *Stegosaurus stenops* No. 5794. Viewed from above. All about 1/63 natural size.

Plate 62.

Life-sized restoration of *Stegosaurus stenops* in United States National Museum No. 5794. Oblique view of the left side. Original modeled by Mr. Charles R. Knight in 1903.

Plate 63.

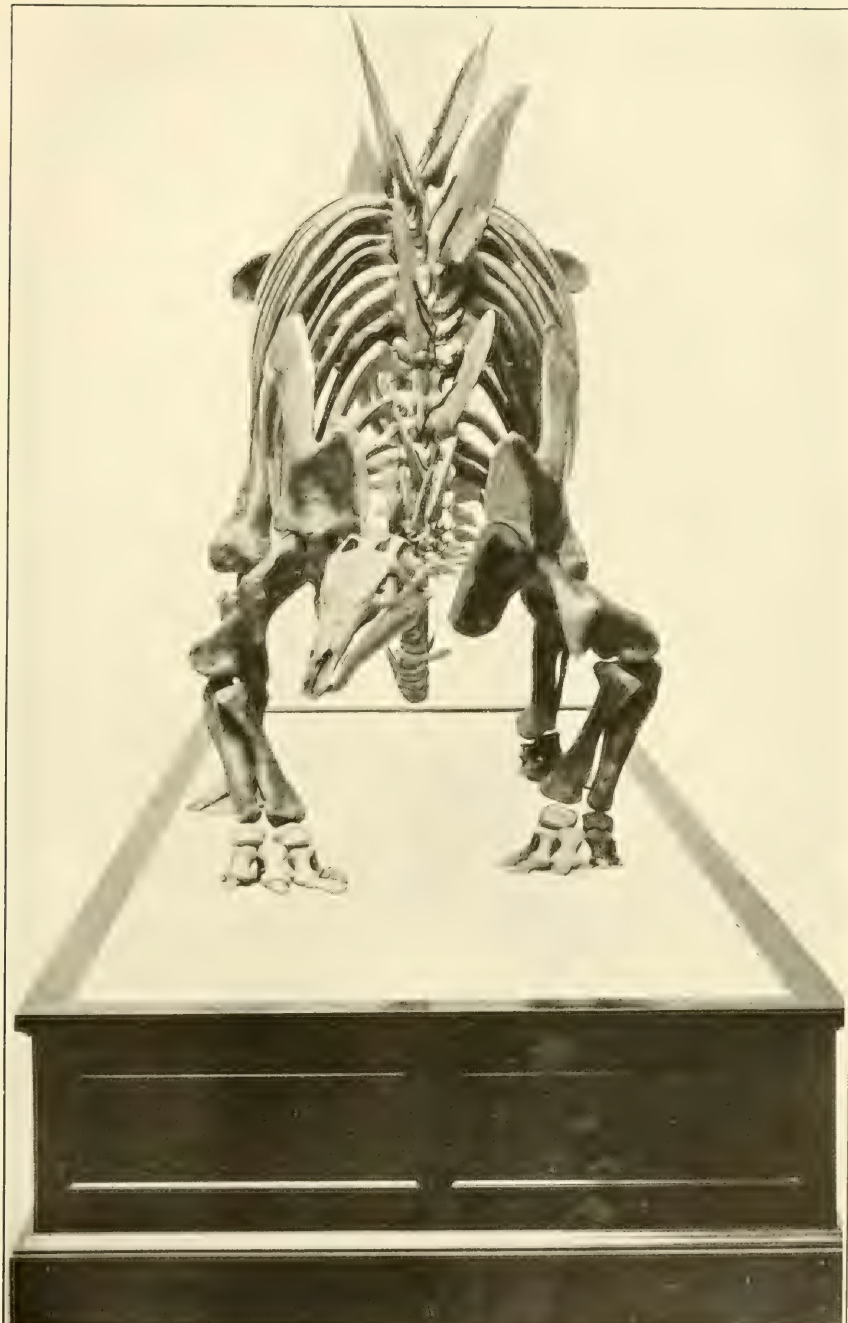
Model restoration of *Stegosaurus stenops* Marsh. About 1/27 natural size. Modeled by Charles W. Gilmore, 1915. Based on the type and other specimens in the United States National Museum.

SKELETON OF STEGOSAURUS STENOPS, FROM THE RIGHT SIDE

FOR EXPLANATION OF PLATE SEE PAGE 390

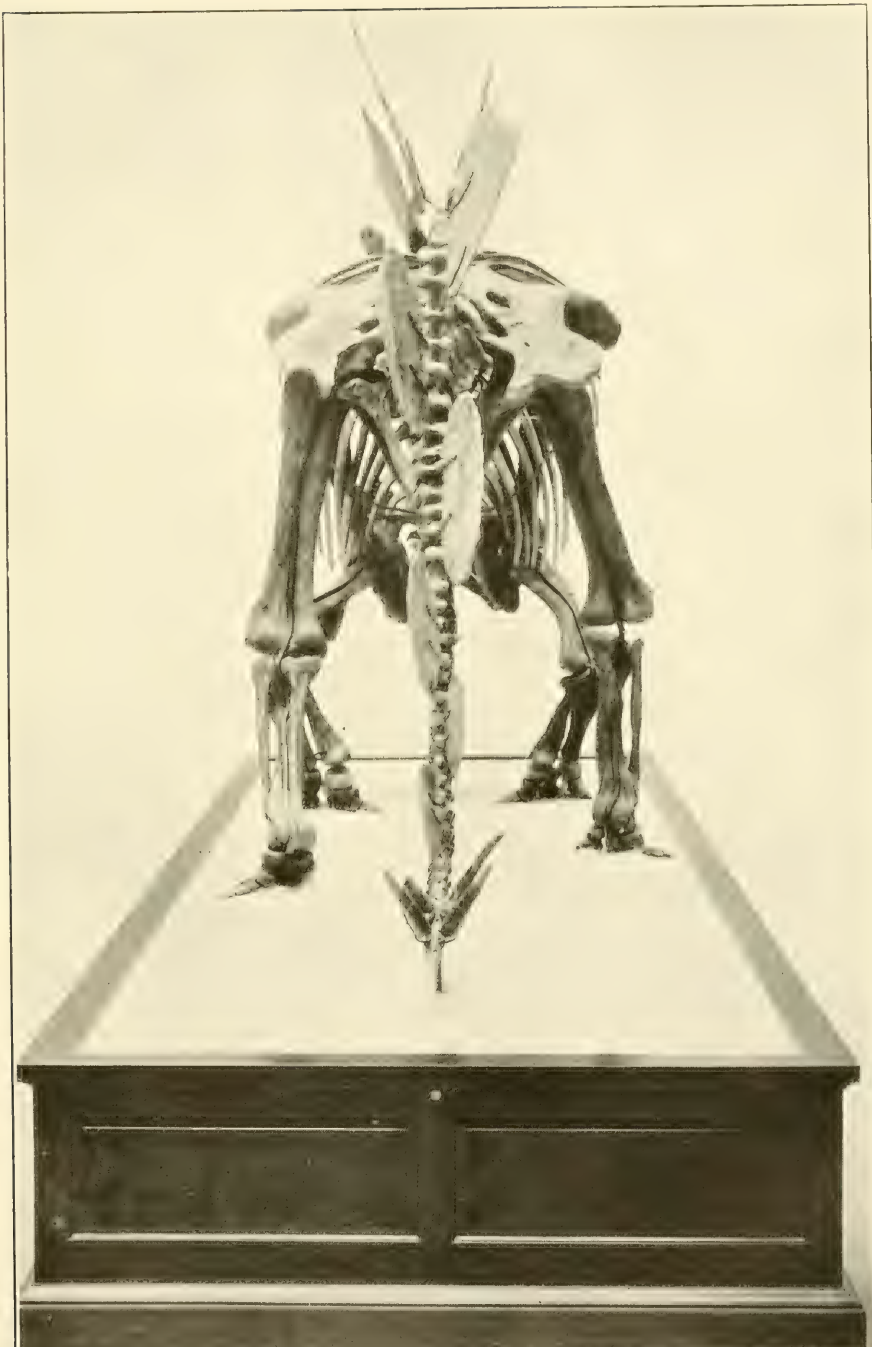
SKELETON OF STEGOSAURUS STENOPS, OBLIQUE VIEW

FOR EXPLANATION OF PLATE SEE PAGE 390.



SKELETON OF STEGOSAURUS STENOPS, FROM THE FRONT

FOR EXPLANATION OF PLATE SEE PAGE 390



SKELETON OF STEGOSAURUS STENOPS, FROM THE BACK

FOR EXPLANATION OF PLATE SEE PAGE 390.

STEGOSAURUS SPECIMENS AS SHOWN IN THE U. S. NATIONAL MUSEUM

FOR EXPLANATION OF PLATE SEE PAGE 393

LIFE-SIZED RESTORATION OF STEGOSAURUS STENOPS IN THE U. S. NATIONAL MUSEUM

FOR EXPLANATION OF PLATE SEE PAGE 390

Model Restoration of Stegosaurus stenops

For explanation of plate see page 390

THE COMPARATIVE MORPHOLOGY OF THE ORDER STREPSIPTERA TOGETHER WITH RECORDS AND DESCRIPTIONS OF INSECTS.

By W. Dwight Pierce,

Of the Bureau of Entomology, United States Department of Agriculture.

INTRODUCTION.

Since publishing in 1911[1] a number of additional species and new records of the Strepsiptera as a supplement to the Monographic Revision in Bulletin 66 of the United States National Museum, enough new material has been accumulated to occasion this second supplement. It is the expectation of the writer from time to time to continue this series of papers summarizing all the known material on this interesting order of parasitic insects.

Material has been received from T. L. Jones (Porto Rico), N. Kourdumoff (Russia), T. B. Fletcher (India), F. Muir (Hawaii), H. G. Champion (England), J. P. Kryger (Denmark), S. E. Crumb (Tennessee), and H. F. Loomis, R. C. Shannon, and J. C. Crawford (Maryland), and much of interest has been recently found in the new acquisitions of the United States National Museum. Determinations of hosts have very kindly been made by Messrs. Crawford, Rohwer, Viereck, and the late Mr. Heidemann.

A large number of errata and corrections are noted herein. The writer is under obligations to Dr. Karl Hofeneder (Austria) for corrections of many of the errors, specially the bibliographic. The most serious errors occur in the Genera Insectorum in the reference to figures and were due to a recasting of the plates by the editors and the addition of many small figures after the page proofs had been seen. No mention of these figures was made in the text or explanation of plates.

The same headings and letterings of paragraphs are used as in Bulletin 66.

[1] Proc. U. S. Nat. Mus., vol. 40, No. 1834, May 17, 1911, pp. 487–511.

BIOLOGY.

Mr. Austin H. Clark has called the attention of the author to an analogy of the parasitic life of the Strepsiptera to certain of the parasitic crabs. The sea urchin, *Strongylocentrotus gibbosus* is parasitized by a soft shelled crab, *Fabia chilensis*, which enters the host through the anal opening, while a larva, and lives in the alimentary canal as a commensal. It causes a distortion of the shell.

The very degenerate crabs, *Sacculina carcini*, etc., live in the body of other crabs and shrimps.

Mr. Ed. Foster has also called attention to the parasitic isopod, *Probopyrus bithynis* Richardson of the Bopyridae, which is parasitic on shrimps. The female in the final instar is merely a sac of eggs, while the males in this stage are triungulinid form.

RELATIONS TO HOST.

1. *Actual relationship to the host.*

RECORDS BY SPECIES.

ANDRENA NIGROAENEA Kirby.

Smith and Hamm (1914) found at Oxford, England, that the female parasites greatly outnumbered the males. Their records are based upon—

Twenty female bees 4 of which contained male puparia; 16 of which contained females.

Fifteen male bees 4 of which contained male puparia; 10 of which contained females.

The data given do not disclose the actual number of parasites contained in the 35 bees, but it was evidently larger than the number of hosts, as one specimen illustrated contained 3 females.

POLISTES ANAHEIMENSIS Provancher.

Prof. L. Bruner collected a male of this wasp at Auburn, California, July 23, 1915, with a female parasite behind the fifth dorsal sclerite.

POLISTES ANNULARIS Linnaeus.

Mr. L. T. Williams collected a female wasp at Omaha, Nebraska, August 20, 1913, which contained 3 females in the fourth lateral, fourth ventral, and fifth dorsal, and a male exuvium in the fourth ventral segments. The females were full of triungulinids.

Messrs E. G. Anderson and H. A. Jones collected seven parasitized females at Louisville, Nebraska, August 2, 1914. These seven wasps contained 58 parasites, of which 52 were males, one with 11 males, one with 8 males, one with 6 males, one with 5 males, one with 4 males and 5 females, and two with 4 males. The parasites were located as follows:

Five males protruding from the second segment, dorsal; 5 males protruding from the second segment, lateral; total, 10.

Ten males protruding from the third segment, dorsal; 7 males protruding from the third segment, lateral; 3 males protruding from the third segment, ventral; total, 20.

Five males protruding from the fourth segment, dorsal; 2 males protruding from the fourth segment, lateral; 3 females protruding from the fourth segment, ventral; 2 males protruding from the fourth segment, ventral; one female larva in the fourth segment; total, 13.

Two females protruding from the fifth segment, dorsal; 1 female protruding from the fifth segment, lateral; 2 females protruding from the fifth segment, ventral; total, 5.

The males were all pupae. The largest number of parasites in a single segment was 7 protruding from the third segment of the wasp that had 11 parasites. These were located 4 dorsally, 2 laterally, and 1 ventrally.

POLISTES AURIFER Saussure.

Prof. L. Bruner collected a female wasp at Auburn, California, August 14, 1915, with a female parasite behind the fifth dorsal sclerite. It was full of triungulinids.

POLISTES VARIATUS Cresson.

Mr. S. E. Crumb collected a female on November 10, 1915, at Clarkville, Tennessee, with four empty male puparia, three in the third dorsal and one in the fifth dorsal segment. The contents of the body cavity were very greatly crowded and reduced. On November 24, 1915, Mr. H. F. Lomis at Lanham, Maryland, collected five female wasps, four containing one female each and one with a male pupa. All the females occurred in the fifth dorsal segment, while the male was in the fourth dorsal.

POLISTES BELLICOSUS Cresson.

The writer collected, on August 25, 1913, in the Santa Rita Mountains, Arizona, a female wasp which contained four male puparia, two behind the third dorsal, one behind the fourth dorsal, and one behind the fifth dorsal segment. The wasp's body organs were considerably crowded. The ovaries contained one fully developed egg, and all the others were very small.

ODYNERUS, species.

The writer collected on August 24, 1913, at Tucson, Arizona, a female wasp which contained two female parasites, one behind the third dorsal and the other behind the fourth dorsal segment. Triungulinids were crawling on the wasp's body.

ONCOMETOPIA UNDATA Fabricius.

Mr. George D. Smith collected at Thomasville, Georgia, a female containing two female *Dacyrtocara undata*, one behind the fourth ventral and the other behind the fifth lateral plate. The leaf hopper died in captivity May 10, 1915, and was immediately placed in alcohol. The two parasites completely filled the abdomen, having absolutely emptied and destroyed the intestines, reproductive organs, and all other abdominal organs.

STENOCRANUS SACCHARIVORUS Westwood.

At Rio Piedras, Porto Rico, in November, 1913, Mr. T. H. Jones collected a large number of sugar-cane leaf hoppers, *Stenocranus saccharivorus*, abundantly parasitized by *Stenocranophilus quadratus* Pierce. A total of 150 leaf hoppers were obtained. On these leaf hoppers the following data were made, as tabulated:

Leaf hoppers.	Unparasitized.	Parasitized.
71 male	50	21
79 female	49	30
150	99	51

47.3 per cent of the leaf hoppers were males, 52.7 per cent females.

41.1 per cent of the parasitized leaf hoppers were males, 58.9 per cent females.

70.4 per cent of the male leaf hoppers were unparasitized, 29.6 per cent parasitized.

62 per cent of the female leaf hoppers were unparasitized, 38 per cent parasitized.

66 per cent of the leaf hoppers were unparasitized, 34 per cent parasitized.

The following data give more specifically the extent of parasitism found in these leaf hoppers, bringing out the percentage of sexes of the parasites and their relations to each other.

1 male leaf hopper with 2 male parasites[1] = 2 parasites.
11 male leaf hoppers with 1 male parasite = 11 parasites.

12 male leaf hoppers with 13 male parasites.

3 female leaf hoppers with 2 male parasites = 6 parasites.
13 female leaf hoppers with 1 male parasite = 13 parasites.

16 female leaf hoppers with 19 male parasites.

28 leaf hoppers with 32 male parasites.

2 male leaf hoppers with 2 female parasites = 4 parasites.
4 male leaf hoppers[2] with 1 female parasite = 4 parasites.

6 male leaf hoppers with 8 female parasites.

[1] This *Stenocranus* also contained 1 dryinid puparium.

[2] One of these also contained a dryinid puparium.

1 female leaf hopper with 3 female parasites= 3 parasites.
1 female leaf hopper with 2 female parasites= 2 parasites.
5 female leaf hoppers with 1 female parasite= 5 parasites.

7 female leaf hoppers with......................10 female parasites.

13 leaf hoppers with..........................18 female parasites.

1 male leaf hopper with 4 male, 1 female (5) parasites=4 male, 1 female=5 parasites.

2 male leaf hoppers with 1 male, 1 female (2) parasites=2 male, 2 female=4 parasites.

3 male leaf hoppers with 6 male, 3 female=9 parasites.

2 female leaf hoppers with 2 male, 1 female (3) parasites=4 male, 2 female=6 parasites.

4 female leaf hoppers with 1 male, 1 female (2) parasites=4 male, 4 female=8 parasites.

1 female leaf hopper with 1 male, 2 female (3) parasites=1 male, 2 female=3 parasites.

7 female leaf hoppers with 9 male, 8 female=17 parasites.

These figures give a total of 48 male and 29 female parasites to 51 hosts. The proportion of parasite sexes is therefore 62.3 per cent males, 37.7 per cent females. Of the female parasites 18, or 61 per cent, occurred in hosts containing no male parasites.

Arranging the parasites according to sex of hosts we find that 39.5 per cent of the males occurred in male hosts and 60.5 per cent in female hosts, while 37.9 per cent of the females occurred in male hosts and 62.1 per cent in female hosts, or taking both sexes together, 38.9 per cent were in male hosts and 61.1 per cent in female hosts.

The location of the parasites may be summarized as follows:

5 males protruding from the third segment, dorsal; 1 male protruding from the third segment, lateral; total, 6.

11 males protruding from the fourth segment, dorsal; 4 males protruding from the fourth segment, lateral; total, 15.

19 males protruding from the fifth segment, dorsal; 3 males protruding from the fifth segment, lateral; 3 males protruding from the fifth segment, ventral; total, 25.

1 male protruding from the sixth segment, dorsal; total, 1.

3 females protruding from the first segment, lateral; 1 female protruding from the first segment, ventral; total, 4.

1 female protruding from the second segment, dorsal; 5 females protruding from the second segment, lateral; total, 6.

2 females protruding from the third segment, dorsal; 9 females protruding from the third segment, lateral; total, 11.

1 female protruding from the fourth segment, dorsal; 6 females protruding from the fourth segment, lateral; total, 7.

1 female protruding from the fifth segment, lateral; total, 1.

These figures show that the majority of the males protrude from the fifth segment, and also that they are most always dorsal, while the females are mostly found in the third and are usually lateral, and almost never ventral.

The following additions should be made to the summaries of the interrelationships of the parasites and hosts on pages 25 and 26 of Bulletin 66:

SEX OF HOSTS EXAMINED.

Polistes metricus (Wheeler, 1910), 1,000 wasps; 13.7 per cent males, 86.3 per cent females.

Polistes variatus (McAtee), 61 wasps, 100 per cent females.

Stenocranus saccharivorus (Jones), 150 leaf hoppers; 47.3 per cent males, 52.7 per cent females.

SEX OF PARASITIZED HOSTS.

Andrena nigroaenea (Theobald, 1892), 40 bees; 45 per cent males, 55 per cent females.

Andrena pratensis (Friese, 1883), 32 bees; 46.8 per cent males, 53.2 per cent females.

Andrena tibialis (Enock, 1875), 45 bees; 82.2 per cent males, 17.8 per cent females.

Polistes annularis (Nebraska records), 8 wasps, 100 per cent females.

Polistes metricus (Wheeler, 1910), 251 wasps, 9.9 females.

Polistes variatus (McAtee), 31 wasps, 100 per cent females.

Stenocranus saccharivorus (Jones), 51 leaf hoppers; 41.1 per cent males, 58.9 per cent females.

PARASITISM OF MALE HOSTS.

Polistes metricus (Wheeler, 1910), 137 males; 18.3 per cent parasitized.

Stenocranus saccharivorus (Jones), 71 males; 29.6 per cent parasitized.

PARASITISM OF FEMALE HOSTS.

Polistes metricus (Wheeler, 1910), 863 females; 26.2 per cent parasitized.

Polistes variatus (McAtee), 61 females; 52.5 per cent parasitized.

PERCENTAGE OF PARASITISM ACCORDING TO SPECIES.

Polistes metricus (Wheeler, 1910), 1,000 wasps; 25.1 per cent parasitized.

Polistes variatus (McAtee), 61 wasps; 52.5 per cent parasitized.

Stenocranus saccharivorus (Jones), 150 leaf hoppers; 34 per cent parasitized.

SEX OF PARASITES.

Polistes annularis (Nebraska), 62 parasites; 85.4 per cent males, 14.6 per cent females.

Polistes metricus (Wheeler). 562 parasites; 78.8 per cent males, 21.2 per cent females.

Polistes variatus (McAtee), 66 parasites: 33.3 per cent males, 66.7 per cent females.

Stenocranus saccharivorus (Jones), 77 parasites: 62.3 per cent males, 37.7 per cent females.

MAXIMUM PARASITISM TO THE INDIVIDUAL.

Polistes annularis (Nebraska), 1 female wasp with 11 male parasites, 1 female with 8 male parasites.

Polistes variatus (McAtee), 3 female wasps with 4 parasites each.

Stenocranus saccharivous (Jones), 1 male leaf hopper with 4 male, 1 female parasite.

To the list of exceptions in which there are more female than male parasites[1] should be added the above-mentioned record of *Polistes variatus*, which, like the other two exceptions, is a winter and spring record.

It is of especial interest that in Homoptera the female parasites are placed farther forward than in Hymenoptera, while the males are farther back. In Hymenoptera the third segment is the normal position for males and the fifth for females. In *Delphax* this is directly reversed. This is probably because the Hymenopterous parasite has the female largest, while the Homopterous parasite has the male largest.

Of special interest are the two occurrences of dryinids and strepsiptera in the same host.

4. Alteration of general features.

e. Punctuation.—According to Smith and Hamm (1914), parasitized *Andrena nigroaenea* males "tend to have the abdomen dull, very much as in the female, and this appears to be due to the deeper and more frequent punctuation on the abdomen and not to a greater hairiness. The stylopised females do not appear to be affected either in punctuation or hairiness."

f. Wing venation.—In Bulletin 66, under the paragraph 5*c*, several instances of alteration of wing venation characters in bees due to stylopization were recorded.

An excellent example of how parasitism renders this valuable character instable is illustrated on Plate 73, which shows the wings of four individuals of *Agallia uhleri* parasitized by *Agalliaphagus uhleri*. The number of apical cells in the wings varies from three to six and various unusual veins occur in unexpected places. Figure 2 on this plate is almost a normal wing. The other wings show several very remarkable features, such as the veins outside the marginal in figure 3 and the complete development of all the anal veins in figure 4. The wing in figure 2 has a total of 14 cells, that in figure 4 has 18 cells.

[1] Bulletin 66, p. 27.

5. *Alteration of external sexual characters.*

SECONDARY SEXUAL CHARACTERS.

a. Color of clypeus.—Smith and Hamm (1914) have added another record of the tendency of clypeus to assume the color of the opposite sex. A stylopised female *Andrena chrysosceles* Kirby was found by Mr. Hamm at Sandford, near Oxford, England, which had the clypeus colored as in the male. An illustration is presented in their plate 35 of the normal faces of each sex and of the face of this parasitized female. The authors are in error, however, when on page 453 they write: "We have already seen that no other observer has apparently described the effect of *Stylops* on the clypeus coloration of certain *Andrena*, noticed by Perez, until we came across the case of *A. chrysosceles* published here." It is hardly conceivable how they could have made such a statement when they claim to have consulted the writer's Revision of the Strepsiptera (Bulletin 66), which on page 33 cites three such instances under the same heading as above.

The same writers also mention cases of *Andrena labialis* furnished them by Messrs. Perez and Perkins, consisting of four female bees parasitized by females, which show the faces colored as in the males, and a male bee parasitized by a male *Stylops* which shows a marked reduction of the white color on the face.

A specimen of male *Panurginus californicus* from Los Angeles, California, is at hand with the yellow on the clypeus reduced to a narrow median line.

d. Antennae.—Smith and Hamm (1914) found no evidence of modification due to stylopization in the antennae of *Andrena nigroaenea.*

e. Organs of work.—Smith and Hamm (1914), in their studies of parasitized *Andrena nigroaenea*, found "that as a result of stylopisation the male does not acquire in any degree the scopa of the female, while the scopa of the female is always to some extent reduced in size by the action of stylopisation."

PRIMARY SEXUAL CHARACTERS.

a. Ovipositor.—Smith and Hamm (1914) were unable to find any modification in this organ in stylopised *Andrena nigroaenea.*

b. Male copulatory organs.—Smith and Hamm (1914) were unable to find any modification in these organs in stylopised *Andrena nigroaenea.*

7. *Injury to internal organs.*

a. Alimentary system.—Perkins (1892) found no effect upon the digestive tract of *Andrena nana* Kirby and *Andrena wilkella* Kirby.

e. Reproduction.—Perkins (1892) writes: "In all the male specimens that I dissected the *vesiculae seminales* were found to contain active spermatozoa. On mounting in water their movements could be plainly seen through the walls. Their form was normal, and they behaved in the usual manner when treated with fluids.

Smith and Hamm (1914) found in 20 females *Andrena nigroaenea* the ovary very greatly reduced in size and incapable of producing mature ova. They gave illustrations to illustrate the extent of the reduction which occurred with both male and female parasites. They found no effect on the male testes or the production of spermatozoa.

The writer has already mentioned the reduction of the ovary in the *Polistes bellicosus* taken in Arizona. Only one mature egg was contained in the ovaries, these organs being crowded into a very small terminal space.

A still later record is that of the parasitized *Oncometopia undata*, recorded above, in which the reproductive organs were completely destroyed.

8. *Effects upon normal functions.*

Smith and Hamm (1914), with regard to *Andrena nigroaenea*, write:

We also find that stylopised females never carry any pollen on their scopae, in marked distinction from the normal females, the majority of which are found with their scopae plastered with pollen, as shown in figure 18. The stylopised females have evidently lost the instinct for collecting pollen, though they still continue to visit the burrows. Of the hundred or so stylopised females examined, not a single individual had pollen on it.

This observation conforms with Perez's generalizations; but it must be remembered that the present writer has cited *Andrena crawfordi* as often carrying pollen when parasitized.

BIOLOGY OF THE PARASITE.

Fertilization.

The question of fertilization of the Strepsiptera is still a matter of controversy. Although the evidence favoring the belief that fertilization occurs is very strong, there are a number of writers who do not accept it as even a possibility.

The evidence pointing toward fertilization is based (1) upon Smith and Hamm's (1914) statement that "the male does not show any trace of degeneracy in its internal reproductive organs, vesiculae seminales being crowded with active spermatozoa;" (2) that many observers have noted the males visiting parasitized hosts containing females; (3) that males have actually been observed in copulation by Sagemehl (1882) on *Andrena parvula*, by Crawford (Pierce, 1909) on *Panurginus innuptus*, by Muir (1906) on *Perkinsiella vitiensis*, and by Crawford on *Andrena*, species (June 12, 1916) in Montgomery County, Maryland.

The arguments in favor of parthenogenesis begin with that of Perkins (1892), who believed that parthenogenesis must occur in the parasites of *Halictus tumulorum* (*Halictoxenos species*) because out of hundreds of parasitized bees he had never found a male parasite. It is quite true that the males are seldom seen, for the writer is the only one who has ever captured an *Halictus* with a male parasite. This is no valid argument for parthenogenesis, however, because it is quite possible that the presence of a male parasite renders the flight of the host more difficult, or that observations were made at the wrong time of the year.

The next claim for parthenogenesis was set forward by Brues (1903) in his studies of *Xenos wheeleri* Pierce in *Polistes metricus* Say based upon his contention that—

> Two polar bodies are produced and the female pronucleus retreats toward the center of the egg. It is closely followed by one of the polar bodies, presumably the second; the chromatin in its nucleus assumes the reticulate form, as does also that of the second polar body, which has a much smaller nucleus and protoplasmic body than the female pronucleus. When both have nearly reached the center of the egg they place themselves side by side and finally fuse, giving rise to the cleavage nucleus.

And also because—

> There is no arrangement for the spermatozoa to reach the eggs without passing through the epithelium closing the internal ends of the oviducts and traversing a considerable part of the fat body.

Smith and Hamm (1914) consider Brues's evidence incomplete because he did not follow polar body formation, but they advance five reasons why they think parthenogenesis does occur. Their first and second reason coincide with the second referred above to Brues:

> (1) There is no opening or apparatus in the female adapted for conveying the spermatozoa to the eggs; (2) the eggs remain throughout their development incased in the follicular epithelium of the ovary, so that access to them by spermatozoa which had entered the body cavity is very difficult to imagine.

The third reason is based upon Perkins's assertion concerning *Halictus*. The fourth reason is that:

> The known stages in the polar body formation of *Stylops* are inconsistent with the view that fertilization by a spermatozoon has been effected.

Elsewhere they make a statement which does not agree with that of Brues quoted above.

> In several females the eggs have been found in an early stage of development the features of which strongly confirm our suspicion that development is parthenogenetic. In these cases all the developing eggs are at approximately the same stage of development, exhibiting two or, in some cases, more segmentation nuclei, while at the periphery of the egg a mitotic spindle is observed, which invariably exhibits a single large chromosome and three or four smaller ones often in process of division. Each egg is completely invested by the follicular epithelium.

Now, it is quite clear that the mitotic spindle must represent the first polar body in process of division. There is, however, no trace of a second polar body, which there certainly ought to be if a second polar body was given off and fertilization effected in the usual way.

Since Brues differs with Smith and Hamm concerning the numbers of polar bodies we may safely claim that in neither case has parthenogenesis been proved.

The fifth reason is that—

Actual copulation by the male has never been adequately observed.

Since Smith and Hamm claim to have consulted Bulletin 66, although they incorrectly refer to it, they evidently are indisposed to accept the three definite records of copulation having been observed, as recorded therein. It is difficult to conceive how one can more adequately observe the act of copulation.

As a supplemental reason they state that—

In a large number of colonies of infected *Andrena* it would appear that the male parasite is very much scarcer than the female, and in certain cases may have almost entirely died out.

It is of interest therefore to note the many records which have been tabulated by the writer on the sex of parasites. Up to the present time the tabulation of all counts of sex by various observers gives 1,318 males to 634 females. Of course no account has been made of the many miscellaneous single observations of stylopisation listed in the host lists of the order.

The evidence for parthenogenesis therefore consists of an inability to explain how the spermatozoa, which are conceded to exist, can reach the eggs, and of contradictory interpretations of the polar body and maturation phenomena observed in a limited number of cases. The burden of the proof lies with the advocates of parthenogenesis.

It is of course possible that parthenogenesis may occur in some cases, but its existence is still a matter of doubt.

Oogenesis.

Hoffman (1913) presents a very complete embryological study of a parasite from an undetermined host from Paraguay beginning with the blastoderm and carrying it to the triungulinid. This parasite was later (Hoffman, 1914b) described as *Xenos bohlsi.* He finds eggs in all states of development in the same parent and not all developing uniformly as found by Brues (1903). He shows the nervous system in the early embryos to consist of a cerebral ganglion and a ventral ganglion reaching to the eighth abdominal segment, but this gradually shortens until it lies in the third or fourth abdominal segment. Six sectional drawings of various stages of the embryo are presented.

The writer has many slides containing triungulinids of various species in various stages of embryonic development as well as ready to emerge, all taken from single parents.

Metamorphosis.

A speciment of *Pseudoxenos* from a female *Rhygchium* collected by F. Muir in Amboina was extracted as a perfect male in its puparium, having shed its pupal skin. The larval skins were in a compact mass at the apex of the puparium. This is the first time they have been found. The material was received preserved in alcohol, which accounts for its perfect condition.

Alimentation.

With regard to the nourishment of *Stylops melittae*, Smith and Hamm (1914) remark that:

> The skin, except where the epithelium of the brood passage is especially modified, is exceedingly thin, and the nourishment of the body must take place by absorption through this skin. There are no special cells for seizing on or elaborating a special kind of food either in the skin or elsewhere, so that we may suppose that the haemolymph of the bee affords a ready-made medium which supplies the parasite with all that is requisite.

Attraction of males to light.

In Bulletin 66 mention was made of the collection of an *Elenchus* at light in Ceylon. This was the first record of such a capture. In the supplement to the monograph (Pierce, 1911) the writer added to this species *Triozocera texana*, taken at light in Texas, and *Myrmecolax nietneri*, taken at light in Ceylon. Four more such records have now appeared in print, and another is added in this paper. The eight species thus recorded belong one in Mengeidae, one in Mengenillidae, one in Myrmecolacidae, one in Stylopidae, three in Halictophagidae, and one in Elenchidae.

AUSTROSTYLOPS GRACILIPES Lea.

Several males were collected in the greasy oil of a lamp at Bridgetown, West Australia, in 1895 (Lea, 1910).

PARASTYLOPS FLAGELLATUS Meijere.

Males were collected at lights at Semarang, Java, in January, February, October, and September (Meijere, 1911).

TETTIGOXENOS CLADOCERAS Jeannel.

The type male of this species was taken at a light at Station No. 8, south of Mombasa, at the river Ramisi, in British East Africa, in November, 1911. The type locality is illustrated (Jeannel, 1913).

NEOCHOLAX JACOBSONI Meijere.

A male of this species was collected at night in Java (Terry, 1912). The host of this species is *Ossoides lineatus* Bierman a Tropiduchid (Meijere, 1911).

CYRTOCARAXENOS JAVANENSIS Pierce.

A male was collected at light, August, 1908, at Buitenzorg, West Java, by F. W. Terry.

BIOLOGICAL NOTES.

STYLOPS MELITTAE Kirby.

Smith and Hamm (1914) write that:

At the end of April and beginning of May, 1912, the male *Stylops* was not uncommon in the vicinity of the colony of *Andrena nigroænea*, being seen on the wing at midday in sunshiny weather.

This observation was made near Oxford, England:

None were observed actually flying over the burrows of the bee and nearly all then first seen were some 10 or 15 feet from the ground.

When placed in boxes with bees containing females:

The male *Stylops*, directly it was introduced into the box, fluttered on to the bee and quickly ran over its body to where the head of the female *Stylops* was everted between the bee's abdominal segments. At this time the male is rapidly vibrating its wings and protruding its last two or three apical segments, which are long and tapering like an ovipositor.

Actual pairing did not occur on any of the three occasions.

After about 10 or 15 minutes of ceaseless running to and fro over the bee, the male *Stylops* voluntarily quitted the *Andrena*, but still continued to run and vibrate its wings for about two hours longer, after which time it dropped apparently exhausted and died shortly afterwards.

DACYRTOCARA UNDATA Pierce.

Two females extracted from a female *Oncometopia undata* Fabricius collected in May, 1915, at Thomasville, Georgia, had the body filled with eggs in an early stage of development. These females were each 7 mm. long.

MORPHOLOGY AND ANATOMY.

INTERNAL STRUCTURE.

An important article on the metamorphosis of some of the anatomical structures of *Xenos rossii*, taken at Freiburg in *Polistes gallica*, has been contributed by Paul Rösch (1913). This work is in reality supplementary to Nassonow's excellent treatises. The principle features of this discussion are the development of the eyes, the development of the cephalic ganglion, and the metamorphosis of the mesoderm.

Alimentary system.—Smith and Hamm describe the alimentary canal of a female *Stylops melittae* Kirby in *Andrena nigroaenea* as follows:

> There is a minute mouth opening, and an equally minute anus at the hind extremity, but the lumen of the gut through the body is obliterated. The whole apparatus is obviously functionless.

This description is supplemented by drawings of longitudinal and cross sections.[1]

Vascular system.—Smith and Hamm state that in *Stylops melittae* the remains of the dorsal blood vessel or heart can be recognized dorsally to the gut.[2]

The aorta is shown very indistinctly by Nassonow in *Stylops melittae* Nassonow (not Kirby).[3]

Nervous system.—To the rather limited knowledge of the nervous system in this order Smith and Hamm have added a brief description and a drawing of a section of the nervous system of *Stylops melittae* Kirby. They found only the normal three ganglionic masses, the brain, the thoracic and ventral ganglia.[4]

Tracheal system.—Although Smith and Hamm refer to Nassonow's valuable works on the anatomy of the Strepsiptera they do not seem to have used them in their own work on anatomy of *Stylops melittae.* Consequently, in their description of the tracheal system, they overlook the existence of dorsal and ventral tracheae in the abdomen as described by Nassonow both for *Stylops* and *Xenos*. They describe only a single main branch which to judge from their figure is probably the dorsal branch.[5]

Considerable mention is made in the present article of the spiracles in the discussion of the comparative morphology of the male and in the descriptions of species.

Reproductive system.—Smith and Hamm working on *Stylops melittae* have studied the brood canal and its trumpetlike invaginations and presented a number of illustrations. These illustrations are of value in that they fully corroborate Nassonow's splendid work. The writers suggest that the spiny processes of the epithelium of the brood canal are so modified as to assist the triungulinids in reaching the exterior.[6]

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[1] Smith and Hamm, 1914, p. 39, pl. 32, figs. 3 and 4, *g*.
[2] Idem, p. 439, pl. 32, figs. 3 and 4.
[3] Nassonow, 1893, *a*, pl. 2, fig. 1, *n*.
[4] Smith and Hamm, 1914, p. 439, pl. 32, fig. 3.
[5] Idem, p. 439, pl. 32, fig. 4.
[6] Idem, pp. 437, 438, pl. 32, figs. 3, 4; pl. 33, figs. 6, 7.

EXTERNAL STRUCTURE.

TRIUNGULINID.

The triungulinid or first larva (fig. 1) of the Strepsiptera resembles most in form the larvae of the Dipterous family Cyrtidae, of which the first stage of *Pterodontia flavipes* Gray has been described. This larva, of course, differs from the Strepsiptera by being legless and without mandibles. The first larvae of the Meloidae and Rhipiphoridae are very different in appearance. Those of Meloidae have the tarsus consisting of three claws (figs. 2, 3), while the Rhipiphoridae have a single claw at the base of a pulvillus (fig. 4).

The Strepsipterous hexapod larva is a well-organized larva with head, 3 thoracic segments, and 10 abdominal segments. The eyes

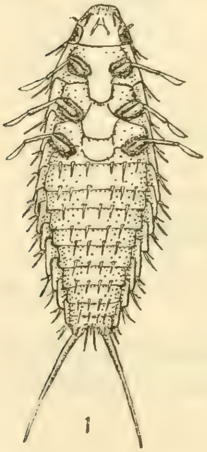

FIG. 1.—STYLOPS SWENKI. VENTRAL VIEW OF TRIUNGULINID SIZE 0.158 MM.

FIG. 2.—MELOID TRIUNGULIN. VENTRAL VIEW.

FIG. 3.—MELOID TRIUNGULIN. VENTRAL VIEW.

consist of rather large ocelli in a group. The largest ocellar lens in proportion to the size of the head is found in the hexapod larva of *Stichotrema dallatorreanum* (pl. 67, fig. 3). It has two pair of smaller ocelli. Large spots of pigment can be seen under the lenses. The antennae of *Stichotrema* are three-jointed, with an arista on the side of the second (pl. 67, fig. 5). The mouth parts consist externally of a pair of mandibles, which in Stichotrema are very large and extend backward. There is a chitinization resembling that of Dipterous larvae surrounding the pharynx (pl. 67, figs. 2–5). The legs consist of coxa, femur, tibiae, and one-jointed clawless tarsus. The episternal sclerites are quite distinct in Stichotrema (pl. 67, fig. 3). The first seven abdominal segments are normal in all species. The eighth, ninth, and tenth are variously modified. The tenth bears a pair of very long stylets (pl. 67, figs. 1, 2).

The larva of *Callipharixenos muiri* has five pair of ocelli, with each one clearly outlined as a separate eye. The tarsi are one-jointed with three terminal filaments or claws (pl. 68, figs. 4–7).

The larva of *Stylops swenki* is illustrated in text figure 1 and of *Stylops californica* on plate 71.

It is presumed that the first elongate joint of the leg is the femur, although it may be the trochanter. In the latter case tarsus would be

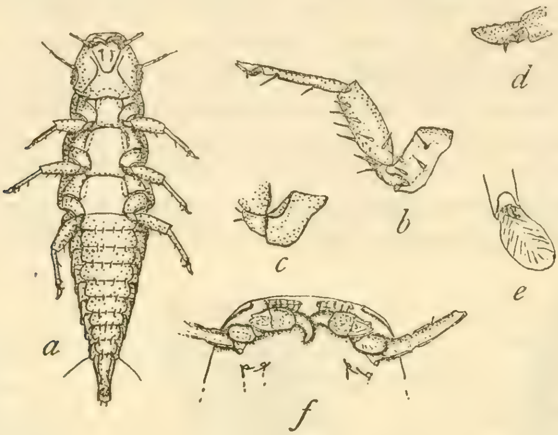

FIG. 4.—MYODITES SOLIDAGINIS PIERCE. *a*, TRIUNGULINID, VENTRAL VIEW; *b*, POSTERIOR LEG; *c*, POSTERIOR COXA; *d*, PULVILLUS, LATERAL VIEW; *e*, PULVILLUS, VENTRAL VIEW; *f*, MOUTH PARTS, VENTRAL VIEW.

absent in Stichotrema (pl. 67), *Stylops* (pl. 71, fig. 7), etc., and the writer is not willing to accept this view.

Aberrations.—Hoffman (1914*b*) describes aberrant triungulinids of *Xenos bohlsi* Hoffman and *Eupathocera sphecidarum* Dufour.

FEMALE.

The female structure is not subject to as many modifications as that of the male. In fact, so few are the characters that the writer had been obliged to use comparative measurements of the dimensions of the cephalothorax to separate species. Figure 5 represents a generalized female cephalothorax and shows the location of the measurements which are used throughout the present paper. Measurement No. 1 is the width at the spiracles (posterior pair when two occur); No. 2 is the width of the base of the head; No. 3 is the width of the head at the emargination near the base of the mandibles; No. 4 is the width of the cephalothorax at the base; No. 5 is the length from the front edge of the spiracle to apex of head; No. 6 is the length from base to apex of cephalothorax.

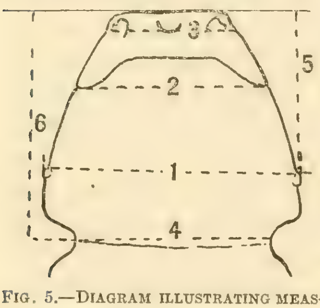

FIG. 5.—DIAGRAM ILLUSTRATING MEASUREMENTS USED IN DESCRIBING FEMALE CEPHALOTHORAX.

The mandibles show some fair characters in the genus *Stylops* and are used in the tables. The principal variation is in the number and position of the teeth. (See pl. 71.)

The spiracles furnish good characters as to number, position, and form. The Callipharixenidae have two pair of spiracles on the cephalothorax (pl. 68, figs. 1, 2). The Xenoidea have otherwise only one pair, and it is presumable therefore that this family are not Xenoid but rather Mengeoid. Abdominal spiracles have not been noticed except on *Dacyrtocara undata*, which has three pair. (pl. 74, figs. 5, 6.)

The median unpaired genital tubes are so often impossible to find because of the condition of the material that it is the writer's practice to note them whenever observed. In addition to the records already published it may be noted that *Callipharixenos muiri*, *Chrysocorixenos siamensis*, and *Stylops vicinae* have five tubes, and *Dacyrtocara undata* has two (pl. 74, figs. 5, 6).

In the Dacyrtocara the first abdominal segment extends far in front of the cephalothorax, but within the host's abdomen (pl. 74, figs. 5, 6).

The female type of *Chrysocorixenos siamensis* has an asymmetrical cephalothorax, there being a sort of tumor near the base of one side.

MALE.

The writer has from the beginning of his work on this order attempted to find other characters beside those of the appendages for use in classification. Although it was quite apparent that the legs, antennae, mouth parts, and genitalia gave a satisfactory and logical system of classification, there was always the possibility of not being able to identify the insect if the appendages were lost.

The dorsal thoracic characters were delineated in the specific descriptions in Bulletin 66, and transferred to the generic descriptions in Genera Insectorum. But the great divergence of thoracic structure did not seem to permit their use in family descriptions or phylogenetic studies.

Since the last contribution on the order many new species have been received and a study of these with a review of material already described now makes it possible to give a clearer treatment of the comparative morphology of the group.

Progression of characters.—Certain striking trends of modification are apparent. The antennae may be considered to have had typically seven joints with at least the third laterally produced, flabellate. These appendages are found in the order with any number of joints from four to seven, and with from one to five joints flabellately produced.

The tarsi are typically five-jointed with two terminal claws (pl. 64, figs. 1, 10; pl. 65, fig. 1). In the progression of characters we find four-jointed (pl. 69, fig. 1), three-jointed (pl. 75, figs. 1, 7), and two-jointed tarsi without claws.

The wings have typically eight primary veins—costa, subcosta, radius, medius, cubitus, and three anal. One or more of these is frequently absent, although the first four are always present.

The prothorax has a tendency to crowd forward into the head.

The metathoracic praescutum rises from a depressed necklike position (pl. 66, figs. 1, 5, 6) to a part of the disk (pl. 64, figs. 1, 10) and tends to crowd backward (pl. 69, fig. 1), separating the scutum into two lateral pieces and pushing the scutellum far back (pl. 76, fig. 1). The scutum, in addition to dividing on each side of scutellum (pl. 64, fig. 10), also tends to divide transversely from the base of the wing to the scutellum to form the parascutellum (pl. 65, fig. 8). The postlumbium, although normally intersegmental (pl. 69, fig. 2), has at least in one case become a chitinous part. The pleural suture frequently fails to reach the coxae (pl. 65, fig. 7). The scutellum proper never reaches the base of the wings, but a small, absolutely detached part is connected by a long axillary cord to the wing (pl. 65, figs. 6, 7; pl. 66, fig. 7; pl. 70, fig. 4; pl. 72, fig. 1).

Normally the abdomen has the ninth or genital segment ventrally greatly surpassing the tenth or anal segment, and all the other segments normal ringlike.

In the Halictophagoidea the eighth segment ventrally also is often greatly produced (pl. 75, fig. 4; pl. 78, fig. 3).

COMPARATIVE MORPHOLOGY.

Eyes.—The head is characterized by the large raspberrylike eyes with separated ommatidia. These vary slightly in shape, but are usually spherical and very hairy on the partitions. The number of ommatidia is quite variable (see the various plates).

Mouth parts.—The mouth parts are extremely simple, being merely a pair of mandibles and a pair of maxillae placed distant from the exposed pharyngeal opening. Labrum and labium are absent in the adult, although present in the last larva. The mandibles in the earlier groups are all elongate, falciform, glabrous, and chitinous (pl. 66, figs. 4, 7). In the Halictophagoidea they are often mere fleshy pubescent appendages. The mandible of *Triozocera mexicana* is the most minute yet seen, being reduced to the size of a seta (pl. 65, fig. 4). The maxillae are fleshy, pubescent appendages usually with a one-jointed palpus (pl. 74, fig. 2), but in *Crawfordia* with a two-jointed palpus. The palpus is usually terminal, but in *Triozocera mexicana* (pl. 65, fig. 5) and several species of *Xenos* it is lateral. In *Liburnelenchus koebelei* a chitinous filament is attached to the basal joint of the maxilla.

Vertex.—The head is emarginate behind in Mengeoidea, but the emargination is merely taken up by intersegmental skin (pls. 64, 65, 66). In the Halictophagoidea it is also frequently emarginate, with the thorax crowded into the emargination (pls. 74, 75, 76, 78).

Antennae.—The antennae are very remarkable in all genera of the order. They furnish an excellent basis for family characterization.

The Mengeidae have seven jointed antennae, with the third and fourth joints laterally produced, flabellate (pls. 64, 65).

The Mengenillidae have six jointed antennae with the last four joints laterally produced, flabellate (pl. 66).

The Myrmecolacidae have seven jointed antennae with the third joint laterally produced, the fourth minute, and the following joints greatly elongated (pl. 69).

The Stylopidae have six jointed antennae with the third joint only laterally produced (pl. 70).

In the Hylecthridae the antennae are five-jointed, with the third oint laterally produced, the fourth minute, and the fifth flabellate.

The Xenidae (pl. 72) and Diozoceridae (pl. 78), have four jointed antennae, with the third joint laterally produced and the fourth flabellate subequal to the produced part of the third.

The Halictophagidae have seven jointed antennae, with the last five joints laterally produced and flabellate (pls. 74–78).

The Elenchidae have five jointed antennae, with only the third joint laterally produced, but the fourth and fifth are elongate and similar to the prolongation of the third.

The surface of the antennae is extremely sensitive, being covered with little cylindrical disks which are protected by multitudes of setigerous tubercles.

Prothorax.—The prothorax throughout the order is small and reduced. Normally it is ringlike, with no differentiated parts dorsally or laterally. In *Triozocera texana* (Mengeidae) (pl. 64, fig. 2), the most generalized species available for study, the sternum has a tiny triangular area in front (presternum), a narrow transverse eusternum, a subquadrate central area (the sternellum) which is divided longitudinally and transversely by heavily marked chitinizations, a tiny poststernellum and a transverse spinasternite. The pleural area is not visibly separated from the notum or the eusternum, but posteriorly forms a hook, opposite the transverse chitinization of sternellum. These two points form the bases of attachment of coxa.

In Tetrozocera (Mengenillidae) the sternum consists solely of a spindlelike piece longitudinally divided, and which is probably composed of sternellum, precoxale, and trochantin at least, because the coxa is attached to a point at the extreme lateral tip; and a small triangular poststernellum in the middle (pl. 66, fig. 2).

Dacyrtocara oncometopiae (Halictophagidae) has the same type of prosternum but lacks the tiny poststernellum. The pronotum is pushed far forward in the head, and the pleurites are narrow strips almost invisible from above, being inclosed in the head (pl. 74, fig. 2).

Xenos hubbardi (Xenidae) has the pronotum simple, but the sternum is transversely divided into a narrow eusternum and a slightly broader band, which is longitudinally divided and has a posterior projection about the middle of each piece to which the coxa is attached. This piece is therefore the sternellum+precoxale+trochantin+episternum+epimeron.

Pyrilloxenos compactus (Halictophagidae) furnishes the best opportunity for understanding the prosternal and mesosternal areas. The eusternum is a narrow transverse piece. The sternellum is longitudinally divided. Each side forms a half ring, composed also probably of precoxale and trochantin, between the points of which the coxa is attached. This is the only prosternum in which a distinct pleural suture has been noticed. The episternum reaches the coxal attachment in front of the suture and behind it the epimeron is divided, reaching the coxa as hypoepimeron. The epimeron is slightly visible above. Episternum is not visibly separated from the epinotum (pl. 77, fig. 2).

Anthericomma barberi (Halictophagidae) has a very interesting prothorax. The pronotum is a circular disk completely inclosed by the head and mesonotum. The pleural region is completely within the mesopleurum. The sternum consists merely of two oval pieces longitudinally separated, to which the coxae are attached, and at each side of which appear parts of mesosternum. These two pieces are the combined parts of sternellum, precoxale, and trochantin.

In *Delphacixenos anomalocerus* (Halictophagidae) the pronotum is even smaller than in the preceding species, and the prosternum is similarly reduced.

In summary therefore we may describe the prothorax as a very highly modified segment with the parts crowded and often fused.

The prolegs are composed of a tiny coxa at the base of an elongate trochanter, femur, tibia, and tarsus. In previous works the coxa was overlooked. Practically all the important variation is in the tarsus, which is five-jointed with two claws in the Mengeoidea (pl. 64–66), four-jointed without claws in the Xenoidea (pls. 69, 70, 72), three-jointed in the Halictophagoidea (pls. 73–78), and two-jointed in the Elenchoidea. In the Mengeoidea the first three joints are cylindrical, the fourth flattened with pulvillus, the fifth elongate with pulvillus. In the Halictophagoidea the first joint is often very broadly flattened, pulvillate, and the succeeding joints are narrower, the last elongate (pl. 74, fig. 1). The femur and tibia are greatly shortened and broadened in *Pentozoe peradeniya* and *Dacyrtocara oncometopiae* (pl. 74, fig. 2).

Mesothorax.—The mesothorax throughout the order is small and reduced, but not so much as the prothorax. Normally it is ring-like. The mesonotum of *Triozocera texana* (Mengeidae) is transversely faintly divided into two parts, the front probably best considered as the scutum and the posterior part the scutellum. The elytra or balancers are club-shaped and attached near the front of the pleural zone. They have a tiny hook at base, which probably assists in the noise making produced when the elytra are in vibration. The pleural zone immediately beneath the attachment of the elytra is broadly lobately produced and has the anterior edges rough. This may serve as a sort of drum. The lobe is the episternum+epimeron, and probably includes the trochantin in its posterior hook to which the coxa is attached. The sternellum is quadrate and longitudinally divided; the eusternum is a transverse band laterally enlarged and partially merging in the episternal lobe. It is depressed in the enlarged portion and bears a long stigmatal opening (pl. 64, figs. 2, 5).

There is a distinct anal lobe on the elytron of *Xenos auriferi*, *Stylops championi*, and *Neostylops Shannoni.* It has not been noticed on other species (pl. 70, fig. 6).

Tetrozocera santchii (Mengenillidae) has a simple band-like mesonotum, but the mesosternum has three transverse areas, the presternum, eusternum, and sternellum. The latter is longitudinally divided, each half being triangular with the coxae attached at the lateral angles. The epimeron is only visible from the side (pl. 66, fig. 2).

In *Muirixenos dicranotropidis* (Halictophagidae) the mesonotum consists of three transverse distinct areas—the praescutum, scutum and scutellum, and postscutellum (pl. 76, fig. 1). These areas are also distinct but differently formed in *Pentozoe peradeniya*, and *Dacyrtocara oncometopiae* (pl. 74, fig. 1).

In *Delphacixenos anomalocerus* only two transverse dorsal areas are distinguishable, the front piece being praescutum. This condition is also found in *Pyrilloxenos compactus.*

Dacyrtocara oncometopiae has the eusternum large, triangular, extending between the hooks of the sternellum. The episternum is large, lobed beneath the base of elytra, and posteriorly forms with trochantin the hook to which the coxa is attached (pl. 74, fig. 2).

Pyrilloxenos compactus has the most parts to its mesosternum of any species examined. The eusternum is large, triangular, as in the preceding, and separates the two hooks of sternellum. The half ring, at the ends of which coxa is attached, consists of three distinct parts, sternellum, precoxale, and trochantin. The pleural suture separates episternum and epimeron to the tips of the hooks formed with trochantin (pl. 77, fig. 3).

The middle legs are like the anterior legs except that in the Halictophagidae the first tarsal joint is usually mucronate. The coxae and tronchanter are apparently often fused. The coxa is never more than a tiny basal piece of trochanter.

Metathorax.—The metathorax is the dominant part of the body of the male strepsipteron and is the part most characteristic of the order as a whole. It differs most from other orders in the prominence of the postlumbium throughout the order, and the unusual development of the postscutellum. The pleural suture is almost horizontal and longitudinal instead of vertical, as is usually found in other orders. The posterior attachment of the wings is very distant from the lateral prolongation of the scutellum and if attached at all the axillary cord is very long.

In view of the fact that the metathorax has been illustrated for each genus and fully described in the generic descriptions, this discussion will take up the various parts separately and trace their modifications.

Praescutum.—The anterior visible piece of the metanotum is the praescutum. It is as broad as the scutum, and band-like as the pronotum and mesonotum in *Mengea* (Mengeidae) (pl. 64, fig. 1), large and broad and not fully separated from the scutum in *Triozocera* (Mengeidae) (pl. 64, fig. 10; pl. 65, fig. 1); suppressed as a neck in *Tetrozocera* and *Austrostylops* (Mengenillidae) (pl. 66, figs. 1, 5); raised to the disk but narrower than scutum in *Mengenilla* (Mengenillidae) (pl. 66, fig. 6). In these two families which form the Mengeoidea the praescutum lies entirely in front of scutum and scutellum and does not in any way push backward.

In the remaining superfamilies the praescutum lies between the lobes of the scutum and its anterior line is more or less continuous with the anterior line of the scuti. In *Myrmecolax* the scuti somewhat constrict the praescutum before its posterior apex, but in *Caenocholax*, also of the Myrmecolacidae, this piece is semioval (pl. 69, fig. 1). In both genera of Myrmecolacidae it is longer than broad.

In Xenidae the praescutum varies but little, being either semilunar or keystone-shaped and broader than long (pl. 72, fig. 2).

In Diozocera (Diozoceridae) it is oblong, and in all Halictophagidae it is longer than broad, varying more or less in shape from oblong in Anthericomma and semielliptical in Pentozoe to pyriform in Pentozocera.

In Elenchidae it is elongate, very greatly narrowed behind (Deinelenchus) and sometimes constricted (Liburnelenchus).

Scutum.—This part is the next transverse dorsal sclerite behind the praescutum, but in most Strepsipterous genera would not be recognized as transverse. It is always strongly lobed. Normally the two lobes are connected behind the praescutum and in front of the scutellum, but this connection is only to be found in a few genera:

In *Triozocera* (Mengeidae) the scutum is narrowly connected with the praescutum on each side of the anterior apex of scutellum. It is greatly produced posteriorly (pl. 64, fig. 10; pl. 65, fig. 1). In *Mengea* it is very narrowly united in front of the broader scutellum (pl. 64, fig. 1). The lobes are posterior. The same condition exists in *Tetrozocera* (Mengenillidae) (pl. 66, fig. 1).

On the other hand, the pushing of the praescutum into the scutum in the Xenoidea and subsequent families has made the scutum humerally lobate. The bridge between the lobes occurs also in *Caenocholax* (Myrmecolacidae) (pl. 69, fig. 1), *Neostylops* (Stylopidae) (pl. 70, fig. 1), *Cyrtocaraxenos* (Halictophagidae) (pl. 78, fig. 1), and *Deinelenchus* (Elenchidae).

In all other genera studied the scutum occurs as two lateral humeral lobes separated by praescutum and scutellum (see pls. 66, 72, 75, 76, 77).

Parascutellum.—The scutum in the more generalized genera was bounded by praescutum, scutellum, and epimeron, but early in the modification of the group a suture appears, beginning at the anterior base of the wing and extending diagonally toward some part of the scutellum. This does not occur at all in *Tetrozocera* (Mengenillidae) (pl. 66, fig. 7), and is incomplete in *Triozocera* (Mengeidae) (pl. 65, fig. 8), *Neostylops* (Stylopidae) (pl. 70, fig. 4), *Myrmecolax* (Myrmecolacidae), *Halictoxenos*, and *Crawfordia* (Xenidae), *Diozocera* (Diozoceridae), and *Deinelenchus* (Elenchidae). It is complete in *Caenocholax* (Myrmecolacidae) (pl. 69, fig. 2), *Xenos* (pl. 72, fig. 1) *Pseudoxenos*, and *Tachytixenos* (Xenidae), all Halictophagidae (pl. 75, fig. 2; pl. 76, fig. 5; pl. 78, fig. 3), and *Liburnelenchus* (Elenchidae). The part behind the suture is called parascutellum because it is beside the scutellum.

Scutellum.—The third median sclerite of the metanotum is the scutellum, which is invariably broadest at its base, and anteriorly is more or less rounded or constricted. In the Megeoidea it reaches forward almost as far as the scutum and is subtriangular, but rounded at apex in *Triozocera* and more broadly rounded in *Mengea*. In these two genera it does not separate the scutal lobes completely.

In *Austrostylops* (Mengenillidae) the scutellum is very long and broadly separates the scuti in front. In *Tetrozocera* it is similar to that of *Mengea*. In *Mengenilla* it is shaped as in *Triozocera* and narrowly separates the scuti (pl. 66, fig. 6).

In *Myrmecolax* and *Caenocholax* (pl. 69, fig. 1) (Myrmecolacidae) the scutellum is short and broadly rounded. In *Neostylops* it is longer and broadly rounded (pl. 70, fig. 1).

Throughout the Xenidae scutellum is longer than praescutum (pl. 72, fig. 2). In *Crawfordia* it is anteriorly very broad, a little less so in *Halictoxenos* and truncate at apex, and in the true *Xenini* it is constricted, pedunculate at apex.

Diozocera (Diozoceridae) has a short broadly rounded scutellum. In all the Halictophagoidea and Elenchoidea the scutellum is short and transverse, but variously curved or truncate on its anterior margin (pls. 74–78).

In other orders of insects the scutellum laterally reaches the posterior attachment of the wing, being connected therewith by the axillary cord. In the Strepsiptera the base of the scutellum is very far behind the posterior attachment of the wings, but in several genera (*Triozocera*, *Neostylops*, *Xenos*) there is a cord from the base of the wing running back and attached to a tiny sclerite on the epimeral area (pl. 65, fig. 6; pl. 66, fig. 7; pl. 70, fig. 4; pl. 72, fig. 1). In *Xenos vesparum* there is a small piece detached from scutellum but next to it and between the parascutellum and postscutellum, and beyond this is the little piece to which the cord is attached. This would indicate that two little pieces of scutellum have separated off and in later genera disappeared completely (pl. 72, fig. 1).

Postlumbium.—This flexible area behind the base of scutellum is always present and always transverse. It lies in an emargination of the base of the postscutellum, practically at the transverse axis of the body. It is usually soft intersegmental skin, but in *Eupathocera* is chitinized and of the same texture as the remainder of the notum. (See all plates with illustrations of males.)

Postscutellum.—The fifth median zone of the metanotum (counting scutellum as the second) is the postscutellum, which is the largest single piece on the entire body. It extends back far over the abdomen and is concave, allowing considerable flexibility to the abdomen, which can, to a large measure, be retracted into it in some genera. (See all plates with illustrations of males.)

Pretergite and prealare.—Pretergite occurs in front of the praescutum, but so far has only been seen in *Delphacixenos anomalocerus* (Halictophagidae). The prealare is recognizable besides the scutum or praescutum and in front of the base of the wing (pl. 75, fig. 2).

Wing sclerites.—A number of tiny pieces occur around the attachment of the wing, but have not been carefully studied (pl. 64, fig. 2; pl. 75, fig. 2).

Pleurotergite.—Between the postscutellum and epimeron or hypoepimeron is an elongate area known as the pleurotergite, and probably derived from the postscutellum. In *Tetrozocera* and other genera this is apparently divided into two pieces (pl. 66, fig. 3).

Wing.—The wings are attached far front on the metathorax, being surrounded at their base by prealare, tegula, scutum, parascutellum, epimeron, and episternum, with certain tiny pieces difficult to under-stand. The scutellum is only connected distinctly by the cord to the tiny area far behind on epimeron opposite the base of the scutellum.

The wing venation typically consists of eight radial veins, costa, subcosta, radius, medius, cubitus, and three anal. The costa is but a short humeral thickening, beside the subcosta, which arises from it and braces the anterior margin to the middle of the wing. In *Triozocera* (pl. 64, fig. 2) the radius and medius do not have basal connections, but appear to arise from subcosta. Cubitus is isolated. The first and second anal arise from a strong basal area, and the third anal is represented by a darkened area only. In this genus a detached piece of radius strengthens the border beyond the apex of subcosta. Medius has beyond the middle two detached branches, one in front and one behind.

In *Pyrilloxenos* the number of veins is as above with the exception of the second medial branch and the third anal, both of which are lacking. Here radius branches from medius, and these with cubitus have a common source (pl. 77, fig. 7).

The cubital and anal veins are less stable than the others, and in the Elenchidae only one of them persists. The number of detached branches of radius and medius is also variable and has been discussed in previous contributions of the writer.

Pleural suture.—This suture between the episternum and epimeron is diagonally longitudinal from the base of the wing to the coxa, as in *Diozocera insularum* (Diozoceridae) (pl. 78, fig. 7), and *Tetrozocera santchii* (Mengenillidae) (pl. 66, fig. 3). It is often terminated on the sternum opposite the junction of eusternum and sternellum, as in *Xenos* (pl. 72, fig. 1).

Epimeron.—The epimeron is usually a very narrow elongate piece, reaching the base of the wing in a point and extending back above the pleural suture and beyond it to the coxa. It is sometimes separated into several parts. In *Tetrozocera* it is one continuous unbroken area from wing to coxa and hardly varies in width (pl. 66, fig. 3). In *Triozocera* it is interrupted by the small detached scutellar piece to which the axillary cord is attached (pl. 65, fig. 6). A similar piece of scutellum with attachment to the axillary cord occurs on the epimeral area of *Neostylops crawfordi* and *Xenos vesparum*. We may consider the part of epimeron in front of this little piece the epimeron pteropleurite and the posterior part which reaches the base of the coxae as hypoepimeron (pl. 65, fig. 6; pl. 66, fig. 7; pl. 70, fig. 4; pl. 72, fig. 1).

In many species epimeron also shows relationship to the sternellum (furcasternite of Crampton). This is in case the pleural suture does not reach the coxa, as in *Triozocera* (pl. 65, fig. 7), *Xenos* (pl. 72, fig. 1), and *Delphacixenos* (pl. 75, fig. 2), in which case epimeron and sternellum are fused.

Episternum.—The episternum is a well-defined, always closed area, beginning at the base of the wing, usually longitudinally elongate, and always inferior to the pleural suture. It is sometimes bilobed with a large lobe extending forward to the front of the sternum and with the alar lobe smaller and acute, as in *Triozocera mexicana* (pl. 65, fig. 7). The episternum is much broader in *Delphacixenos anomalocerus*, but is bilobed. The episternum proper is the lobe to the wing; the inferior lobe is the lateropleurite. The episternum never reaches the coxal area in the strepsipterous metathorax and in this it greatly differs from most orders of insects (pl. 64, fig. 2; pl. 65, fig. 7; pl. 66, figs. 3, 7; pl. 69, fig. 2; pl. 70, figs. 2, 4; pl. 72, fig. 1; pl. 75, fig. 2; pl. 76, fig. 5; pl. 78, figs. 3, 7).

Sternum.—The Strepsipterous sternum is a large area without distinct sutures but always having a strong median longitudinal chitinization behind. This chitinization divides the sternellum into two parts. The sternellum (furcasternite) is transversely separated from eusternum (basisternite) in front of it, mereby by a faint line, which is sometimes distinct at the sides, where it branches from the pleural suture. The anterior area or presternum is also indistinctly separated by a faint line (pl. 64, fig. 2; pl. 65, fig. 7; pl. 66, fig. 2; pl. 69, fig. 3; pl. 74, fig. 2; pl. 75, fig. 3; pl. 76, fig. 5; pl. 77, fig. 4).

Sternellum.—The sternellum, as has been said before, is sometimes fused with epimeron. It usually also contains the precoxale and trochantin. It is always, however, distinctly separated from the coxa, to which the trochanter is loosely articulated.

Postcoxale.—In Tetrozocera a tiny strip continuing from epimeron passes behind the coxa (pl. 66, fig. 2).

Poststernellum.—In Tetrozocera there is also a small piece between the coxae, which is probably the poststerellum (postfurcasternite) (pl. 66, fig. 2).

Abdomen.—The Strepsipterous abdomen contains 10 segments, of which the first two or three are usually greatly interrupted or crowded dorsally and ventrally, but normal laterally between the postscutellum and the hypoepimeron (called femoralia by early writers). The first abdominal spiracle occurs near the anterior margin of the first segment near the lower pleurotergite of the metathorax (pl. 64, fig. 7; pl. 65, fig. 9; pl. 66, fig. 3). The other spiracles are usually difficult to find, but in *Tetrozocera santchii* there are eight abdominal spiracles (pl. 66, fig. 3).

The ninth segment is always ventrally produced beyond the tenth, which is merely a little flaplike covering of the large concavity made by the ninth. At the tip of the ninth is the oedeagus, a chitinous unpaired median tube with a subapical pore for the exertion of the penis. This oedeagus rests in the depression of the ninth and is apically covered by the flap of the tenth segment. The shape of the oedeagus differs very greatly between genera and slightly between species (pl. 64, fig. 8; pl. 65, fig. 10; pl. 72, fig. 7; pl. 74, fig. 4; pl. 75, fig. 6; pl. 76, fig. 4; pl. 77, fig. 8; pl. 78, figs. 5, 6, 9, 12).

The tenth segment bears the anal pore. The eighth segment is in some Halictophagidae (Pentozoe, Pyrilloxenos, Delphacixenos, Pentacladocera) produced beneath the ninth segment (pl. 75, fig. 4; pl. 78, fig. 3). Otherwise, it is normal, ringlike.

CLASSIFICATION.

REASONS FOR CONSIDERING THE STREPSIPTERA AN ORDER.

Argument based on rules of establishing an order.

In 1813 Kirby set down an excellent set of four rules for the establishment of an order of insects, to which the present writer added a fifth and its converse in Bulletin 66. Taking these rules one by one we may consider the evidence supporting the contention that the Strepsiptera must be considered an order.

Rule I. *When an insect in its perfect state combines the characters of two or more orders (unless it be deemed advisable to place it in an order by itself), it should arrange with those whose metamorphosis is the same.*

The Strepsiptera do not combine the characters of any two or more orders, being easily distinguishable in either sex from all other insects. They have the usual parts belonging to the insect anatomy with certain exceptions. Some of the peculiarities of structure have counter parts in other orders, such as the flabellate antennae, the oedeagus, the ensiform mandibles, the elongate trochanters. They do not conform in type of metamorphosis with any other order, although certain features of the metamorphosis have counterparts in other orders. For instance, we find viviparous reproduction occurring here and there in other orders, but none showing it as a constant type; we find hexapod first larvae and legless later larvae in various families of Coleoptera; we find pupation in a puparium or last larval skin in Diptera and rarely in Coleoptera; we find a similar pupa in Hymenoptera; but we do not find any order in which the entire Strepsipterous type of metamorphosis is duplicated. Hence, on the basis of Rule I, we are obliged to consider the Strepsiptera an order.

Rule II. *When an insect possesses the characteristics of one order and the metamorphosis of another, in this case it should follow the characters.*

The Strepsiptera do not fit this premise in any way. There is therefore no reason under Rule II for aligning them with any other order.

Rule III. *Where an insect exhibits the metamorphosis of an order, or of a section of it but none of its characters nor those of any other* *order, it should not on that account be arranged in such order, but, on the contrary, form a distinct one.*

The metamorphosis of the Strepsiptera is classed as hypermetamorphic, beginning with larviparous reproduction of free living hexapod larvae, which are conveyed by various means to the larvae of their future hosts. These hexapods after beginning the parasitic existence distend and become legless, and each succeeding molt makes the female more degenerate, while the males undergo a transformation of specialization. Both sexes exsert the head and thorax from the abdomen of the host as larvae, and the male pupa is formed within this last larval skin. The female remains imprisoned within the last larval skin and has no pupal stage, remaining absolutely larviform.

The larviparous reproduction occurs in the family Micromalthidae of the Coleoptera, in Hemiptera, in Diptera, and elsewhere in insects. There is nothing on this score to associate the Strepsiptera to any one of these orders. The hexapod larva of the Strepsiptera has its counterparts in the triungulin of the Meloidae (figs. 2, 3), the triungulinid of the Rhipiphoridae (fig. 4), the planidium type of larvae in the Hymenoptera, and especially the first larvae of the Dipterous family Cyrtidae. The larvae of *Pterodontia flavipes* Gray of the Cyrtidae are parasitic in spiders. They look more nearly like a Strepsipterous triungulinid than any of the others but are distinguished by the absence of legs. The internal chitinous structures of the Strepsipterous larvae and the backward pointing mandibles are points of resemblance to the Diptera and of separation from the Coleoptera.

However, no other insects have a metamorphosis which is similar throughout to the Strepsipterous type, and we have but one type in the entire group. Metamorphosis can not link the Strepsiptera to either the Diptera or the Coleoptera because the structure is not similar to either of these orders.

Rule IV. *Where the genera which compose an order have invariably one kind of metamorphosis, no insects that vary from it in that circumstance should be placed in it, unless they exhibit a perfect agreement with it in characters.*

The genera of Strepsiptera have invariably one type of metamorphosis. They can not therefore be placed with any other order which has a different type of metamorphosis. This precludes their being placed in the Coleoptera, Neuroptera, Diptera, or Hymenoptera, with all of which various authors have associated them. Certain Coleoptera have a type of hypermetamorphosis with points of similarity, but these Coleoptera by virture of their characters, under Rule II, remain Coleoptera. The Strepsiptera could only be arranged with them if they exhibited a perfect agreement in characters. They do not agree with any part of the Coleoptera in their characters. Therefore by Rule IV the Strepsiptera are an order.

Rule V. *When insects formerly placed arbitrarily in some of the older orders are found by paleontology to be a distinct line of descent from the order with which they have been ranked, and show decided difference from this order in structure or in metamorphosis, they should be separated out to form a new order.*

In converse: *Insects which should be separated from an older order in accordance with any of the preceding rules, and yet which show a common origin, must also constitute a new order.*

The Strepsiptera are at least Tertiary in age, and possessed in that period all of the essential characters which so well distinguish them now from other orders. The geographic distribution of the group, in every faunal zone of the globe, especially their occurrence in the South Seas, in Australia, and the Malay Archipelago, is evidence of a very ancient origin. It is of great interest that the most primitive superfamily contains representatives in Australia, Algeria, Mexico, and Germany.

No group of insects has yet been found with which the Strepsiptera can be associated phylogenetically. They stand alone in their peculiar structure and habits.

The evidence therefore is all for their separation as a distinct order.

The assemblage of characters which distinguish the order may be summarized below. It must be understood that analogies may be found to many of these characters singly, but that the combination nowhere else is to be found.

CHARACTERISTICS DISTINGUISHING THE ORDER.

Morphological characters.

1. Dissimilarity of sexes, the male winged, hexapodal, active; the female blind, wingless, legless, inactive.

2. A regular sequence of structural modifications from primitive to highly specialized, is observable throughout the order, paralleling yet not approaching similar evolutions in other orders, and in some ways more remarkable.

3. The male thorax, which is undoubtedly the most important ordinal character, is absolutely different from the thorax of all other orders. The thorax of *Myodites solidaginis*, a Rhipiphorid, is shown in plate 69, figures 4, 5. This is the only Coleopterous family which any author has tried to ally to the Strepsiptera.

a. The prothorax and mesothorax are both greatly reduced, and the metathorax is preponderant. This is the only group of insects in which the metathorax has received the preponderance of size. Certain Coleoptera have a greatly enlarged metathorax but they also have the prothorax greater than the mesothorax. The greatest reduction of Coleopterous thorax occurs on the mesothorax (see pl. 69, fig. 4). The greatest reduction of Strepsipterous thorax occurs on the prothorax.

b. The prothorax never consists of more than a tiny ring, but it is often crowded far forward into the head until the pleurae are reduced to mere intersegmental skin.

c. The mesothorax is a little larger than prothorax, with several small pieces, all separated by intersegmental skin. There is no strength in this segment.

d. The seat of bodily power is entirely in the metathorax, which embraces over half the body.

e. The head is separated from the thorax, and each segment of the thorax from the others by intersegmental skins; furthermore the various pieces of the prothorax and mesothorax are likewise separated. In addition to this longitudinal freedom of movement there is also great vertical freedom imparted to the body by the intersegmental areas of the pleural region. Such a bodily formation is very primitive among insects, occurring otherwise only in the lower orders of hemimetabolous insects. It indicates a very different line of descent from all the other holo-metamorphic orders.

f. The metathorax displays several remarkable characteristics. The praescutum migrates from a position as a depressed neck to a poposition in the braced part of the segment and pushes backward breaking the scutum and reducing the scutellum. The scutum also shows a tendency to divide to form the parascutellum and in the extreme modification is separated from it by intersegmental skin. The postscutellum is the predominant piece in the entire body, being as large as all the rest of the thorax. No other insect known has the postscutellum thus enlarged, and it alone is sufficient to absolutely identify a Strepsipteron. At the base of the postscutellum is an area known as postlumbium, which in the more primitive groups is intersegmental, but which becomes in some genera a chitinized piece.

g. The metathorax of the Strepsiptera is far more divided than the metathorax of any other order.

h. The front wings are reduced to inflated balancers, which rapidly vibrate and assist in the making of noise. They have the rudiments of wing veins.

i. The hind wings are membranous, longitudinally folding with only radial veins. The axiliary cord is not attached directly to the scutellum, which is quite distant from the base of the wing, but to a small detached piece located on the epimeral area. The number of veins varies from eight to five.

j. The pro- and meso-coxae are free and small, the metacoxae are larger and more broadly attached. The pro- and meso-trochanters are very long, the meta-trochanters are shorter. The femora and tibiae display no unusual characters. The tarsi are isomerous, typically five-jointed with claws, but progressively reduced to four, three and two joints without claws.

4. The male Strepsipterous head is characteristic.

a. The eyes are large, bulbous, with the ommatidia separated by partitions.

b. The antennae vary from seven- to four-jointed and always have at least the third and the last joints flabellately produced and covered with sensitive organs.

c. There is neither labrum nor labium, and the pharyngeal area is broadly exposed.

d. The mandibles are ensiform and distant from the buccal opening.

e. The maxillae are two- or three-jointed, resembling palpi, and also distant from the buccal opening.

5. The thorax has 10 segments, with the tenth serving as a flap over the extended ninth. The tenth bears the anal opening. The ninth has at its extremity an everted acute chitinous tube, with a subapical pore for the extrusion of the penis.

6. The female is permanently inclosed in the last larval skin and remains in the body of its host. It is a mere sac of eggs, larviform in appearance and legless.

a. The head and thorax are united to form a chitinous disk known as the cephalothorax. This has only a mouth opening, a pair of mandibles and one or two pair of spiracles. It is the only exposed part of the body.

b. Between the head and thorax on the venter of the cephalothorax is the opening of the brood canal, which extends between the female and the uncast skin at least to the third and sometimes to the sixth segment.

c. Entering this canal are from five to three unpaired median tubes through which the young escape into the brood canal and thus leave the parent.

7. The male pupa is of the form of the Hymenopterous pupa. It is contained within a puparium formed by the chitinization of the last larval stage. The puparium shows definite homologues of all appendages. The head forms a cap or cephalothorax, which is burst off when the male emerges.

8. The female has no pupal stage.

9. The larvae are legless, except in the first stage.

10. The first larva is active, hexapodal, with long anal stylets, with backward pointing mandibles and peculiar internal chitinization surrounding the mouth.

Internal anatomy.

11. The intestines in later stages are closed behind.

12. The nervous system is reduced to three ganglia, supraoesophageal, thoracic, and ventral. Even in the degenerate female there is a large brain.

13. The malpighian vessels and cutaneous glands are absent or greatly modified.

Biology.

14. Always hypermetamorphic:

a. Hexapod first larvae.

b. Legless degenerate later larvae.

c. Dissimilar sexual development.

d. Pupation in puparium (male).

e. No pupation in female.

15. Always parasitic, female never free.
16. Always larviparous.
17. Each morphological group confined to a definite group of hosts.
18. A type of parasitism which sterilizes but does not kill until the young parasites are free from the parent.

DESCRIPTIONS OF STREPSIPTERA.

Order STREPSIPTERA Kirby.

SYNONYMY.

Corrections to Bulletin 66, page 82:

Line 31. *Xenos,* 1793 (a genus next to Ichneumon), Rossi, 1793.

Line 32. *Phthiromyiae,* 1809 (Tribe III, Diptera), Latreille, 1809.

Line 46. *Strepsiptera,* 1859 (a family, Neuroptera Trichoptera), Gegenbaur, 1859.

Corrections to Genera Insectorum, fasc. 121, page 2:

Line 3. *Phthiromyiae.* Latreille (tribe 3, Diptera), Gen. Crust. Ins., vol. 4, p. 388 (1809).

Line 7. *Strepsiptera.* Gegenbaur (family, Neuroptera Trichoptera), 1859.

Line 11. *Stylopides.* Lacordaire (family, Coleoptera), Gen. Col., vol. 5, pp. 634–641 (1859).

In view of many new lights on the classification new descriptions are given to many groups and genera and detailed studies have been made of the transition of various characters from group to group. Notwithstanding the many new characters brought out there is no change necessary in the family classification except as to the position of Stichotrematidae. This fact amply bears out the author's original choice of superfamily and family characterizations.

Table of superfamilies of Strepsiptera.

1. Male tarsi with five joints and two tarsal claws, prothorax and mesothorax short, transverse; metapraescutum entirely in front of the scuti and not extending between them. Female unknown________ 1. *Mengeoidea* Pierce.
   Male tarsi lacking at least one joint and claws__________________________ 2.
2. Female thoracic spiracles more or less easily discernible, generally prominent. Male tarsi with four joints (possibly not in Stichotrematoidea)_ 3.
   Female thoracic spiracles not usually discernible, never prominent; Homoptera parasites____ 4.
3. Female with three rows of 12 or more genital tubes entering brood canal. Males unknown. Orthoptera parasites___ 2. *Stichotrematoidea* Hofeneder.
   Female with four of five unpaired genital tubes entering brood canal. Male tarsi with four joints; prothorax and mesothorax short, transverse. Parasites of Hymenoptera and Hemiptera_______________ 3. *Xenoidea* Pierce.

4. Male tarsi with three joints; prothorax sometimes invisible at sides. Female head apically lobed; only two genital tubes entering brood canal.
4. *Halictophagoidea* Pierce.

Male tarsi with two joints. Female head with tubercles ventral, more or less obsolete; only three genital tubes entering brood canal.
5. *Elenchoidea* Pierce.

I. Superfamily MENGEOIDEA Pierce.

This superfamily is characterized in the male by its five-jointed tarsi with two tarsal claws and is therefore the most generalized type in the order. The metathorax also shows the simplest characters, the five known genera all having the praescutum entirely anterior to the scutum and scutellum. In the family Mengeidae the praescutum is bandlike and similar to the pronotum and mesonotum. In the family Mengenillidae the praescutum is depressed necklike.

Two families, five genera, six species.

Germany, Algeria, Australia, Texas, Mexico.

Hosts unknown; females unknown.

Table of families of Mengeoidea.

Antennae seven-jointed, third and fourth joints laterally produced; metathoracic praescutum transverse, reaching humeri; scuti entirely behind praescutum; scutellum broadly rounded in front, longer than praescutum; postlumbium very short and transverse________________ 1. *Mengeidae* Pierce.

Antennae six-jointed, third, fourth, and fifth joints laterally produced, sixth elongate; metathoracic praescutum transverse quadrate, not reaching humeri, depressed and serving as a sort of neck; scuti at humeral angles reaching mesothorax; scutellum very long, narrowed and rounded in front; postlumbium about as long as broad____________________ 2. *Mengenillidae* Hofeneder.

It is quite possible that the families Stichotrematidae and Callipharixenidae, described from females, may correspond with these families base on males.

1. Family MENGEIDAE Pierce.

This family is characterized by five-jointed tarsi with claws; seven-jointed antennae with the third and fourth joints laterally prolonged; large eye facets distinctly separated one from another; transverse metapraescutum not prolonged behind between scuti; postlumbium short, transverse; abdomen with 10 segments, the first eight normal, the ninth ventrally prolonged and bearing the oedeagus at apex, the tenth serving as a flaplike covering of the ninth and containing the anal opening.

The scuti are narrowly connected in front of the scutellum in *Mengea tertiaria*, but in Triozocera they are narrowly connate with the praescutum at the sides of and in front of the scutellum.

Table of genera of Mengeidae.

Wings having eight primary veins from base, with one distal detached vein between radius and medius and with the second and third anal veins apically united and a detached anal vein beyond these; fifth and sixth antennal joints short, not much longer than first and second----------------1. *Mengea* Grote.

Wings having eight primary veins from base, with one distal detached vein beyond the tip of the radius, medius with two detached branches, third anal faint; fifth and sixth antennal joints elongate------------2. *Triozocera* Pierce.

1. Genus MENGEA Grote.

Correction to Bulletin 66, p. 207:

Lines 17, 18, 19. Grote, Augustus Radcliffe. *1886. (Changes *Triaena* Menge preoccupied, to *Mengea*, new name), Can. Ent., vol. 18, p. 100.

Corrections to Genera Insectorum:

Page 8, last line. *Mengea.* Grote, The Canad. Entom., vol. 18, p. 100 (1886).

Page 9, lines 14–16. *Mengea tertiaria*, Grote, The Canad. Entom.. vol. 18, p. 100 (1886); Pierce, Bull. U. S. Nat. Mus. No. 66, p. 84, pl. 1, fig. 1 (1909); Hofeneder, Bericht. Naturw. Med. Ver. Innsbruck, vol. 32, pp. 33–57, figs. 10–15 (1910).

This genus contains one species, which was found fossil in amber in Germany.

1. MENGEA TERTIARIA Grote.

The study of thoracic characters has enabled the writer to make an interpretation of Menge's drawing and description of this species. This drawing is necessarily arbitrary, but differs from Menge's mainly in the addition of the postlumbium (pl. 64, fig. 1).

This species differs principally from *Triozocera* by the length of the last three antennal segments. In *Mengea* the fifth and sixth joints are short, the seventh longer. In *Triozocera* these three joints are subequal and elongate, the sixth being a little shorter than the others.

2. Genus TRIOZOCERA Pierce.

This genus has several interesting characteristics. The facets of the eyes are large and well separated. The head is not crowded. The mandibles are reduced to a tiny chitinous filament and the maxillae are one-jointed. The pronotum is arched forward in *texana*, but not in *mexicana*. It is a simple band in both species. Mesonotum is composed of two indistinctly separated transverse pieces. The metascuti are not or at most only partially divided transversely to form the parascutellar pieces. The mesopleurum is enlarged to form a lobe under the base of the elytra, beneath which is the spiracular opening. This location of the spiracle is entirely analogous to that in *Xenos*. The tiny pro- and meso-coxae are loosely attached to lateral hooks, which are apparently a fusion of trochantin, episternum, and epimeron. The pro- and meso-trochanters are elongate. The metacoxae terminate the sternum, being contiguous medially, and bear the trochanters, which are much shorter than those of the other two pair of legs.

Table of species of Triozocera.

1. Prothorax arched forward; first abdominal spiracle distinctly on the first abdominal segment; host unknown; Texas________________*texana* Pierce.
2. Prothorax not arched forward; first abdominal spiracle on the suture between epimeron and first abdominal segment; host unknown; Mexico____*mexicana* Pierce.

TRIOZOCERA TEXANA Pierce.

Plate 64, figs. 2–10.

This species has served to make *Mengea tertiaria* intelligible, as it differs mainly in antennal and wing characters. Unfortunately the specimen was caught at light and the head was singed, loosing its antennae (the antennae in Pl. I, fig. 10, are reconstructions based on *T. mexicana*). Otherwise the type is perfect and gives a fine understanding of the most primitive characters in the order. By tracing the descriptions through the paper it will be apparent that the scutum in later families has become medially separated by the backward crowding of the praescutum and that the parascutellum is the result of a transverse fision of scutum. Other modifications also become clear. The thoracic structure of this genus is therefore given below in considerable detail.

Prothorax with notum arched forward, simple. Sternum lobate at anterior angles, the lobe possibly a part of episternum. Presternite tiny, triangular. Eusternum short, transverse, united laterally to episternum, which is prolonged posteriorly in the form of a hook, at the apex of which coxa is attached. This hook probably also contains trochantin and epimeron. The sternellum (furcasternite) is medially divided by a strong black line, which forms an inverted T with the posterior margin. The poststernellum is a tiny area behind the sternellum. The remainder of the sternum is composed of soft intersegmental skin, which extends forward into the coxal area. The tiny coxa appearing like a tiny basal piece of trochanter is attached to the pleural hook and by a tiny filament to a little hook at the side of the sternellum. The trochanter, femur, tibia, and first tarsal joint are elongate; second and third tarsal joints together about equal to the first, pubescent and cylindrical; fourth joint short, inferiorly lobate pulvilliform; fifth joint arising about the middle of fourth, more slender and armed with two minutely dentate, curved ungues.

Mesothorax with notum of a single piece faintly divided by a transverse fold. The anterior part is divided by its pubescence into a central area and two anterior lateral triangular pieces. The latter are probably the praescutum and the central piece the scutum.

Behind the transverse fold is the scutellum and at the apex folded in, is the transverse postscutellum. The posterior angles are elongate, passing beneath. Below the attachment of the clavate elytra the pleuri are greatly inflated, lobate, with the anterior margin granulate, three edged, and immediately below a small elytral hook. The sternum is divided into four parts, the pleurum is fused into one. The anterior piece on the median line is a very narrow transverse strip (eusternum) enlarging very greatly toward the side. This latter area is strongly depressed and distinctly margined behind by the inner edge of the pleural lobe. The depression becomes deepest at the acute posterior corner and appears to be diagonally cleft to form a spiracular opening. In fact on focusing, the trachea can be seen terminating practically at this cleavage. The pleural area (trochantin+episternum+epimeron) behind the angle of the so-called spiracular orifice narrows into a curved hook to which the coxa is attached. Behind the eusternum the sternellum is medially divided by a strong inverted T as on the presternum. The post sternellum is a transverse area behind the sternellum. The coxa appears as a small basal piece to the trochanter. The legs are as in pronotum.

Metathorax almost four times as large as prothorax and mesothorax combined. Notum consists of praescutum, prelare, scutum, scutellum, postlumbium and postscutellum. The praescutum is convex on anterior margin and lies entirely in front of the scutum. Scutum is narrowly connected with praescutum at apex of scutellum. A faint line on each side separates the suralare. Scutum is divided to form parascutellum by a line from base of wing. Scutellum is elongate subtriangular.

Opposite the base of the scutellum on the epimeron there is a tiny lobe, to which is attached the axillary cord. This is a detached part of scutellum. Behind this little piece the epimeral area is enlarged and continues unbroken to the coxae and behind them, and is fused with the sternellum in front of the coxae. This large area may be called hypoepimeron to the coxae, and postcoxale behind them. A faint color line separates presternum from eusternum, and a faint fold the eusternum from sternellum. The coxae are conical pieces and are contiguous on the median line. The trochanters are shorter than for the other two pair. Femur, tibia, and first tarsal joint are elongate.

The first abdominal spiracle is distinctly on the first abdominal segment, but near the edge of the hypoepimeron.

The oedeagus is slightly sinuate, acute.

The wings have a faint indication of the third anal vein, so the generic description is changed in the key to read with eight primary veins. This is made clear in the drawing of the venter which shows the bases of the wings.

TRIOZOCERA MEXICANA Pierce.

Plate 65, figs. 1–10.

Only two specimens of this species occur, the type in the United States National Museum collection and the paratype in the author's private collection at the museum.

New drawings have been made to illustrate the thoracic characters.

By the use of improved microscope accessories the mouth parts have been studied. These are very aberrant, the mandibles being reduced to a tiny filament and the maxillae being long pubescent appendages with a small second joint attached before the tip (pl. 65, figs. 4, 5).

The antennal structure is very rough, consisting of round sensory organs surrounded by setigerous tubercles (pl. 65, fig. 3).

The description of *texana* will fit this species in general. It is important to note that the author's illustration in Genera Insectorum (pl. 1, fig. 1) was in error as to the shape of the scutellum. The specimen was mounted slightly on its side and hence not easily studied.

II. Family MENGENILLIDAE Hofeneder.

Erratum: Gen. Insect., p. 10, line 2, read "Vol. 32" for "Vol. 31."

This family is characterized in addition to the six-jointed, four-branched antennae, and five-jointed tarsi, by an emargination of the head, a metathoracic praescutum placed entirely in front of the scutum and not reaching the lateral angles; a very large meta coxa; and a large postlumbium.

Table of genera.

1. Scutum divided by scutellum____2.
   Scutum narrowly connected in front of scutellum______*Tetrozocera* Pierce.
2. Scutellum broad in front; wings lacking the third anal vein, with two detached veins between radius and medius and one behind medius; mandibles triangular__________________________________*Austrostylops* Lea.
   Scutellum narrow in front; wings lacking two anal veins, with two detached veins between radius and medius and one behind medius; mandibles elongate, acute ____________________________________*Mengenilla* Hofeneder.

3. Genus MENGENILLA Hofeneder.

Errata: Gen. Insect., pp. 10, 11, 16, 29, read "Vol. 32" for "Vol. 31."

MENGENILLA CHOBAUTII Hofeneder.

Plate 66, figs. 6, 7.

Because of Hofeneder's misinterpretation of the parts of the thorax the writer has made drawings based on the original illustrations to serve as an aid to the proper understanding of the following remarks.

It is apparent from Hofeneder's drawings that this insect has structures strictly analogous to those of the other species in the family.

The pronotum is simple. The mesonotum is simple, with small lateral basal pieces. Metanotum has the praescutum raised to the level of the remainder of the metathorax and slightly angulate behind. The scuti are narrowly separated by the scutellum. The postlumbian is very large and the postscutellum relatively small. At the side of postscutellum are two small pleurotergite areas, the lower of which was called epimeron by Hofeneder. The prelare is a large piece and was considered part of episternum by Hofeneder. Episternum is longitudinally divided, but only the lower lobe or lateropleurite was recognized as episternum by Hofeneder. The pleural suture extends to the coxae. The epimeron is a large strip from wing to coxa, the front part of which was called parapleuron by Hofeneder, and in his figure "6*a*" the part labeled "*st.*" is the hypoepimeron. Hofeneder figures the little triangular piece on epimeron, which the writer considers a detached piece of scutellum, to which the axillary cord is attached, as described under *Triozocera*.

The prosternum has a tiny eusternum and a transverse sternellum, biemarginate, with the coxae attached at the outer angles of the emargination.

The mesosternum has a transverse presternum and a transverse eusternum, which is fused with episternum. The sternellum is as in the prothorax.

The metasternum is large and not divided transversely, but with the usual longitudinal division of the sternellar area. The epimeron extends as a postcoxale behind the coxae. The coxa is a very large lobate area bearing the trochanter.

4. Genus AUSTROSTYLOPS Lea.

Plate 66, fig. 5.

Lea's figure of *Austrostylops gracilis* is so poor that it is impossible to interpret adequately the thoracic scelerites. The writer has made a drawing in which a slight interpretation of Lea's original is added.

5. TETROZOCERA, new genus.

Type of the genus.—*Tetrozocera santchii*, new species.

Name derived from τέτρα (four) + ὄζος (branch) + κέρας. (horn) = four branched antennae.

Male.—Head transverse; eyes large, prominent, with many large facets. Mandibles large, flattened, triangular; maxillae two-jointed, elongate. Antennae six-jointed, sensitive, with the third, fourth, and fifth joints laterally produced and the sixth elongate. Prothorax and metathorax transverse. Elytra subclavate. Metathorax very large, with praescutum small, necklike, depressed, and almost concealed by mesothorax and scutum. Scutum narrowly connected in front of the broadly rounded scutellum. There is no indication of a fission to form the parascutellum. Postlumbium large, postscutellum relatively smaller than usual. Wings with two anal veins lacking. There are two small detached veins between redius and medius, but none behind medius. Tarsi five-jointed, armed with two long claws.

Female.—Unknown.

Hosts.—Unknown.

TETROZOCERA SANTCHII, new species.

Plate 66, figs. 1–4.

Described from a single male collected by F. Santchi at Kairouan, Algeria, in August, 1907.

This species differs from *Mengenilla chobautii* Hofeneder, also of Algeria in the following characteristics: The praescutum is depressed, not raised to the disk. The scuti are connected, not separated by the scutellum. The scutellum is broadly rounded, not acute at apex. The head is broadly emarginate, not sharply. The eyes are diagonal, elongate, not rounded when seen from above.

The specimen had been rather badly treated, having been originally in alcohol and later dry mounted. One wing is missing. It has been impossible to locate the tiny scutellar triangle on the epimeron, but it may be present. This is the first specimen in the order in which the abdominal spiracles have all been visible. They are quite large on all but the eighth segment. The first is located just below the suture, between the lower lateropleurite and the epimeron, but entirely on the first segment. The lateropleurite extends forward almost to the wing.

Type.—Cat. No. 21434, U.S.N.M.

II. Superfamily STICHOTREMATOIDEA Hofeneder.

III. Family STICHOTREMATIDAE Hofeneder.

6. Genus STICHOTREMA Hofeneder.

1. STICHOTREMA DALLATORREANUM Hofeneder.

Plate 67.

Parasite of *Sexava nubila* Stal; Admiralty Islands, and of *Sexava*. species; Schouten Islands.

Triungulinid: Described from paratype specimens from Schouten Islands, sent the author by Doctor Hofeneder. Oblong, with transverse quadrate head; subequal thoracic segments; eight simple abdominal segments; the ninth dorsal being very long and covering the tenth, quadrate, with apical angles armed with short bristles and with two apical tubercles bearing long bristles; ninth ventral short quadrate with setigerous tubercles at apical angles; tenth apical, dorsally covered by ninth, armed with a very long pair of approximate bristles; tarsi consisting of single-jointed pads.

Head apically emarginate, containing very peculiar internal chitinizations. The mouth opening causes an emargination of the apex. This is braced by a ventral bridge which sends forward an arm on each side of the mouth and also two similar arms backward. This chitinization extends dorsally and forms an elliptical orifice for the esophagus. Externally lying over this chitinization and apparently connected with it is a four-pronged piece with at least three of the prongs prominent when viewed from the side (illustrated in pl. 67, fig. 3). The mandibles are also peculiar. They are attached apparently to the anterior arms of the ventral bridge and extend laterally almost to the eyes and have a long tooth extending to the base of the head. The antennae appear to be three jointed and are placed near the anterior margin about halfway between mouth and ocelli. The second joint has a long lateral arista. The ocelli are in three pairs, the anterior being immense in comparison to the size of the head. The crystalline lens is convex and beneath it at some distance are clusters of pigment granules. Two smaller ocelli lie behind this as shown in figure 3, plate 67.

Paratypes.—Cat. No. 21435, U.S.N.M.

III. Superfamily XENOIDEA Pierce.

Table of families.

1. Male unknown. Female cephalothorax narrow and elongated with two pair of spiracles; five genital tubes entering brood canal. Parasites of Heteroptera ---------------------------IV. *Calliphariхenidae*, new family.
   Males known. Female cephalothorax broader, with only a single pair of spiracles -- 2
2. Scutellum broadly rounded in front-------------------------------------- 3
   Scutellum more or less broadly truncate, and pedunculate in front------ 4
3. Scutellum shorter than praescutum; postlumbian short, transverse; antennae seven-jointed, third joint laterally produced, fourth joint short, fifth to seventh joints elongate. Female unknown. Parasites of Formicoidea---V. *Myrmecolacidae* Pierce.
   Scutellum longer than praescutum; postlumbium at least half as long as broad; antennae six-jointed, the third joint laterally produced. Female cephalothorax broadly truncate or rounded at apex; head almost one-half as wide as metathorax at spiracles; five genital tubes entering brood canal. Parasites of Apoidea------------------------VI. *Stylopidae* Kirby.
4. Praescutum as broad as mesothorax at base; antennae five-jointed, the third joint laterally produced, fourth very short, fifth elongate. Female cephalothorax with head not more than one-half as wide as metathorax at spiracles. Parasites of Apoidea--------------VII. *Hylecthridae* Pierce.
   Praescutum not as broad as mesothorax at base; antennae four-jointed, the

third joint laterally produced, fourth joint elongate. Female cephalothorax variable in shape, four or five genital tubes entering brood-canal. Parasites of Xenoidea, Sphecoidea, and Apoidea_____VIII. *Xenidae* Semenov.

IV. CALLIPHARIXENIDAE, new family.

Female cephalothorax elongate, with margin distinctly indicating thoracic segments, mesothoracic and metathoracic spiracles present, not surpassing the margin; brood canal extending to apex of sixth abdominal segment and apparently with five median unpaired genital tubes.

Triungulinid with seven simple abdominal segments, eighth dorsally enlarged, ninth greatly enlarged and partially enclosing the tenth whcih is terminated by two long stylets. Shorter hairs at sides of ninth. Tarsi one-jointed with three filaments or claws.

Includes two genera and two species.

1. *Callipharixenos* Pierce, type *muiri* Pierce; parasitic on *Calliphara;* Amboina.

2. *Chrysocorixenos* Pierce, type *siamensis* Pierce: parasitic on *Chrysocoris;* Siam.

7. CALLIPHARIXENOS, new genus.

Female with five unpaired median tubes and two pair of cephalothoracic spiracles; cephalothorax very elongate not narrowing perceptibly until base of head is reached.

Parasites of the Scutellarid genus *Calliphara.*

Type of the genus.—Callipharixenos muiri, new species; Amboina; *Calliphara billiardierei* Fabricius.

1. CALLIPHARIXENOS MUIRI, new species.

Plate 68, figs. 2–7.

Described from three females extracted from specimens of *Calliphara billiardierei* Fabricius, collected in Amboina by F. Muir, under his number 388. One female contained two female parasites in the fifth ventral segment and a male contained one female in the fifth ventral. Triungulinids were present.

Female (pl. 68, figs. 2, 3).—Entire body 8 mm. long, cephalothorax 1.2 mm. long, about 0.6 mm. wide. Abdomen with five unpaired median genital tubes. Cephalothorax elongate with two pair of spiracles opening on the sides. The measurements are based on the metathoracic spiracles as usual. The sides of the head extend backward and inclose the prothorax. The first abdominal segment is also apparently a part of the cephalothorax, separated by slight constriction. Mandibles subquadrate with tooth at inner apical angle.

From this point on whenever females are measured the following dimensions are taken with the aid of a Bausch and Lomb microscope, 160 mm. tube length, 1 inch eyepiece micrometer, 16 mm. objective. The measurements represent spaces on the micrometer scale in which one space =0.0149 mm.

The measurements are given by number as follows:

1. Breadth of cephalothorax at spiracles.
2. Breadth of head at base.
3. Breadth of head at base of mandibles.
4. Breadth of basal constriction of cephalothorax.
5. Length from anterior edge of spiracles to apex.
6. Length from base to apex.

These measurements are also given in a second table under each species comparing them proportionately with measurement No. 1. (See text fig. 5, p. 406.)

Table of measurements.

Measurements	1	2	3	4	5	6	Index total.
Type	47	45	17	36	50	69	....
Relative length compared to breadth at spiracles	1.00	0.95	0.36	0.76	1.06	1.47	5.60

This shows what a different mathematical formula this species has from the genus Stylops.

Triungulinid (pl. 68, figs. 4–7): Elongate, hexapodal. Head transverse, emarginate, with five ocelli in a dark patch on each side. These ocelli are completely separated, perfect, simple eyes with rather large lenses and the outline of the entire eye darkened. The crystal body is funnel shaped, extending through the ocellus. Mandibles elongate, slender, curved, turned backward, and apparently with an opening in the enlarged tip. The pharyngeal skeleton is much more slender than in *Stichotrema*, consisting of an arched piece and two almost straight diverging rods. The antennae are very indistinct even with the highest power magnification, but seem to be composed of two joints and a filament.

The coxae are very large; femora and tibiae apically spined; tarsus one jointed, terminated apparently by three slender filaments. This is a very unusual type of tarsus for Strepsiptera. The eighth, ninth, and tenth segments of the abdomen are greatly modified. The eighth laterally extends almost to the apex of the ninth, but is dorsally emarginate and ventrally is normal. The ninth incloses the tenth, which bears a pair of stylets.

Types (female and triungulinids).—Cat. No. 21436, U.S.N.M.

8. CHRYSOCORIXENOS, new genus.

Female with five unpaired genital tubes, and two pair of cephalothoracic spiracles. Cephalothorax very elongate, only narrowing in front of base of head.

Parasites of the Scutellarid genus *Chrysocoris.*

Type of the genus.—*Chrysocorixenos siamensis*, new species; Siam; *Chrysocoris grandis* Thunberg.

1. CHRYSOCORIXENOS SIAMENSIS, new species.

Plate 68, fig. 1.

Described from one female from a specimen of *Chrysocoris grandis* Thunberg, from Siam.

Female.—Brood canal extends to apex of sixth segment and segments 2–6 have median unpaired genital tubes. Cephalothorax apparently includes first abdominal segment with slight constriction at base of thorax. Two pair of cephalothoracic spiracles. Head prolonged behind at sides.

Table of measurements.

Measurements	1	2	3	4	5	6	Index total.
Type	62	58	21	40	60	85	......
Relative length compared to breadth at spiracles	1.00	0.93	0.34	0.64	0.96	1.37	5.24

Type.—Cat. No. 21437, U.S.N.M.

V. Family MYRMECOLACIDAE Pierce.

Table of Genera.

Wings short in proportion to body, with eight primary veins; fifth and sixth antennal joints subclavate; tenth dorsal abdominal segment small, not concealing oedeagus and anal cavity..........9. *Myrmecolax* Westwood.

Wings long, with only six primary veins from base, the cubitus and third anal missing, with a short detached vein just below the apex of the radius, medius short and continued by a long detached vein beginning behind it and shortly before its apex; fifth and sixth antennal joints slender throughout; tenth dorsal segment very large, completely covering oedaegus and anal cavity. 10. *Caenocholax* Pierce.

9. Genus MYRMECOLAX Westwood.

1. *M. nietneri* Westwood; parasite of formicid; Ceylon.

10. Genus CAENOCHOLAX Pierce.

1. *C. fenyesi* Pierce; host unknown; Mexico.

1. CAENOCHOLAX FENYESI Pierce.

Plate 69, figs. 1–3.

Errata: Gen. Insect., p. 14, last line, add "Pl. 1, unnumbered figures"; p. 52, lines 14, 15, read "4" for "3."

The dorsal portions of the thorax of this species are adequately described in previous papers, but a few points ought to be emphasized at this time. The mesonotum is distinctly divided into three transverse areas. The pronotum is pushed far forward between the eyes. The metathoracic scutum is not divided by praescutum and scutellum. Parascutellum is completely separated from scutum.

The pleural plates of the prothorax and mesothorax are conspicuous, and ventrally are united with the eusternum. The sternellum is, as usual, longitudinally strongly marked on the median line. The front and middle trochanters are normally elongate.

The metathoracic pleurae are greatly twisted. The prelare is a large piece indistinctly separated from the lower lobe of the episternum (lateropleurite). The epimeron is narrow in front but very large in the hypoepimeral zone. The pleural suture is very sinuous and reaches the coxae. Episternum does not come near the coxae, being terminated as usual in this order, far forward. The sternum is indistinctly marked into two areas. The coxa is large and bears a very small trochanter. The hind femora are short and broad.

VI. Family STYLOPIDAE Kirby.

As now characterized, the family Stylopidae has in the male six-jointed antennae, with only the third joint laterally produced; four-jointed tarsi without claws; metathoracic praescutum extending between scuti but not always separating them; postlumbium rather large; parascutellum distinct; and in the female, five genital tubes, distinct mandibles, distinct spiracles.

The following genera and subgenera are included:

Stylops Kirby 1802, type, *melittae* Kirby; 50 species.

Subgenus *Stylops* Kirby; 48 species.

Subgenus *Katastylops* Pierce, type, *polemonii* Pierce; 1 species.

Subgenus *Prostylops* Pierce, type, *pilipedis* Pierce; 1 species.

Neostylops Pierce, type, *crawfordi* Pierce; 5 species.

Parastylops Meijere 1908, type, *flagellatus* Meigere; 1 species.

Table of genera of Stylopidae (Males).

1. Metathoracic scutum not divided by praescutum and scutellum---------- 2.
   Metathoracic scutum divided by praescutum and scutellum; antennae short and robust-- 11. *Stylops* Kirby.
2. Antennae short and robust-------------------------- 12. *Neostylops* Pierce.
   Antennae attenuate------------------------------- 13. *Parastylops* Meijere.

Table of species of female Stylopidae.

1. (*a*) Spiracles not reaching margin------------------------------------ 2.
   (*b*) Spiracles reaching margin--------------------------------------- 3.
2. (*a*) Mandibles with an apical tooth and a strong lateral tooth near base; base of head 0.61 as wide as cephalothorax at spiracles; distance from spiracles to apex 0.71 the breadth at spiracles (*Stylops*, group 1)---*bipunctatae*.

(b) Mandibles broad, subquadrate, with apical tooth; base of head 0.62 as wide as cephalothorax at spiracles; distance from spiracles to apex 0.80 the breadth at spiracles (*Stylops*, group 1) ---- *moestae*.

3. (a) Spiracles not prominent ---- 4.
(b) Spiracles prominent ---- 23.

4. (a) Mandibles without tooth ---- 5.
(b) Mandibles toothed ---- 8.

5. (a) Cephalothorax broader than long ---- 6.
(b) Cephalothorax longer than broad ---- 7.

6. (a) Base of head 0.56 as wide as cephalothorax at spiracles; base of cephalothorax 0.65 breadth at spiracles; length of cephalothorax only 0.94 breadth at spiracles (*Neostylops*, group 1) ---- *crawfordi*.
(b) Base of head 0.61 as wide as cephalothorax at spiracles; base of cephalothorax 0.80 breadth at spiracles; length of cephalothorax 0.96 breadth at spiracles (*Stylops*, group 2) ---- *mandibularis*.

7. (a) Base of head 0.60 as wide as cephalothorax at spiracles; base of cephalothorax 0.72 breadth at spiracles; length of cephalothorax 1.10 breadth at spiracles; very small (*Katastylops*) ---- *polemonii*.
(b) Base of head 0.67 as wide as cephalothorax at spiracles; base of cephalothorax 0.74 breadth at spiracles; length of cephalothorax 1.03 breadth at spiracles; very large (*Prostylops*) ---- *pilipedis*.

8. (a) Mandibles with only one tooth, not angulate on side ---- 9.
(b) Mandibles with an apical tooth, and an angulation or tooth on side ---- 17.

9. (a) Cephalothorax broader than long ---- 10.
(b) Cephalothorax as long as, or longer than, broad ---- 11.

10. (a) Mandibles subquadrate with tooth at inner apical angle; base of head 0.51 as wide as cephalothorax at spiracles; base of cephalothorax 0.67 breadth at spiracles; length of cephalothorax 0.87 breadth at spiracles (*Stylops*, group 3) ---- *nubeculae*.
(b) Mandibles rounded with tooth near apex; base of head 0.62 as wide as cephalothorax at spiracles; base of cephalothorax 0.54 breadth at spiracles; length of cephalothorax 0.97 breadth at spiracles (*Stylops*, group 4) ---- *subcandidae*.

11. (a) Cephalothorax as long as broad ---- 12.
(b) Cephalothorax longer than broad ---- 15.

12. (a) Mandibles elongate rounded ---- 13.
(b) Mandibles subquadrate ---- 14.

13. (a) Mandibles with tooth on inner side, surpassed by apex; base of head 0.58 as wide as cephalothorax at spiracles; base of cephalothorax 0.74 breadth at spiracles; spiracles lateral, hardly prominent (*Stylops*, group 5) ---- *krygeri*.
(b) Mandibles with acute tooth at apex; base of head 0.58 as wide as cephalothorax at spiracle; base of cephalothorax 0.82 breadth at spiracles; spiracles lateral, convex, but not strongly prominent (*Stylops*, group 6) ---- *multiplicatae*.

14. (a) Tooth of mandible near inner apical angle; base of head 0.56 as wide as cephalothorax at spiracles; base of cephalothorax 0.87 breadth at spiracles; spiracles barely marginal (*Stylops*, group 6) ---- *advarians*.
(b) Tooth of mandible apical; base of head 0.60 as wide as cephalothorax at spiracles; base of cephalothorax 0.78 breadth at spiracles; spiracles lateral, but not prominent (*Stylops*, group 6) ---- *bisalicidis*.
(c) Tooth of mandible halfway between apical angles; base of head 0.62 as wide as cephalothorax at spiracles; base of cephalothorax 0.80 breadth at spiracles; spiracles slightly convex on margin but not prominent (*Stylops*, group 6) ---- *sparsipilosae*.

15. (*a*) Mandibles rounded with apical tooth ---------- 16.
(*b*) Mandibles emarginate at apex with strong outward curved tooth at inner angle and outer angle rounded; spiracle slightly convex but not prominent; base of head 0.56 to 0.65 as wide as cephalothorax at spiracles; base of cephalothorax 0.71 to 0.78 breadth at spiracles; length of cephalothorax 1.02 to 1.18 breadth at spiracles (*Stylops*, group 7) ---------- *erigeniae.*

16. (*a*) Base of head 0.64 as wide as cephalothorax at spiracles; base of cephalothorax 0.79 breadth at spiracles; length of cephalothorax 1.03 breadth at spiracles; spiracles barely marginal (*Stylops*, group 8) ---------- *hippotes.*
(*b*) Base of head 0.55 as wide as cephalothorax at spiracles; base of cephalothorax 0.77 breadth at spiracles; length of cephalothorax 1.06 breadth at spiracles; spiracles laterally slightly convex but not prominent (*Stylops*, group 8) ---------- *nasoni.*

17. (*a*) Mandibles two-angled at apex and slightly emarginate between, not distinctly toothed; base of head 0.66 as wide as cephalothorax at spiracles; base of cephalothorax the same; length of cephalothorax 1.03 breadth at spiracles; spiracles barely marginal (*Stylops*, group 9) ---------- *swenki.*
(*b*) Mandibles toothed at apex and angled on outer side ---------- 18.

18. (*a*) Cephalothorax as long as broad; spiracles barely marginal (*Stylops*, group 10) ---------- *claytoniae* 19.
(*b*) Cephalothorax longer than broad ---------- 20.

19. Varieties of *S. claytoniae;* base of cephalothorax 0.68 breadth at spiracles.
(*a*) Mandibles rounded with apical tooth and slight angle on outer side; base of head 0.54 as wide as cephalothorax at spiracles.
var. *claytoniae.*
(*b*) Mandibles subquadrate with tooth near inner apical angle and with strong angle near middle of outer side; base of head 0.58 as wide as cephalothorax at spiracles ---------- var. *imitatrix.*
(*c*) Mandibles strongly two-toothed; base of head 0.64 as wide as cephalothorax at spiracles ---------- var. *vierecki*

20. (*a*) Lateral angle of mandible not toothlike ---------- 21
(*b*) Lateral angle of mandible toothlike and subbasal ---------- 22

21. (*a*) Base of head 0.56 to 0.59 as wide as cephalothorax at spiracles; base of cephalothorax 0.66 breadth at spiracles; length of cephalothorax 1.07 breadth at spiracles (*Stylops*, group 11) ---------- *bruneri.*
(*b*) Base of head 0.59 as wide as cephalothorax at spiracles; base of cephalothorax 0.70 breadth at spiracles; length of cephalothorax 1.09 breadth at spiracles (*Stylops*, group 11) ---------- *oklahomae.*
(*c*) Base of head 0.60 as wide as cephalothorax at spiracles; base of cephalothorax 0.80 breadth at spiracles; length of cephalothorax 1.06 breadth at spiracles (*Stylops*, group 11) ---------- *salictariae.*
(*d*) Base of head 0.62 as wide as cephalothorax at spiracles; base of cephalothorax 0.73 breadth at spiracles; length of cephalothorax 1.04 breadth at spiracles (*Stylops*, group 11) ---------- *andrenoides.*
(*e*) Base of head 0.61 as wide as cephalothorax at spiracles; base of cephalothorax 0.75 breadth at spiracles; length of cephalothorax 1.08 breadth at spiracles; outer apical angle of mandible strongly rounded, apex emarginate between angle and tooth (*Stylops*, group 11).
medionitans.

22. Base of head 0.57 as wide as cephalothorax at spiracles; base of cephalothorax 0.69 breadth at spiracles; length of cephalothorax 1.08 breadth at spiracles (*Neostylops*, group 2) ---------------- *solidulae*.

23. (*a*) Mandibles with apical tooth or sharp angle, but without lateral angle - 24
 (*b*) Mandibles with apical tooth and an angle on lateral margins -------- 29

24. (*a*) Cephalothorax broader than long or exactly as long as broad; base of head 0.59 as broad as cephalothorax at spiracles ---------------- 25
 (*b*). Cephalothorax longer than broad ---------------------------------- 26

25. (*a*) Mandibles broadly rounded, toothed near inner apical angles; breadth at base of mandibles 0.40 as broad as cephalothorax at spiracles; base of cephalothorax 0.77 breadth at spiracles (*Stylops*, group 12) --- *sinuatus*.
 (*b*) Mandibles subquadrate with apical tooth pointed outward; breadth at base of mandibles 0.31 as broad as cephalothorax at spiracles; base of cephalothorax 0.73 breadth at spiracles (*Stylops*, group 12) --- *grandior*.
 (*c*) Mandibles narrowly rounded, toothed at apex; breadth at base of mandibles 0.36 as broad as cephalothorax at spiracles; base of cephalothorax 0.74 breadth at spiracles (*Stylops*, group 12) --- *nudae*.

26. (*a*) Mandibles merely angulate at apex; breadth of head 0.67 as wide as cephalothorax at spiracles; breadth of cephalothorax at base 0.83 breadth at spiracles; length of cephalothorax 1.07 breadth at spiracles (*Stylops*, group 13) ------------------------------------ *salicifloris*.
 (*b*) Mandibles distinctly toothed at apex ------------------------------ 27

27. (*a*) Mandibles subquadrate with outward pointing tooth ---------------- 28
 (*b*) Mandibles rounded with apical tooth; base of head 0.52 to 0.56 as wide as cephalothorax at spiracles; base of cephalothorax 0.69 breadth at spiracles (*Stylops*, group 12) ------------------------------ *cornii*.

28. (*a*) Base of head 0.60 to 0.63 as wide as cephalothorax at spiracles; distance from spiracles to apex 0.64 to 0.68 breadth at spiracles (*Stylops*, group 12) -- *californica*.
 (*b*) Base of head 0.57 to 0.64 as wide as cephalothorax at spiracles; distance from spiracles to apex 0.69 to 0.74 breadth at spiracles (*Stylops*, group 12) -- *vicinae*.

29. (*a*) Cephalothorax broader than long; breadth of head 0.53 as wide as cephalothorax at spiracles; of cephalothorax 0.69 breadth at spiracles; length of cephalothorax 0.92 breadth at spiracles (*Stylops*, group 14) -- *graenicheri*.
 (*b*) Cephalothorax longer than broad ---------------------------------- 30.

30. (*a*) Breadth of head 0.53 as wide as cephalothorax at spiracles; base of cephalothorax 0.83 breadth at spiracles; length of cephalothorax 1.04 breadth at spiracles (*Stylops*, group 15) ------------------ *cressoni*.
 (*b*) Breadth of head 0.56 as wide as cephalothorax at spiracles; base of cephalothorax 0.77 breadth at spiracles; length of cephalothorax 1.04 breadth at spiracles (*Stylops*, group 15) ------------------- *diabola*.
 (*c*) Breadth of head 0.60 as wide as cephalothorax at spiracles; base of cephalothorax 0.86 breadth at spiracles; length of cephalothorax 1.06 breadth at spiracles (*Stylops*, group 16) -------------- *hartfordensis*.
 (*d*) Breadth of head 0.61 as wide as cephalothorax at spiracles; base of cephalothorax 0.71 breadth at spiracles; length of cephalothorax 1.04 breadth at spiracles (*Stylops*, group 16) ---------------- *neonanae*.

Arrangement of female stylopidae according to breadth of cephalothorax at spiracles.

polemonii	34.5	*claytoniae*	55.5
salictariae	40.7	*salicifloris*	57.5
bruneri	41.7	*imitatrix*	58.0
neonanae	42.0	*nubeculae*	58.0
andrenoides	44.4	*cressoni*	59.5
hartfordensis	45.0	*moestae*	61.0
nasoni	45.0	*diabola*	62.0
oklahomae	46.5	*mandibularis*	62.0
erigeniae	47.6	*krygeri*	62.6
bipunctatae	48.8	*advarians*	64.0
medionitans	49.0	*californica*	64.0
sparsipilosae	50.0	*grandior*	65.0
subcandidae	50.0	*dunningi*	72.0
sinuatus	50.2	*vicinae*	73.8
vierecki	50.7	*crawfordi*	74.0
nudae	52.7	*cornii*	76.0
swenki	53.0	*solidulae*	79.2
hippotes	54.3	*pilipedis*	80.5
multiplicatae	54.5	*graenicheri*	81.0
bisalicidis	55.0		

Family Stylopidae arranged according to proportionate measurements.

Breadth of head in proportion to breadth of spiracles.	Breadth at base of mandibles in proportion to breadth at spiracles.	Breadth at base of cephalothorax in proportion to breadth at spiracles.	Length from spiracles to apex in proportion to breadth at spiracles.	Length of cephalothorax in proportion to breadth at spiracles.
nubeculae 0.51	*grandior* 0.31	*subcandidae* 0.54	*nubeculae* 0.58	*nubeculae* 0.87
graenicheri .53	*graenicheri* .33	*crawfordi* .65	*mandibularis* .59	*grandior* .88
cressoni .53	*mandibularis* .33	*bruneri* .66	*grandior* .62	*graenicheri* .92
claytoniae .54	*imitatrix* .34	*swenki* .66	*subcandidae* .62	*crawfordi* .94
cornii .54	*pilipedis* .34	*nubeculae* .67	*imitatrix* .62	*mandibularis* .96
nasoni .55	*crawfordi* .35	*imitratrix* .68	*claytoniae* .63	*subcandidae* .97
crawfordi .56	*californica* .35	*claytoniae* .68	*graenicheri* .63	*sinuatus* .97
grandior .56	*cressoni* .35	*vierecki* .68	*crawfordi* .63	*vierecki* .99
advarians .56	*nubeculae* .36	*graenicheri* .69	*sparsipilosae* .64	*imitatrix* 1.00
diabola .56	*claytoniae* .36	*cornii* .69	*nasoni* .64	*claytoniae* 1.00
bruneri .57	*nudae* .36	*solidulae* .69	*neonanae* .64	*nudae* 1.00
solidulae .57	*oklahomae* .36	*oklahomae* .70	*multiplicatae* .64	*sparsipilosae* 1.00
imitatrix .58	*bisalicidis* .36	*dunningi* .70	*hippotes* .64	*multiplicatae* 1.00
multiplicatae .58	*cornii* .37	*neonanae* .71	*nudae* .65	*bisalicidis* 1.00
krygeri .58	*diabola* .37	*polemonii* .72	*medionitans* .65	*advarians* 1.00
nudae .59	*polemonii* .37	*grandior* .73	*californica* .66	*swenki* 1.00
vicinae .59	*advarians* .37	*andrenoides* .73	*diabola* .67	*krygeri* 1.01
sinuatus .59	*krygeri* .37	*vicinae* .73	*vierecki* .67	*moestae* 1.03
oklahomae .59	*vierecki* .38	*nudae* .74	*cressoni* .67	*cornii* 1.03
polemonii .60	*sparsipilosae* .38	*pilipedis* .74	*pilipedis* .68	*californica* 1.03
salictariae .60	*vicinae* .38	*krygeri* .74	*salictariae* .68	*pilipedis* 1.03
bisalicidis .60	*erigeniae* .39	*medionitans* .75	*bisalicidis* .69	*vicinae* 1.03
hartfordensis .60	*moestae* .39	*erigeniae* .75	*polemonii* .69	*hippotes* 1.03
medionitans .61	*sinuatus* .40	*californica* .76	*erigeniae* .70	*diabola* 1.04
mandibularis .61	*neonanae* .40	*sinuatus* .77	*sinuatus* .70	*cressoni* 1.04
neonanae .61	*multiplicatae* .40	*diabola* .77	*oklahomae* .70	*neonanae* 1.04
californica .61	*medionitans* .40	*nasoni* .77	*cornii* .71	*andrenoides* 1.04
erigeniae .61	*hippotes* .40	*bisalicidis* .78	*solidulae* .71	*bipunctatae* 1.04
bipunctatae .61	*salicifloris* .40	*hippotes* .79	*vicinae* .71	*nasoni* 1.06
subcandidae .62	*dunningi* .40	*bipunctatae* .79	*advarians* .71	*hartfordensis* 1.06
moestae .62	*bruneri* .41	*mandibularis* .80	*andrenoides* .71	*salictariae* 1.06
dunningi .62	*solidulae* .41	*sparsipilosae* .80	*bipunctatae* .71	*bruneri* 1.07
sparsipilosae .62	*swenki* .41	*salictariae* .80	*hartfordensis* .71	*salicifloris* 1.07
andrenoides .62	*andrenoides* .41	*moestae* .81	*krygeri* .72	*solidulae* 1.08
vierecki .64	*bipunctatae* .41	*multiplicatae* .82	*bruneri* .72	*medionitans* 1.08
hippotes .64	*subcandidae* .42	*cressoni* .83	*swenki* .75	*erigeniae* 1.08
swenki .66	*nasoni* .42	*salicifloris* .83	*dunningi* .75	*oklahomae* 1.09
salicifloris .67	*salictariae* .42	*hartfordensis* .86	*salicifloris* .76	*polemonii* 1.10
pilipedis .67	*hartfordensis* .44	*advarians* .87	*moestae* .80	*dunningi* 1.11

11. Genus STYLOPS Kirby (1802).

The genus is hereby limited in the strict sense to those species in which the scutum is completely divided into two lateral pieces by the praescutum and scutellum. Typically it is also characterized by the scutellum being rather broadly rounded in front, not pedunculate.

The illustrations published by various authors, especially F. Smith,[1] show the general characters of the genus. On the strength of these *trimmerana* Smith is to be separated from *aterrima* Newport and placed in the genus *Neostylops.*

The genus in the strictest sense is now composed of the following species:

1. *melittae* Kirby, 1802 (type of genus); Europe; parasite of *Andrena nigroaenea* Kirby.
2. *kirbii* Leach, 1817; England; host unknown.
3. *dalii* Curtis, 1828; England; parasite of *Andrena labialis* Kirby.
4. *childreni* Gray, 1832; Nova Scotia; parasite of *Andrena victima* Smith.
5. *spencii* Pickering, 1835; Europe; parasite of *Andrena tibialis,* Kirby.
6. *aterrima* Newport, 1847; England; parasite of *Andrena trimmerana,* Kirby.
7. *dominiquei* Pierce, 1909; France; parasite of *Andrena flessae,* Panzer.
8. *championi* Pierce, new species; England; host unknown.

It probably also contains:

9. *thwaitei* Saunders, 1872; Europe; parasite of *Andrena afzeliella* Kirby.
10. *nassonowi* Pierce, 1909; Europe; parasite of *Andrena carbonaria* Linnaeus.
11. *ventricosae* Pierce, 1909; Hungary; parasite of *Andrena ventricosa* Dours.

As full descriptions of most of these species occur in Bulletin 66 no further mention will be made unless new notes require it.

2. STYLOPS KIRBII Leach, 1817.

Stylops kirbii LEACH, Zool. Misc., vol. 3, p. 135, pl. 149.

The illustration of *Stylops kirbyi* Leach by the author proves that it differs from any of the other English species, by the frontal prominence, the shape of the maxillae, and the antennae. Unfortunately the methathoracic structure is very indistinctly drawn, but judging from the shading the species must remain in typical *Stylops.*

[1] Trans. Ent. Soc. Lond., vol. 4, n s., 1856, pp. 1–4, pl. 24.

Dale (1841) records collecting on April 28, 1840, at Glanville's Wootten, England, a male on an Andrena containing females.

3. STYLOPS DALII Curtis.

Erratum: Gen. Insect., p. 16, line 38, read "pl. 226" for "p. 226."

5. STYLOPS SPENCII Pickering.

Erratum: Gen. Insect., p. 17, line 15, read "p. 168" for "p. 68."

8. STYLOPS CHAMPIONI, new species.

Plate 70, figs. 5, 6.

Described from a type male collected at Woking, Surrey, England, April 24, 1900, by G. C. Champion, and two paratype males collected April 5, 1912, and April 23, 1912, at Woking by H. G. Champion.

Length 3.5 mm. Velvety black, with appendages and wing veins piceous black, tarsal pads creamy yellow, ninth abdominal segment and oedeagus, yellowish, tenth segment black. Wings milky.

Eyes stalked with many ommatidia, very narrowly separated. Head triangularly produced. Antennae six-jointed; first joint longer and broader than second, which is ring like; third, ring like with long, broad, flattened flabellum, reaching about to middle of sixth; fourth, broad, flattened, as long as the next two together, which are subequal. Mandibles small, transparent yellowish, acute, ensiform, barely as long as the first joint of the maxillae. Maxillae two-jointed, the first longer than the second, broad, flabellate, longitudinally curved, with the depression beneath; first joint longer than second, the two equalling the third and fourth antennal joints. Head with small circular emargination behind.

Prothorax and mesothorax simple. Metathorax with keystone shaped praescutum, scutum two-lobed, separated by scutellum, which is narrowly pedunculate in front. Scuti carinate from wings almost to scutellum, thus indicating partial separation of parascutellum. Postlumbium black subchitinous, bisinuate at base, elongate rounded behind, as broad as long. Postscutellum longer than anterior portions of metathorax. Concave for reception of abdomen.

Wing venation consists of the basal costa, strong marginal subcosta; the approximate radius with the area between darkened, a short detached vein arising near the apex of radius; the usual medius with a faint detached vein in front of it and a short approximate detached vein behind it near apex; cubitus and three anal, the last rather short. A strong fold occurs between medius and cubitus.

The hypoepimeron (femoralium) practically incloses the posterior coxae.

The color of the anal regions is unusual.

The elytra have a strong marginal vein and at base have a small rounded flap.

Type.—Cat. No. 21438, U.S.N.M.

The remaining species are to be retained in *Stylops* until the male characters are known.

UNPLACED AS TO GROUP.

12. *asteridis* Pierce, 1911; Illinois; parasite of *Andrena asteris* Robertson.

GROUP 1.

13. *bipunctatae* Pierce, 1909; Indiana, Nebraska, Wisconsin, parasite of *Andrena bipunctata* Cresson.
14. *moestae* Pierce, new species; Washington; parasite of *Andrena moesta* Smith.

GROUP 2.

15. *mandibularis* Pierce, 1911; Illinois; parasite of *Andrena mandibularis* Robertson.

GROUP 3.

16. *nubeculae* Pierce, 1909; Colorado; parasite of *Andrena nubecula* Smith.

GROUP 4.

17. *subcandidae* Pierce, 1909; Southern California; parasite of *Andrena subcandida* Viereck.

GROUP 5.

18. *krygeri* Pierce, new species; Denmark; parasite of *Andrena*, species.

GROUP 6.

19. *multiplicatae* Pierce, 1909; Wisconsin; parasite of *Andrena multiplicata* Cockerell.
20. *advarians* Pierce, 1909; British Columbia; parasite of *Andrena advarians* Viereck.
21. *bisalicidis* Pierce, new species; Alabama; parasite of *Andrena bisalicis* Viereck.
22. *sparsipilosae* Pierce, 1909; Maine; parasite of *Andrena sparsipilosa* Viereck.

GROUP 7.

23. *erigeniae* Pierce, new species; Maryland, Illinois; parasite of *Andrena erigeniae* Robertson.

GROUP 8.

24. *hippotes* Pierce, 1909; Ohio; parasite of *Andrena hippotes* Robertson.
25. *nasoni* Pierce, 1909; Pennsylvania; parasite of *Andrena nasoni* Robertson.

GROUP 9.

26. *swenki* Pierce, 1909; Nebraska, Pennsylvania; parasite of *Andrena solidaginis* Robertson.

GROUP 10.

27*a*. *claytoniae*, var. *claytoniae* Pierce, 1909; Georgia, Illinois; parasite of *Andrena imitatrix* Cresson (*claytoniae* Robertson).
  b. var. *imitatrix* Pierce, 1909; Texas; parasite of *Andrena imitatrix* Cresson.
  c. var. *vierecki* Pierce, 1909; Texas; parasite of *Andrena imitatrix* Cresson (*texana profunda* Viereck).

GROUP 11.

28. *bruneri* Pierce, 1909; Nebraska, Illinois; parasite of *Andrena illinoiensis* Robertson.
29. *oklahomae* Pierce, 1909; Oklahoma; parasite of *Andrena falvoclypeata miserabilis* Cresson.
30. *salictariae* Pierce, new species; Illinois; parasite of *Andrena salictaria* Robertson.
31. *andrenoides* Pierce, 1911; Illinois; parasite of *Andrena andrenoides* Cresson.
32. *medionitans* Pierce, new species; Colorado; parasite of *Andrena medionitans* Cockerell.

GROUP 12.

33. *sinuatus* Pierce, new species; Illinois; parasite of *Andrena mandibularis* Robertson.
34. *grandior* Pierce, new species; Montana; parasite of *Andrena grandior multiplicatiformis* Viereck.
35. *nudae* Pierce, 1911; Illinois; parasite of *Andrena nuda* Robertson.
36. *cornii* Pierce, 1909; Wisconsin; parasite of *Andrena commoda* Smith.
37. *californica* Pierce, 1909; southern California; parasite of *Andrena subtilis* Smith.
38. *vicinae* Pierce, 1909; New Hampshire, Connecticut, Canada, Massachusetts, Colorado; parasite of *Andrena vicina* Smith.

GROUP 13.

39. *salicifloris* Pierce, 1909; Washington; parasite of *Andrena salicifloris* Cockerell.

GROUP 14.

40. *graenicheri* Pierce, 1909; Wisconsin; parasite of *Andrena nivalis* Smith.

Group 15.

41. *cressoni* Pierce, 1909; Maine; parasite of *Andrena cressoni* Robertson.
42. *diabola* Pierce, new species; North Dakota; parasite of *Andrena bisalicis* Viereck, var.

Group 16.

43. *hartfordensis* Pierce, 1909; Georgia, parasite of *Andrena hartfordensis* Cockerell.
44. *neonanae* Pierce, new species; Georgia; parasite of *Andrena neonana* Viereck.

12. STYLOPS ASTERIDIS Pierce.

Table of measurements.

Specimen	1	2	3	4	5	6
Type, Carlinsville, Illinois	(?)	41	26	(?)	41	(?)

Group 1.

13. STYLOPS BIPUNCTATAE Pierce.

It has two toothed mandibles and spiracles distant from margin.

Table of measurements of female.

Specimen	1	2	3	4	5	6
1. Type, Indiana	50	31	22	41	36	53
2. Nebraska	50.5	31	20	38	34	50
3. Polk Co., Wisconsin	46	28	19	38	34	50
Average	48.8	30	20	39	35	51

Taking measure 1 as unit, the following relative lengths of the other measurements are obtained:

Specimen	1	2	3	4	5	6	Index total.
Relative length compared to width at spiracles:							
1	1.00	0.62	0.44	0.82	0.72	1.06	4.66
2	1.00	.61	.39	.75	.67	.99	4.41
3	1.00	.60	.41	.82	.73	1.09	4.65
	1.00	.61	.41	.79	.71	1.04	4.56

The range of differences is very small. A numerical index may be obtained by adding the six relative measurements together. This gives totals ranging from 4.41 to 4.66 and averaging 4.56, which we may call the species index.

14. STYLOPS MOESTAE, new species.

Described from two females extracted from a specimen of *Andrena moesta* Smith, determined by H. L. Viereck, collected at Govan, Washington, March 29, 1911, by J. A. Hyslop.

Female.—Cephalothorax broad; yellowish brown with dark reddish brown basal band; spiracles not reaching lateral margin; mandibles broad, subquadrate with apical tooth. Length of cephalothorax, 1 mm.; breadth, 0.8 mm.

Table of measurements.

Specimen	1	2	3	4	5	6	Index total.
1. Type, Govan, Washington	63	38	24	50	49	61	......
Paratype, Govan, Washington	59	38	24	50	49	64.5	......
Average	61	38	24	50	49	62.7	......
Relative length compared to breadth at spiracles:							
1	1.00	0.60	0.38	0.79	0.77	0.97	4.51
2	1.00	.61	.40	.84	.83	1.09	4.80
Average	1.00	.62	.39	.81	.80	1.03	4.65

Type.—Cat. No. 21439, U.S.N.M.

Group 2.

15. STYLOPS MANDIBULARIS Pierce.

Table of measurements of female.

Specimen	1	2	3	4	5	6	Index total.
Type, Carlinville, Illinois	62	38	21	50	37	60	......
Relative length compared to width at spiracles	1.00	0.61	0.33	0.80	0.59	0.96	4.29

Group 3.

16. STYLOPS NUBECULAE Pierce.

Table of measurements of female.

Specimen	1	2	3	4	5	6	Index total.
Type	58	30	21	39	33	51	......
Relative length compared to width at spiracles	1.00	0.51	0.36	0.67	0.58	0.87	3.99

Group 4.

17. STYLOPS SUBCANDIDAE Pierce.

Table of measurements of female.

Specimen	1	2	3	4	5	6	Index total.
1. Type, Southern California	50	31	21	36	30	47	......
2. Paratype, Southern California	50	31	21	38	32	50	......
Average	50	31	21	37	31	48.5	......
Relative length compared to width at spiracles:							
1	1.00	0.62	0.42	0.52	0.60	0.90	4.10
2	1.00	.62	.42	.56	.64	1.00	4.24
Average	1.00	.62	.42	.54	.62	.97	4.17

Group 5.

17. STYLOPS KRYGERI, new species.

Described from three females, extracted from two specimens of an Andrena, originally determined as *Halictus zonulus* Smith, collected at Fejo, Denmark, November 6, 1915, and sent the author by Mr. J. P. Kryger.

Female.—Cephalothorax reddish brown with large basal dark brown area extending almost to the middle; rather elongate, not strongly narrowed in front; constricted at base; spiracles lateral, hardly prominent; mandibles rounded with the tooth on the inner side surpassed by the apex.

Length of cephalothorax, 1.1 mm.; breadth, 1 mm.

Table of measurements.

Specimen	1	2	3	4	5	6	Index total.
1. Type	61.5	37	27.5	45	47	65	......
2. Paratype	62.0	37	23.0	......	45	......	......
3. Paratype	64.5	37	26.0	49	44	63	......
Average	62.6	37	25.5	47	45.3	64	......
Relative length compared to breadth at spiracles:							
1	1.00	0.60	0.44	0.73	0.76	1.05	4.58
2	1.00	.59	.37	......	.72	......	......
3	1.00	.57	.40	.76	.68	.97	4.38
Average	1.00	.586	.40	.745	.72	1.01	4.46

Types.—Cat. No. 21440, U.S.N.M.

Group 6.

19. STYLOPS MULTIPLICATAE Pierce.

Table of measurements of female.

Specimen	1	2	3	4	5	6	Index total.
Type, Milwaukee, Wisconsin, Apr. 9, 1904	54.5	32	22	45	35	55	......
Relative length compared with width at spiracle	1.00	0.58	0.40	0.82	0.64	1.00	4.44

20. STYLOPS ADVARIANS Pierce.

Plate 71, figs. 11, 12.

Table of measurements of female.

Specimen	1	2	3	4	5	6	Index total.
Type, Vancouver, British Columbia	64	36	24	56	46	64	......
Relative lenght compared to width at spiracles	1.00	0.56	0.37	0.87	0.71	1.00	4.51

Illustrations are presented of the female cephalothorax and the right mandible.

21. STYLOPS BISALICIDIS, new species.

Described from one female extracted from an *Andrena bisalicis* Viereck (determined by Viereck) from Alabama collected by C. F. Baker, No. 2223.

Female.—Cephalothorax reddish brown with darker basal band; broad at base, narrowed at apex; mandibles subquadrate, with single apical tooth; spiracles lateral, but not prominent. Length of cephalothorax, 0.9 mm.; breadth, 0.9 mm.

Table of measurements.

Specimen	1	2	3	4	5	6	Index total.
Type	55	33	21	43	38	55	......
Relative length compared to breadth at spiracles	1.00	0.60	0.36	0.78	0.69	1.00	4.43

Type.—Cat. No. 21441, U.S.N.M.

22. STYLOPS SPARSIPILOSAE Pierce.

Table of measurements of female.

Specimen	1	2	3	4	5	6	Index total.
Type, Waldoboro, Maine	50	31	19	40	32	50	......
Relative length compared to width at spiracles	1.00	0.62	0.38	0.80	0.64	1.00	4.44

Group 7.

23. STYLOPS ERIGENIAE, new species.

Described from two females from a female *Andrena erigeniae* Robertson, collected on *Erythronium americanum* at Plummers Island, Maryland, March 29, 1915, by J. C. Crawford; the type in the collection of the United States National Museum and the paratype in the collection of the author. Another paratype specimen in the museum collection was taken from an *Andrena erigeniae* collected at Carlinville, Illinois, April 1, by Charles Robertson.

Female.—Cephalothorax yellowish brown, with broad basal dark reddish brown band. Length of cephalothorax of type 0.8 mm.; breadth, 1 mm. Mandibles with one sharp curved tooth. Cephalothorax broadest behind spiracles which are laterally prominent.

Table of measurements of female.

Specimen	1	2	3	4	5	6	Index total.
1. Carlinville, Illinois	51	31	19	40	35	58	......
2. Plummers Island, Maryland	49	32	20	37	38	58	......
3. Type, Plummers Island, Maryland	50	32	21	39	32	51	......
4. Plummers Island, Maryland	42.5	24	16	30.5	29	45	......
5. Plummers Island, Maryland	45.5	28	18	(?)	33	47	......
Average	47.6	29.4	18.8	36.6	33.4	51.8	......
Relative length compared to width at spiracles:							
1	1.00	0.60	0.36	0.78	0.68	1.13	4.55
2	1.00	.65	.40	.75	.77	1.18	4.75
3	1.00	.64	.42	.78	.64	1.02	4.50
4	1.00	.56	.37	.71	.68	1.05	4.37
5	1.00	.61	.39	(?)	.72	1.03	(?)
Average	1.00	.61	.39	.75	.70	1.08	4.53

Specimen No. 4 is quite different from the other specimens in its proportions and size. In fact it is possibly a distinct species.

Type.—Cat. No. 21442, U.S.N.M.

GROUP 8.

24. STYLOPS HIPPOTES Pierce.

Table of measurements of female.

Specimen	1	2	3	4	5	6	Index total.
Type, Columbus, Ohio	54.3	35	22	43	35	56	......
Relative length compared to width at spiracles	1.00	0.64	0.40	0.79	0.64	1.03	4.50

25. STYLOPS NASONI Pierce.

Table of measurements of female.

Specimen	1	2	3	4	5	6	Index total.
Type	45	25	19	35	29	48	......
Relative length compared to width at spiracles	1.00	0.55	0.42	0.77	0.64	1.06	4.44

GROUP 9.

26. STYLOPS SWENKI Pierce.

Plate 71, figs. 1, 2, 8, 9, 10.

Table of measurements of female.

Specimen	1	2	3	4	5	6	Index total.
4. Paratype, Lincoln, Nebraska	53	35	22	35	40	55	......
Relative length compared to width at spiracles	1.00	0.66	0.41	0.66	0.75	1.03	4.51

An illustration of the female cephalothorax is presented.

Group 10.

27a. STYLOPS CLAYTONIAE, var. CLAYTONIAE Pierce.

Table of measurements of female.

Specimen	1	2	3	4	5	6	Index total.
Type, Thomasville, Georgia	55.5	30.5	20	38	35	59	......
Relative length compared to width at spiracles	1.00	0.54	0.36	0.68	0.63	1.06	4.27

27b. STYLOPS CLAYTONIAE, var. IMITATRIX Pierce.

Table of measurements of female.

Specimen	1	2	3	4	5	6	Index total.
Type, Round Mountain, Texas	58	34	20	40	36	58	......
Relative length compared to width at spiracles	1.00	0.58	0.34	0.68	0.62	1.00	4.22

27c. STYLOPS CLAYTONIAE, var. VIERECKI Pierce.

Table of measurements of female.

Specimen	1	2	3	4	5	6	Index total.
1. Type, Fedor, Texas	49	31.7	19.5	35	33	51	......
2. Cotype, Fedor, Texas	51	34	20	35	37	52	......
3. Cotype, Fedor, Texas	51.5	32	19	35	33	48	......
Average	50.7	32.5	19.5	35	34.5	50	......
Relative length compared to width at spiracles:							
1	1.00	0.64	0.39	0.71	0.67	1.04	4.45
2	1.00	.66	.39	.68	.72	1.01	4.46
3	1.00	.62	.36	.67	.64	.93	4.22
Average	1.00	.64	.38	.68	.67	.99	4.37

Group 11.

28. STYLOPS BRUNERI Pierce.

Plate 71, figs. 1, 2, 8, 9, 10.

Table of measurements of female.

Specimen	1	2	3	4	5	6	Index total.
1. Type, Sioux County, Nebraska	45	25.5	19	30	33	48.5	......
2. Lincoln, Nebraska	38.5	23	16.5	(?)	28	41	......
Average	41.7	24.2	17.7	......	32.5	44.7	......
Relative length compared to width to width at spiracles:							
1	1.00	.56	.42	.66	.73	1.07	4.44
2	1.00	.59	.40	(?)	.72	1.07	(?)
Average	1.00	.57	.41	.66	.72	1.07	4.43

The range of differences is very small. A numerical index may be obtained by adding the six relative measurements together. This gives an average index of 4.43. Illustrations are given of the female cephalothorax and mandibles.

29. STYLOPS OKLAHOMAE Pierce.

Table of measurements of female.

Specimen	1	2	3	4	5	6	Index total.
Type, Ardmore, Oklahoma	46.5	27.5	17	33	33	51	......
Relative length compared to width at spiracles	1.00	0.59	0.36	0.70	0.70	1.0	4.44

30. STYLOPS SALICTARIAE, new species.

Described from seven female specimens from *Andrena salictaria* Robertson, collected by Charles Robertson at Carlinville, Illinois. Specimens in collection United States National Museum.

Female.—Cephalothorax yellowish brown, with broad basal dark reddish brown band. Length of cephalothorax of type 1.8 mm.; breadth 0.7 mm. Mandibles broad, bluntly two toothed. Spiracles laterally slightly prominent.

Table of measurements of female.

Specimen	1	2	3	4	5	6
Carlinville, Illinois:						
1 (type)	41.2	24	17	35	27	44
2	43.3	26.5	17.5	35	29.5	45
3	42	26.5	18	34	30	45
4	38.7	23	18	33	28	45
5	45	27	18	34	29	44
6 (immature)	40	24	16	(?)	26	(?)
7 (immature)	35	23	16	(?)	25	(?)
Average	40.7	24.8	17.2	34.2	27.7	44.6

Taking measurement 1 as unit, the following relative lengths of the other measurements are obtained:

Specimen	1	2	3	4	5	6	Index total.
Relative length compared to width at spiracles:							
1 (type)	1.00	0.58	0.41	0.84	0.65	1.06	4.54
2	1.00	.60	.40	.80	.68	1.04	4.52
3	1.00	.63	.42	.80	.71	1.07	4.63
4	1.00	.59	.46	.85	.72	1.16	4.78
5	1.00	.60	.40	.75	.64	.97	4.36
6	1.00	.60	.40	(?)	.65	(?)	(?)
7	1.00	.65	.45	(?)	.71	(?)	(?)
Average	1.00	.60	.42	.80	.68	1.06	4.56

Type.—Cat. No. 21443, U.S.N.M.

31. STYLOPS ANDRENOIDES Pierce.

Table of measurements of female.

Specimen	1	2	3	4	5	6	Index total.
Illinois:							
1 (type)	51	29	18.5	(?)	32	46	......
2	37	25	17	29	25	38	......
3	44	28	18	30	35	48	......
4	40.2	26	18	30	31	43	......
5	50	30	21	38	35	52	......
6	45	27	21	34	32.5	46	......
7	44	28	17	30	32	48	......
Average	44.4	27.5	18.6	31.8	31.7	45.8	......
Relative length compared to width at spiracles:							
1 (type)	1.00	0.56	0.36	(?)	0.62	0.90	(?)
2	1.00	.67	.40	0.78	.67	1.02	4.54
3	1.00	.63	.40	.68	.79	1.09	4.59
4	1.00	.64	.44	.74	.77	1.07	4.66
5	1.00	.60	.42	.76	.70	1.04	4.52
6	1.00	.60	.46	.75	.72	1.06	4.59
7	1.00	.63	.38	.68	.72	1.09	4.50
Average	1	.62	.41	.73	.71	1.04	4.51

The material may possibly contain two or more or distinct species, but it is more likely that the differences are accounted for by specific variation.

32. STYLOPS MEDIONITANS, new species.

Described from one female extracted from an *Andrena medionitans* Cockerell, determined by Cockerell, collected at Florissant, Colorado, June 24, on *Cerasus melanocarpa*, by T. D. A. Cockerell.

Female.—Cephalothorax yellowish brown with dark basal band; rather broad and rounded; strongly constricted at base; spiracles marginal, not prominent; mandibles dentate at apex, strongly rounded at outer apical angle and angulate on side.

Length of cephalothorax, 0.8 mm.; breadth, 0.8 mm.

Table of measurements.

Specimen	1	2	3	4	5	6	Index total.
Type	49	30	20	37	32	53	......
Relative length compared to breadth at spiracles	1.00	0.61	0.40	0.75	0.65	1.08	4.49

Type.—Cat. No. 21444, U.S.N.M.

GROUP 12.

33. STYLOPS SINUATUS, new species.

Described from two specimens from *Andrena mandibularis* Robertson, collected April 10, at Carlinville, Illinois, by Charles Robertson, but differing from *Stylops mandibularis* in the same host by numerous characters.

Female.—Cephalothorax yellowish brown; with broad basal reddish brown band. Length of cephalothorax, 0.7 mm.; breadth, 0.7 mm. Mandibles subquadrate, rounded, with small outward pointing tooth at apex. Spiracles laterally prominent. Lateral margin strongly sinuous, with two constrictions between spiracles and base of head, which is also constricted and suddenly enlarged just beyond, then again strongly narrowed some distance behind the base of the mandibles.

Table of measurements of female.

Specimens	1	2	3	4	5	6	Index total.
1. Type Carlinville, Illinois	51.5	29.7	21	39	37	52	......
2. Paratype	49	30	20	39	34	47	......
Average	50.2	29.8	20.5	39	35.5	49.9	......
Relative length compared to width at spiracles:							
1	1.00	0.57	0.40	0.75	0.71	1.00	4.43
2	1.00	.61	.40	.79	.69	.95	4.44
Average	1.00	.59	.40	.77	.70	.97	4.43

Type.—Cat. No. 21445, U.S.N.M.

34. STYLOPS GRANDIOR, new species.

Described from two females extracted from a specimen of *Andrena grandior multiplicatiformis* Viereck, determined by Viereck, collected June 21, 1904, at Big Fork, Montana.

Female.—Cephalothorax yellowish brown with dark-brown basal band; very broad at base, strongly narrowed toward apex; sides subparallel for short distance behind spiracles and then strongly constricted; spiracles very prominent laterally; mandibles subquadrate with apical tooth pointed outward. Length of cephalothorax, 0.9; breadth, 1 mm.

Table of measurements.

Specimens	1	2	3	4	5	6	Index total.
1. Type	68	37	22	45	44	63	......
2. Paratype	62	37	19	50	37	53	......
Average	65	37	20.5	47.5	40.5	58	......
Relative length compared to breadth at spiracles:							
1	1.00	0.54	0.32	0.66	0.64	0.92	4.08
2	1.00	.59	.30	.80	.59	.85	4.13
Average	1.00	.56	.31	.73	.62	.88	4.10

Type.—Cat. No. 21446, U.S.N.M.

35. STYLOPS NUDAE Pierce.

Table of measurements of female.

Specimens	1	2	3	4	5	6	Index total.
1. Type, Carlinville, Illinois	54	32	19	40	34	54	......
2. Paratype	51.3	31	18.5	38	33	52	......
Average	52.6	31.5	18.7	39	33.5	53	......
Relative length compared to width at spiracles:							
1	1.00	0.59	0.35	0.74	0.63	1.00	4.31
2	1.00	.60	.36	.74	.66	1.01	4.37
Average	1.00	.59	.36	.74	.65	1.00	4.34

Length of triungulinid, 0.2 mm.

36. STYLOPS CORNII Pierce.

Table of measurements of female.

Specimens	1	2	3	4	5	6	Index total.
1. Type, Milwaukee, Wisconsin	72	38	27	50	53	76	......
2. Paratype, Wisconsin	80	45	30	56	56	81	......
Average	76	41.5	28.5	53	54.5	78.5	......
Relative length compared to width at spiracles:							
1	1.00	0.52	0.37	0.69	0.73	1.05	4.36
2	1.00	.56	.37	.70	.70	1.01	4.34
Average	1.00	.54	.37	.69	.71	1.03	4.35

37. STYLOPS CALIFORNICA Pierce.

Plate 71, figs. 5–7.

Table of measurements of female.

Specimens	1	2	3	4	5	6	Index total.
1. Type, Southern California	64	40.5	22.5	46	44	66	......
2. Paratype, Southern California	64	39	22.5	52	41	66	......
Average	64	39.7	22.5	49	42.5	66	......
Relative length compared to width at spiracles:							
1	1.00	0.63	0.35	0.71	0.68	1.03	4.40
2	1.00	.60	.35	.81	.64	1.03	4.43
Average	1.00	.61	.35	.76	.66	1.03	4.41

Illustrations are presented of the female cephalothorax and mandible and of a triungulinid.

38. STYLOPS VICINAE Pierce.

Table of measurements of female.

Specimens	1	2	3	4	5	6	Index total.
1. Type, New Hampshire	71	44	28	52	50	73	......
2. Paratype, New Hampshire	69	44.5	29	53	51	73	......
3. Paratype, Canada	75	43	26	57	54.5	75	......
4. Paratype, Canada	77	48	32	54	55	80	......
5. Salina, Colorado	75	44.5	28	57	56	80	......
6. Boulder, Colorado	75	44	29	55.5	54	77	......
7. Plummer's Island, Maryland	72.5	41	28	50	52	73	......
8. Plummer's Island, Maryland	74	44	28.5	52.5	54	76	......
9. Cabin John Bridge, Maryland	74	45	27	53	54.5	81	......
10. Lahaway, New Jersey	76	47	30	57	53	80	......
11. Plummer's Island, Maryland	72	45	29	51	54	80	......
Average	73.6	44.5	28.5	53.7	53.4	77.0	......
Relative length compared to width at spiracles:							
1	1.00	0.61	0.39	0.73	0.70	1.04	4.47
2	1.00	.64	.42	.76	.73	1.05	4.60
3	1.00	.57	.34	.76	.72	1.00	4.39
4	1.00	.62	.41	.70	.71	1.03	4.47
5	1.00	.59	.37	.76	.74	1.06	4.52
6	1.00	.58	.38	.74	.72	1.02	4.44
7	1.00	.56	.38	.68	.71	1.00	4.53
8	1.00	.59	.38	.70	.72	1.02	4.41
9	1.00	.60	.36	.71	.73	1.09	4.49
10	1.00	.61	.39	.75	.69	1.05	4.49
11	1.00	.62	.40	.70	.75	1.11	4.58
Average	1.00	.60	.38	.72	.72	1.04	4.46

Group 13.

39. STYLOPS SALICIFLORIS Pierce.

Table of measurements of female.

Specimen	1	2	3	4	5	6	Index total.
Type	57.5	59	23	48	44	62	......
Relative length compared to width at spiracles	1.00	0.67	0.40	0.83	0.76	1.07	4.73

Group 14.

40. STYLOPS GRAENICHERI Pierce.

Table of measurements of female.

Specimen	1	2	3	4	5	6	Index total.
Type, Milwaukee, Wisconsin	81	43	27	56	51	75	......
Relative length compared to width at spiracles	1.00	0.53	0.33	0.69	0.63	0.92	4.10

Group 15.

41. STYLOPS CRESSONI Pierce.

Table of measurements of female.

Specimen	1	2	3	4	5	6	Index total.
Type, Waldoboro, Maine	59.5	32	21	50	40	62	......
Relative length compared to width at spiracles	1.00	0.53	0.35	0.83	0.67	1.04	4.42

42. STYLOPS DIABOLA, new species.

Described from one female extracted from an *Andrena bisalicis* Viereck, var. (determined by Viereck) from Devils Lake, North Dakota, collected May 15, 1916, on *Amelanchier*.

Female.—Cephalothorax yellow with a very dark brown basal band; spiracles very prominent; mandibles rounded, with subapical tooth on inner margin and an angle on outer margin. Length, 1 mm.; breadth, 1 mm.

Table of measurements of female.

Specimen	1	2	3	4	5	6	Index total.
Type	62	35	23	48	42	65	......
Relative length compared to breadth at spiracles	1.00	0.56	0.37	0.77	0.67	1.04	4.41

Type.—Cat. No. 21447, U.S.N.M.

GROUP 16.

43. STYLOPS HARTFORDENSIS Pierce.

Table of measurements of female.

Specimen	1	2	3	4	5	6	Index total.
Type, Thomasville, Georgia	45	27	20	39	32	48	......
Relative length compared to width at spiracles	1.00	0.60	0.44	0.86	0.71	1.06	4.67

44. STYLOPS NEONANAE, new species.

Described from one female extracted from a specimen of *Andrena neonana* Viereck, paratype, collected in Georgia, and the property of the Philadelphia Entomological Society.

Female.—Cephalothorax, yellowish brown with dark-brown basal band; broad, rounded; spiracles prominent; mandibles with apical tooth and with lateral angle almost a tooth. Length of cephalothorax, 0.7 mm.; breadth, 0.7 mm.

Table of measurements of female.

Specimen	1	2	3	4	5	6	Index total.
Type, Georgia	42	26	17	30	27	44	......
Relative length compared to breadth at spiracles	1.00	0.61	0.40	0.71	0.64	1.04	4.40

Type.—In the Philadelphia Academy of Sciences.

KATASTYLOPS, new subgenus.

I have separated off this subgenus because of the great difference between its type, *Stylops polemonii* Pierce, and the other species of

Stylops in female characters. It is the smallest known parasite of the genus *Andrena* and differs greatly in the proportions of the cephalothorax; although taken separately the various proportions range within the variations of typical *Stylops*. The mandibles are not dentate and the spiracles not prominent. It can not be separated as a genus until the male is known.

Species: 1. *polemonii* Pierce, 1909; Colorado; parasite on *Andrena polemonii* Robertson.

STYLOPS (KATASTYLOPS) POLEMONII Pierce.

Table of measurements of female.

Specimen	1	2	3	4	5	6	Index total.
Type, Colorado	34.5	21	13	25	21	38	....
Relative length compared to width at spiracles	1.00	0.60	0.37	0.72	0.67	1.10	4.48

PROSTYLOPS, new subgenus.

I have separated off this subgenus because of the great difference between its type, *Stylops pilipedis* Pierce, and the other species of *Stylops* in female characters. It is the largest known parasite of the genus *Andrena*, and differs greatly in the proportions of the cephalothorax from other *Stylops*. The mandibles are not dentate and the spiracles barely surpass the lateral margin. It can not be separated as a genus until the male is known.

Species: 1. *pilipedis* Pierce, 1911; China; parasite of *Andrena pilipes* Fabricius.

STYLOPS (PROSTYLOPS) PILIPEDIS Pierce.

Table of measurements of female.

Specimen	1	2	3	4	5	6	Index total.
Type, Pekin, China	80.5	54	28	60	55	83	....
Relative length compared to width at spiracles	1.00	0.67	0.34	0.74	0.68	1.03	4.46

12. NEOSTYLOPS, new genus.

Type of the genus.—*Neostylops crawfordi* Pierce.

Male.—Methathoracic scutum connected between praescutum and scutellum.

Female.—Cephalothorax with marginal, but not prominent spiracles, and mandibles without teeth, or with but a single tooth (*solidulae*).

The genus probably includes several species still included in *Stylops sensu latiore*, because the males are unknown. The differences in the females recorded indicate that probably further subdivisions will become necessary.

It includes the following species:

1. *crawfordi* Pierce (Stylops), parasitic on *Andrena crawfordi* Viereck; Texas.

2. *trimmerana* Smith (Stylops), parasitic on *Andrena trimmerana* Kirby; England.

3. *solidulae* Pierce (Stylops), parasitic on *Andrena solidula* Viereck; Washington.

4. *shannoni* Pierce; host unknown; Maryland.

1. NEOSTYLOPS CRAWFORDI Pierce.

Plate 70, figs. 3, 4.

Stylops crawfordi PIERCE, 1909, U. S. Nat. Mus., Bull. 66. pp. 100–102.

Errata: Gen. Insect. Page 52, lines 16, 17, read "5" for "4." Page 16, line 36, add "Pl. 1, unnumbered figure."

Male.—The male has a very interesting mesothoracic spiracle located on the margin between the propleuron and mesopleuron and immediately at the base of the elytra. This spiracle has a very large oval opening and is of the annular type with a crenulate soft lip. It is impossible to see the form of the inner opening and of the closing apparatus. The figure given shows the position with relation to the elytron, which happens to be so folded as to obscure a considerable portion of the opening. It is bounded in front by the proepimeron, above by the mesopraescutum+scutum, and behind by intersegmental skin (pl. 70, fig. 3).

A drawing of the side view of the male (pl. 70, fig. 4) is also presented.

Table of measurements of female.

Specimens	1	2	3	4	5	6	Index total.
1. Type, Dallas, Texas	73	41	25	50	45	70	......
2. Paratype, Dallas, Tex	75	43	28	47	50	70	......
Average	74	42	26.5	48.5	47.5	70	......
Relative length compared to width at spiracles:							
1	1.00	0.56	0.34	0.68	0.61	0.95	4.14
2	1.00	.57	.37	.62	.66	.93	4.15
Average	1.00	.56	.35	.65	.63	.94	4.14

2. NEOSTYLOPS TRIMMERANA Smith.

Stylops trimmerana SMITH, 1856, Trans. Ent. Soc. Lond., ser. 2*a*, vol. 4, p. 118, pl. 24, fig. 6.

Stylops aterrima (Newport) (*trimmerana* Smith) SAUNDERS, 1872, Trans. Ent. Soc. Lond., 1871, p. 29. [Not *aterrima* Newport.]

According to the drawings made by Smith, this species differs greatly from *aterrima* in thoracic characters and should be referred to this genus.

3. NEOSTYLOPS SOLIDULAE Pierce.

Table of measurements of female.

Specimens	1	2	3	4	5	6	Index total.
1. Type, Pullman, Washington	82	48	35	55	59	90	......
2. Paratype, Washington	76.5	44	29	54	55.5	82	......
Average	79.2	52	32	54.5	57.2	86	......
Relative length compared to width at spiracles:							
1	1.00	0.58	0.42	0.67	0.71	1.09	4.47
2	1.00	.57	.39	.70	.72	1.07	4.45
Average	1.00	.57	.41	.69	.71	1.08	4.46

The male pupa has scutum united in front of scutellum.

4. NEOSTYLOPS SHANNONI, new species.

Plate 70, figs. 1, 2.

Described from one male collected on Plummers Island, Maryland, April 7, 1915, by R. C. Shannon.

Male.—Velvety black, pro- and mesothorax shining, eyes, antennae, femora, elytra, and wing veins piceous; tibiae, tarsi and last ventral segment lighter, straw colored.

Antennae with second joint minute; third short with flabellum surpassed by sixth; fourth longer; fifth shorter than sixth. Mandibles very slender, not reaching beyond basal third of second maxillary joint. Maxillae very large, lamellate, second joint longer than first and about equal to fourth antennal joint. Front flattened into an overhanging triangular ledge over the mouth parts.

The mesothoracic spiracle is located at the base of elytron. The prothorax and mesothorax are very small and each is divided by a transverse fold. The metathorax is very large; the praescutum keystone shape; the scutum broadly connected behind praescutum, but with a deep depression in front of the scutellum; scutellum broadly rounded in front; postlumbium very large, depressed and heavily chitinized, of the same color as the remainder of the thorax; postscutellum longitudinally depressed.

The elytron has a small anal lobe.

Type.—Cat. No. 21448, U.S.N.M.

12. Genus PARASTYLOPS Meijere (1908).

Parastylops MEIJERE, 1911.

1. *P. flagellatus* Meijere, host unknown; Java.

VII. Family HYLECTHRIDAE Pierce.

In all my publications the spelling of this family name and of the genus *Hylecthrus*, except when used in quoting bibliographic references, should be changed from "Hylechthridae" and "Hylechthrus" to "Hylecthridae" and "Hylecthrus" to agree with the original spelling. The original description cites the Greek origin of the word, which should have properly been spelled Hylechthrus.

13. Genus HYLECTHRUS Saunders.

LIST OF SPECIES.

1. *H. rubi* Saunders; parasite of *Prosopis rubicola* Saunders; Epirus.
2. *H. quercus* Saunders; parasite of *Prosopis gibba* Saunders; Epirus.
3. *H. sieboldii* Saunders; parasite of *Prosopis variegata* Fabricius, Epirus.

1. HYLECTHRUS RUBI Saunders.

Errata: Gen. Insect., p. 18, line 23, add "Pl. 1, numbered figure."

VIII. Family XENIDAE Semenov.

Table of subfamilies.

1. Male metathoracic scutellum broadly truncate in front, not pedunculate; postlumbium more than half as long as wide. Parasites of Apoidea---- 2.
   Male metathoracic scutellum pedunculate anteriorly, postlumbium short and transverse; maxillae two-jointed; oedeagus inflated at basal angle, sharply angulate at apical third. Female with four median genital tubes entering brood canal---- 3. XENINAE Pierce.
2. Male maxillae simple, two-jointed; oedeagus not conspicuously inflated at basal angle, sharply angulate at apical third. Female with five median genital tubes entering brood canal---- 1. HALICTOXENINAE Pierce.
   Male maxillae three-jointed; oedeagus beginning as a slender tube, then greatly inflated, bent at right angles and produced as a very slender process---- 2. CRAWFORDINAE Pierce.

1. Subfamily HALICTOXENINAE Pierce.

Table of genera.

Male maxillae with first joint longer than second; oedeagus strongly arcuate beneath at middle---- 14. *Halictoxenos* Pierce.
Male maxillae with first joint shorter than second, oedeagus not strongly arcuate beneath at middle; wings with two detached branches of radius and two of medius, between radius and medius---- 15. *Apractelytra* Pierce.

14. Genus HALICTOXENOS Pierce.

Table of subgenera.

Female cephalothorax triangular, narrowly and roundingly truncate at apex, obviously constricted at base of head; breadth of cephalothorax at widest point 1.9 to 2.3 times as wide as breadth of head at base. Parasites of *Chloralictus*---- 1. *Halictoxenos* Pierce.
Female cephalothorax less apparently triangular, broadly and evenly rounded to apex, with very slight sinuations at sides; breadth of cephalothorax at widest point 1.4 times as wide as breadth of head at base. Parasites of *Evylaeus*---- 2. *Halictophilus* Pierce.

Female cephalothorax almost triangular, narrowly truncate at apex; head about one-third as wide as metathorax at spiracles. Parasites of *Halictus*. ________ 3. *Halictostylops* Pierce.

Female cepthalothorax very broad at base, triangular, convexly truncate at apex, strongly constricted at base of head; breadth of cephalothorax at widest point 1.5 times as wide as breadth of head at base. Parasite of *Augochlora* ________ 4. *Augochlorophilus* Pierce.

LIST OF SPECIES.

1. *H.* (*Halictoxenos*) *crawfordi* Pierce; parasite of *Halictus* (*Chloralictus*) *bruneri* Crawford, Nebraska.
2. *H.* (*H.*) *graenicheri* Pierce; parasite of *H.* (*C.*) *albipennis* Robertson; Wisconsin.
3. *H.* (*H.*) *jonesi* Pierce; parasite of *H.* (*C.*) species; Texas, Louisiana.
4. *H.* (*H.*) *nymphaeari* Pierce; parasite of *H.* (*C.*) *nymphaearum* Robertson; Illinois.
5. *H.* (*H.*) *sparsi* Pierce; parasite of *H.* (*C.*) *sparus* Robertson; Oklahoma.
6. *H.* (*H.*) *versati* Pierce; parasite of *H.* (*C.*) *versatus* Robertson; Wisconsin.
7. *H.* (*H.*) *zephyri* Pierce; parasite of *H.* (*C.*) *zephyrus* Smith; Wisconsin.
8. *H.* (*Halictophilus*) *manilae* Pierce; parasite of *H.* (*Evylaeus*) *manilae* Ashmead; Philippines.
9. *H.* (*H.*) *robbii* Pierce; parasite of *H.* (*E.*) *robbii* Ashmead; Philippines.
10. *H.* (*Halictostylops*) *spencii* Nassonow; parasite of *Halictus minutus* Kirby; Europe.
11. *H.* (*Augochlorophilus*) *viridulae* Pierce; parasite of *Augochlora viridula* F. Smith; Illinois.

3. HALICTOXENOS JONESI Pierce.

Errata: Gen. Insect., p. 21, line 12, add "Pl. 3, unnumbered figure."

15. Genus APRACTELYTRA Pierce.

1. *A. schwarzi* Pierce; host unknown; District of Columbia.

1. APRACTELYTRA SCHWARZI Pierce.

Errata: Gen. Insect., p. 22, line 21, add "Pl. 2, unnumbered figure"; pl. 2, unnumbered figure, for "Aproctelytra" read "Apractelytra."

2. Subfamily CRAWFORDINAE Pierce.

16. Genus CRAWFORDIA Pierce.

1. *C. pulvinipes* Pierce; parasite of *Panurginus innuptus* Cockerell; Nebraska.
2. *C. cockerelli* Pierce; parasite of *Panurginus boylei* Cockerell; New Mexico.
3. *C. labrosi* Pierce; parasite of *Panurginus labrosus* Robertson; Illinois.
4. *C. rudbeckiae* Pierce; parasite of *Panurginus rudbeckiae* Robertson; Illinois.

5. *C. californica* Pierce; parasite of *Panurginus californicus* Cresson; Califronia.
6. *C. labrosiformidis* Pierce; parasite of *Panurginus labrosiformis* Robertson; Illinois.

1. CRAWFORDIA PULVINIPES Pierce.

Errata: Gen. Insect., p. 23, line 13, add "Pl. 2, unnumbered figure."

Subfamily XENINAE Pierce.

1. Anterior edges of scutellum convergent, not parallel; wings with eight primary veins from base ---------- 2.
   Anterior edges of scutellum parallel or almost so ---------- 3.
2. Parasites of Vespidae. Wings with radius sometimes indistinct, radius sometimes broken for a short distance. one detached vein between radius and medius ---------- 1. *Xenini* Pierce.
   Parasites of Eumenidae. Wings with two detached veins between radius and medius ---------- 2. *Pseudoxenini* Pierce.
3. Metathoracic postlumbium spindle-shaped, constricted at middle. Parasites of Larridae ---------- 3. *Tachytixenini* Pierce.
   Metathoracic postlumbium not constricted at middle ---------- 4.
4. Parasites of Sphecidae. Wings with two detached veins between radius and medius. and one between medius and cubitus.
   4. *Ophthalmochlini* Pierce.
   Parasites of Bembecidae. Wings with two detached veins between radius and medius ---------- 5. *Paraxenini* Pierce.

1. Tribe XENINI Pierce

1. Triungulinid with two apical stylets ---------- 2.
   Triungulinid with four apical stylets. Parasites of Belonogaster.
   19. *Belonogastechthrus* Pierce.
2. Parasites of Polistes ---------- 17. *Xenos* Rossi.
   Parasites of Vespa ---------- 18. *Vespaexenos Pierce.*

17. Genus XENOS Rossi, 1793.

Xenops Leach 1815, 1830, in Brewster's Edinburgh, Encyclopedia, vol. 9, pp. 117, 1187. *X. peckii* Kirby, *X. rossi* Kirby (*vesparum* Rossi).

Errata: Bull. 66, p. 116, lines 16. 19, 23, read "1793" for "1790." Gen. Insect. p. 24, line 28, read "1794" for "1793"; p. 26, line 14, read "114" for "14"; p. 52, lines 18, 19, read "6" for "5."

Gen. Insect, pp. 25, 26, unnumbered figures on plate 1 are not mentioned for *X. bowditchi*, *pallidus*, *pecosensis*, *wheeleri*, or *vesparum*, and unnumbered figures on plate 2 are not mentioned for *X. hubbardi* or *jurinei.*

LIST OF SPECIES OF XENOS.

1. *X. auriferi* Pierce; parasite of *Polistes aurifer* Saussure; California.
2. *X. bowditchi* Pierce; parasite of *P. pallipes* Lepeletier; Massachusetts, Ohio.

3. *X. bruesi* Pierce; parasite of *P. metricus* Say; Michigan.

4. *X. hubbardi* Pierce; parasite of *P. crinitus* Felton; Florida.

5. *X. hunteri* Pierce; parasite of *P. n. sp.* near *minor;* Texas.

6. *X. jurinei* Saunders; parasite of *P. gallicus* Linnaeus; Switzerland.

7. *X. maximus* Pierce; parasite of *P. rubiginosus* Lepeletier; Texas.

8. *X. nigrescens* Brues; parasite of *P. rubiginosus* Lepeletier; Louisiana, Texas.

9. *X. pallidus* Brues; parasite of *P. annularis* Linnaeus; Texas, Florida, Nebraska, District of Columbia.

10. *X. peckii* Kirby; parasite of *P. fuscatus* Fabricius; Massachusetts.

11. *X. pecosensis* Pierce; parasite of *P. texanus* Cresson; Texas.

12. *X. rubiginosi* Pierce; parasite of *P. rubiginosus* Lepeletier; Louisiana.

13. *X. texani* Pierce; parasite of *P. texanus* Cresson; Texas.

14. *X. wheeleri* Pierce; parasite of *P. metricus* Say; Connecticut, New York, District of Columbia.

15. *X. vesparum* Rossi; parasite of *P. gallicus* Linnaeus; Europe.

16. *X. bohlsi* Hoffman; parasite of *P. canadensis* L.; Paraguay.

4. XENOS HUBBARDI Pierce.

The mesostigmatal lobe of the male, ventral view, is figured in Genera Insectorum, plate 1, figure 3, but not mentioned in the text.

14. XENOS WHEELERI Pierce.

Errata: Gen. Insect, pl. 2, unnumbered figure, for "*Xenos roheeleri*" read "*Xenos wheeleri.*"

15. XENOS VESPARUM Rossi.

Plate 72, fig. 1.

Errata: Bull. 66, p. 116, line 27, and p. 117, lines 6, 12, read "1793" for "1790"; p. 117, line 13, read "1794" for "1793."

Gen. Insect, pl. 1, unnumbered figure, for "*Xenos resparum*" read "*Xenos vesparum.*"

An illustration is presented of the side view of a male from *Polistes gallica diadema*, collected at Innsbruck, Austria, by Mr. Karl Hofeneder.

16. XENOS BOHLSI Hoffman.

Xenos bohlsi Hoffman, Zool. Anz., vol. 45, pp. 100–103, 106, figs. 1, 2. Nov. 13, 1914.

Host.—*Polistes canadensis* Linnæus, Paraguay.

Male.—Described from specimen extracted from puparium. Length of body, 4.5 mm. Breadth of head from eye to eye, 0.95 mm. Greatest breadth of thorax, 1 mm. Length of thorax above, 2.3 mm.

Head brown, eyes deep black and stalked; antennae light brown, somewhat darker at base, the first joint enveloping the second, third and fourth ensiform, the terminal joint somewhat surpassing the third. Antennae twice as long as the head. Mandibles transparent, brownish at base, somewhat arcuate, acute, about a fourth longer than the maxilla. Maxilla consisting of basal piece and rudimentary palpus. The basal piece is relatively long, the palpus is only about one-third as long as the basal piece. Thorax dark brown, except postlumbium which is light brown. Postlumbium one-third as long as broad. Elytra somewhat longer than mesothorax. Wings reach almost to the tip of the metatarsus. Wings with seven veins arising from base. Costal area strong. Radius broken before the middle, strengthened beyond the break. Between radius and medius is one isolated branch. Between medius and cubitus, quite close to the apex of the medius lies a second detached vein. Oedeagus with basal angle rounded, greater than a rectangle, apex bent with a sharp edge, making an angle of over 45°.

Female.—Length of cephalothorax, 1.94 mm.; greatest breadth of thorax 1.62 mm., which is greater than the distance from the outside of one spiracle to the outside of the other. Brood canal opening, 0.46 mm.; its distance from apex, 0.18 mm. Openings of the brood canal, 4. Cephalothorax very dark except the anterior portions.

Triungulinid.—Length exclusive of apical stylets 0.33 mm.; breadth of abdomen, 0.11 mm.; length of head, 0.05 mm.; length of stylets, 0.16 mm. The pro- and meso- thoracic legs bear an apical pulvillus in the form of a disk; while the posterior legs have a pulvillus that is ladle form. The last three segments are different from the preceding and laterally provided with spines (Hoffman figures eleven abdominal segments).

The above descriptions are translations from Hoffman.

18. Genus VESPAEXENOS Pierce.

LIST OF SPECIES.

1. *V. buyssoni* Pierce; parasite of *Vespa ducalis* Smith; Annam.
2. *V. crabronis* Pierce; parasite of *V. crabro* Linnaeus, Japan.
3. *V. moutoni* Buysson; parasite of *V. mandarina* Smith, *V. magnifica* Smith, *V. nigrans* Buysson; China.

19. Genus BELONOGASTECHTHRUS Pierce.

1. *B. zavattarii Pierce;* parasite of *Belonogaster elegans* Gerstaecker; Congo Free State.

2. Tribe PSEUDOXENINI Pierce.

Table of genera.

Female cephalothorax broadly oval, unevenly rounded from base to apex, broadest behind spiracles; angled at base of head, obtusely rounded at apex.. 20. *Pseudoxenos* Saunders.

Female cephalothorax broader than long, constricted at base, broadest at spiracles, convex from base to spiracles, slightly oblique, but very nearly straight from spiracles to base of head, at which point there is a slight emargination, thence very oblique to mandibles, apex convex.

21. *Monobiaphila* Pierce.

20. Genus PSEUDOXENOS Saunders.

LIST OF SPECIES.

1. *P. arvensidis* Pierce; parasite of *Odynerus arvensis* Saussure; Illinois.
2. *P. corcyricus* Saunders; parasite of *O. spinipes* Linnaeus; Corcyra.
3. *P erynnidis* Pierce; parasite of *O. erynnys* Lepeletier; Florida.
4. *P. foraminati* Pierce; parasite of *O. foraminatus* Saussure; Illinois.
5. *P. fundati* Pierce; parasite of *O. fundatus* Cresson; Illinois.
6. *P. heydenii* Saunders; parasite of *O. deflendus* Saunders; Epirus, Corcyra.
7. *P. histrionis* Pierce; parasite of *O. histrio* Lepeletier; Florida.
8. *P. hookeri* Pierce; parasite of *O. verus* Cresson; Texas.
9. *P. jonesi* Pierce; parasite of *O. colon* Cresson; Louisiana.
10. *P. klugii* Saunders; parasite of *O. laevipes* Shuckard; Epirus.
11. *P. louisianae* Pierce; parasite of *O. vagans* Sausure; Louisiana.
12. *P. neomexicana* Pierce; parasite of *O. toas* Cresson; New Mexico.
13. *P. pedestridis* Pierce; parasite of *O. pedestris* Saussure; Illinois.
14. *P. robertsoni* Pierce; parasite of *O. histrionalis* Robertson; Illinois.
15. *P. schaumii* Saunders; parasite of *O. parietum* Linnaeus; Corcyra.
16. *P. tigridis* Pierce; parasite of *O. tigris* Saussure; Illinois.

6. PSEUDOXENOS HEYDENII Saunders.

Erratum: Gen. Insect. p. 27, line 28, read "p. 141" for "p. 17." The latter page is that given in the separates.

10. PSEUDOXENOS KLUGII Saunders.

Erratum: Gen. Insect. p. 27, line 40, read "p. 142" for "p. 18." The latter page is that given in the separates.

12. PSEUDOXENOS NEOMEXICANUS, new species.

Plate 72, figs. 2–7.

Described from a male extracted from the puparium in a female *Odynerus toas* Cresson var. (determined by Rohwer) collected at Albuquerque, New Mexico, and labeled No. 2934.

Length at least 2.7 mm.; the head and thorax measure 2.1 mm. in length and 0.8 mm. in breadth. Color, dark brown; eyes, black; antennae, light brown; elytra and abdomen still lighter; legs, transparent yellow.

Head, broad; eyes, many faceted, on broad bases; head deeply emarginate between eyes with occiput strongly projecting from the emargination and antennae set on the sides of the prolongation. Front triangularly projecting beneath attachment of antennae. Antennae with second joint shorter than first and ringlike. They are not different from the usual Xenid type. Mandibles elongate, ensiform. Maxillae two-jointed, the first longer. Pronotum transverse, slightly arched forward. Mesonotum with a small anterior detached piece; the posterior angles strongly produced; pleural spiracular lobe beneath elytra of the same shape as in *Xenos*. Metathorax of the usual size. Praescutum keystone-shaped. Scuti broadest behind the base at the attachment of the wings; narrowly separated medianly by the scutellum; divided to form diagonal parascutellum. Scutellum elongate, pedunculate at posterior angles, triangularly produced in front between scuti, rounded at apex; postlumbium transverse, wrinkled, not heavily chitinized; postscutellum elongate, normal. Wings with the normal veins, and two small detached pieces beyond tip of radius. Oedeagus as in *Xenos*. (See pl. 72, fig. 7.)

This is the first male of the genus for America and the first seen by the writer. Whether our American species are congeneric with the European can not yet be determined.

Type.—Cat. No. 21449, U.S.N.M.

21. Genus MONOBIAPHILA Pierce.

1. *M. bishoppi* Pierce; parasite of *Monobia quadridens* Linnaeus, Texas.

3. Tribe TACHYTIXENINI Pierce.

22. Genus TACHYTIXENOS Pierce.

1. *T. indicus* Pierce; parasite of *Tachytes xenoferus* Rohwer; India.

4. Tribe OPHTHALMOCHLINI Pierce.

Table of genera.

Female cephalothorax widest behind spiracles, more or less evenly convex throughout; spiracles dorsal. Male scutellum not locked by the scuti; postlumbium not of a different consistency from the other parts. Parasites of *Sphex*, *Psammophila*, and *Miscus*__________________23. *Eupathocera* Pierce.

Female cephalothorax broader than long, margins irregularly convex, constricted at base, rounded at apex. Male scutellum locked by scuti; postlumbium of a different consistency from the other parts. Parasite of *Chlorion*_____________________________________24. *Ophthalmochlus* Pierce.

Female cephalothorax slightly constricted at base, thence obliquely widening to widest point, just behind the spiracles, which are lateral, but hardly prominent, thence sinuately convex to apex. Parasites of *Sceliphron*.
25. *Sceliphronechthrus* Pierce.

23. Genus EUPATHOCERA Pierce.

LIST OF SPECIES.

1. *E. lugubris* Pierce; parasite of *Sphex* (*Ammophila*) *fragilis* Smith; Ohio.
2. *E. pictipennidis* Pierce; parasite of *S.* (*A*) *pictipennis* Walsh; Illinois.
3. *E. pruinosae* Pierce; parasite of *S.* (*A.*) *pruinosa* Cresson; Colorado.
4. *E. sphecidarum* Dufour; parasite of *S.* (*A*) *sabulosa* Linnaeus; France, Germany.
5. *E. vulgaridis* Pierce; parasite of *S.* (*A.*) *vulgaris* Cresson; Illinois.
6. *E. luctuosae* Pierce; parasite of *S.* (*Psammophila*) *luctuosa* F. Smith; Idaho, Colorado.
7. *E. sieboldii* Saunders; parasite of *Miscus campestris* Latreille; Germany.

20. Genus OPHTHALMOCHLUS Pierce.

Table of subgenera.

Parasites of *Chlorion* (*Priononyx*)__________________1. *Ophthalmochlus* Pierce.
Parasites of *Chlorion* (*Proterosphex*)______________________2. *Homilops* Pierce.
Parasites of *Chlorion* (*Isodontia*)______________________3. *Isodontiphila* Pierce.

LIST OF SPECIES.

1. *O.* (*O*) *duryi* Pierce; parasite of *C.* (*Priononyx*) *atrata* Lepeletier; Ohio.
2. *O.* (*H*) *abbotti* Pierce; parasite of *C.* (*Proterosphex*), species; Siam.
3. *O.* (*H*) *ashmeadi* Pierce; parasite of *C.* (*P.*) *pernanum* Kohl; Santo Domingo.
4. *O.* (*H*) *bishoppi* Pierce; parasite of *C.* (*P.*) *ichneumoneum* Linnaeus; Texas.
5. *O.* (*H*) *westwood* Pierce; parasite of *C.* (*P.*) *ichneumoneum aurifluum* Perty; Brazil.
6. *O.* (*I*) *auripedis* Pierce; parasite of *C.* (*I.*) *auripes* Fernald; Pennsylvania.

1. OPHTHALMOCHLUS DURYI Pierce.

Errata: Gen. Insect. p. 30, line 30, add "pl. 2, unnumbered figure."

5. OPHTHALMOCHLUS (HOMILOPS) WESTWOODI Templeton.

Errata: Gen. Insect. p. 31, line 8, change "(1838)" to read "(1841)"; line 10, add "pl. 2, unnumbered figure"; pl. 2, unnumbered figure, for "*Eupathocera Westwoodi*" read "*Ophthalmochlus Westwoodi.*"

25. Genus SCELIPHRONECHTHRUS Pierce.

1. *S. fasciati* Pierce; parasite of *Sceliphron fasciatus* Lepeletier; Santo Domingo.

5. Tribe PARAXENINI Pierce.

26. Genus PARAXENOS Saunders.

1. *P. erberi* Saunders; parasite of *Bembecinus peregrinus* Smith, Corcyra.

IV. Superfamily HALICTOPHAGOIDEA Pierce.

Table of families.

Male antennae four-jointed, with the flagellum of the third and the fourth joint elongate, subequal______________________ IX. DIOZOCERIDAE Pierce.
Male antennae seven-jointed, with the third, fourth, fifth, and sixth joints laterally produced, and the seventh elongate__ X. HALICTOPHAGIDAE Pierce.

IX. Family DIOZOCERIDAE Pierce.

Errata: Bull. 66, pl. 14. Read "Males" for "Females."

27. Genus DIOZOCERA Pierce.

1. *D. insularum* Pierce; parasite of *Xerophloea viridis* Fabricus, Grenada, St. Vincent.

1. DIOZOCERA INSULARUM Pierce.

Plate 78, fig. 7.

An illustration of the side view of the male is presented. This shows the line separating scutum from parascutellum reaching the apex of scutellum rather than behind the middle, as usual in the other families. The pleural suture is very strongly bent at the apex of episternum and reaches the coxa.

X. Family HALICTOPHAGIDAE Pierce.

This family is probably one of the largest in the order. It now comprises 16 genera. Many more species are in the author's collection from various parts of the world and will be described in subsequent papers. The distribution of the genera is as follows:

Halictophagus Dale, 1 species; England.
Tettigoxenos Jeannel, 1 species; British East Africa.
Pyrilloxenos Pierce, 1 species; India.
Pentacladocera Pierce, 1 species; Australia.
Neocholax Pierce, 1 species; Java.
Muirixenos Pierce, 2 species; Java.
Anthericomma Pierce, 1 species; New Mexico.
Pentozoe Pierce, 1 species; Ceylon.

Dacyrtocara Pierce, 2 species; Georgia.
Pentozocera Pierce, 4 species; Queensland, Guatemala.
Cyrtocaraxenos Pierce, 1 species; Java.
Delphacixenos Pierce, 1 species; Russia.
Stenocranophilus Pierce, 1 species; Porto Rico.
Agalliaphagus Pierce, 2 species; Ohio, Maryland.
Colacina Westwood, 1, species; Borneo.
Megalechthrus Perkins, 1 species; Queensland.

Errata: Bull. 66, pl. 14, read "males" for "females." Gen. Insect, p. 39, line 19, change "Prothorax bank-like" to read "Prothorax band-like."

Table of genera.

1. Males known ---------- 1.
   Males unknown ---------- 13.
2. Prothorax bandlike, not pushed forward into head; wings with 7 primary veins, and 2 distal detached veins between radius and medius ---------- 3.
   Prothorax pushed forward into head; wings with 6 or 7 primary veins, and 2 distal detached veins between radius and medius ---------- 5.
3. Median vein broken, or with detached vein commencing just before its apex on the anal side; metathoracic praescutum and scuti very long, scutellum much shorter ---------- 28. *Halictophagus* Dale.
   Median vein not broken or with detached piece on its anal side; metathoracic praescutum and scuti only moderately long, scutellum more than half as long as praescutum ---------- 4.
4. Mandibles and maxillae arising closer to the eyes than the length of the basal joint of maxillae; oedeagus slender, basally arcuate, apically acutely barbed, the outside angle between the outer edges of the hook and the main tube being very acute ---------- 29. *Tettigoxenos* Jeannel.
   Mandibles and maxillae arising at a distance from the eyes at least equal to the length of the basal joint of the maxillae; oedeagus stout, siphonate, greatly inflated at middle, outside angle little less than a right angle ---------- 30. *Pyrilloxenos* Pierce.
5. Prothorax arched forward into head ---------- 6.
   Prothorax so deeply embedded in head that the pleurae can not be seen ---------- 8.
6. Wings with 7 primary veins; head transverse, not greatly arched, but emarginate behind; metapraescutum broad and about twice as long as scutellum ---------- 31. *Pentacladocera* Pierce.
   Wings with six primary veins ---------- 7.
7. Median vein broken, with detached part on anal side; antennae normally flabellate, the flabellae longer than the basal portions of the joints. 32. *Neocholax* Pierce.
   Median vein not broken; antennae with sixth joint attached at middle of fifth, and seventh beyond middle of sixth ---------- 33. *Muirixenos*, new genus.
8. Wings with 7 primary veins ---------- 9.
   Wings with 6 primary veins ---------- 12.
9. Metapraescutum over twice as long as scutellum, very broad its whole length, pronotum subquadrate, embedded in head and mesonotum. 34. *Anthericomma* Pierce.
   Metapraescutum not twice as long as scutellum ---------- 10.
10. Oedeagus with apex reflected ---------- 11.
    Oedeagus with apex reflected and outer angle produced, acutely; scutellum widely separated from praescutum ---------- 35. *Dacyrtocara*, new genus.

11. Scutellum narrowly lobate in front, very narrowly separated from praescutum; oedeagus slender, inflated at base and strongly arched, thence becoming very slender and at apex acutely reflexed--- 36. *Pentozoe* Pierce.
Scutellum convex, not lobate in front, more widely separated from praescutum; oedeagus slender, not greatly enlarged at base and obtusely angulate, but acutely angulate at apex---------- 37. *Pentozocera* Pierce.
Scutellum broadly sinuately rounded in front, broadly separated from praescutum; oedeagus slightly rounded at base, acutely barbed at apex.
38. *Cyrtocaraxenos*, new genus.
12. Fifth and sixth antennal joints merely pectinate, elongate; metapraescutum but little longer than scutellum---------- 39. *Delphacixenos*, new genus.
Fifth and sixth antennal joints normally flabellate; metapraescutum almost twice as long as scutellum---------------- 40. *Stenocranophilus* Pierce.
13. Parasite of *Agallia*-------------------------- 41. *Agalliaphagus* Pierce.
Parasites of *Epora*------------------------------- 42. *Colacina* Westwood.
Parasites of *Platybrachys*, female cephalothorax with narrow transverse slit; thorax longer than head, gradually narrowed to base: sides of head convex------------------------------------ 42. *Megalechthrus* Perkins.

28. Genus HALICTOPHAGUS Dale.

1. *H. curtisii* Dale; host unknown; England.

Dale (1841) records collecting specimens of males on and near the Isle of Portland, England, June 16, July 15, and August 1, 1840.

29. Genus TETTIGOXENOS Jeannel.

Tettigoxenos JEANNEL, 1913, Voyage de Ch. Alluaud et R. Jeannel en Afrique Orientale (1911–1912) Insects Strepsiptères, Paris, A. Schulz, pp. 1–8, 1 fig., pl. 1, April 23.

The following description is a translation from the original, with additions in brackets:

Front excavated between the antennae: antennae 7-jointed, with last 5 laterally flabellate. Prothorax annular, narrow, not arcuate in front. Elytra long, clavate. Wings with "6" [really 7] primary veins; costal [subcostal], radial, medial and three anal; a detached branch of radius and a detached branch in front of medius; medius not broken; cubitus lacking. Metanotum strongly developed; postlumbium membranous. Metasternum formed of two pieces entirely separated on the median line. Legs short, tibiae flattened, tarsi 3-jointed. Oedeagus strongly arcuate at base, reflexed in an acute angle and very pointed at extremity. [This oedeagus is barbed as in *Cyrtocaraxenos* but more arcuate at base.]

Type of the genus.—*Tettigoxenos cladoceras* Jeannel, 1913, from British East Africa. Hosts unknown. Female unknown.

TETTIGOXENOS CLADOCERAS Jeannel.

Tettigoxenos cladoceras JEANNEL, 1913, Insects strepsiptéres, pp. 1–8, pl. 1.

Host.—Unknown. Described from a male caught at light on the River Ramisi south of Mombasa, station No. 8, British East Africa, November, 1911, and now in the Museum of Paris.

Following is a translation of the original description, with comments in brackets:

Male.—Length 2.75 mm.; wing expanse 3.5 mm. Color brilliant pitchy-brown. Form rather slender, with abdomen elongate, as long as the costal margin of the wings.

Head very large, transverse, slightly deflexed. Front concave between antennae which are attached beneath little angular salients. Eyes enormous on great peduncles, hemispherical, with fifty great ocelli. Face with rudimentary mandibles [as illustrated for *Cyrtocaraxenos*] and maxillae without lacinia [Jeannel's illustration, fig. 3, is apparently at fault in the delineation of the maxillae]. Antennae slender, first two joints simple, cylindrical, the first a little longer than broad, the second almost as long as broad; joints 3 and 4 almost as long as joint 2; joint 5 half as long, very flat, joint 6 a little longer but smaller; joints 3 to 6 laterally flabellate, strongly punctate [rather, provided with organs of sense]; flabellum of third about one-fifth longer than that of the fifth; joint 7 similarly elongate, as long as flabellum of fourth and longer than fifth.

Prothorax annular, not anteriorly arched, slightly longer on dorsum, separated from mesothorax by intersegmental skin, on which are a number of small chitinous sclerites. Mesothorax formed of a transverse mesonotum, a little mesosternal piece, and large oblique pleural pieces. Elytra inserted at upper edge of mesopleural piece, with a small V-shaped stigmatal piece covering the orifice of the spiracle at its base. Coxal cavities open behind. Metanotum composed of triangular praescutum flanked by "pleuri" [scuti] a little longer than itself; scutellum transverse pentagonal; [parascutellum oblique, subquadrate]; postlumbium membranous; postscutellum very large, navicular, covering first two abdominal segments. Metasternum formed of two elongate pieces in juxtaposition on median line. [This is the line of the furca, usually found only on the sternellum.]

Abdomen with 10 segments. Sternites more strongly chitinized than tergites. [Jeannel has misinterpreted the last three segments. He calls the eighth the ninth, and calls the ninth the tenth, and the tenth the anal tube. He refers to the ninth and tenth as the "podex." In reality, the eighth segment is ventrally produced to an acute point, reaching as far as the ninth. The ninth is likewise normally produced and concave, bearing at its extremity the oedeagus. The dorsal portion of the ninth is not shown in Jeannel's drawings. The tenth is like a flap over the oedeagus.]

Female.—Unknown.

30. Genus PYRILLOXENOS Pierce.

Pyrilloxenos Pierce, 1914, Proc. Ent. Soc. Wash., vol. 16, p. 128.

Male.—Head not conspicuously excavated behind. Eyes large, convex with very large facets. Mandibles short, triangular, glabrous. Antennae short, seven jointed, flattened, foliaceous, with large sensory pits; first two joints simple, the second shorter; the remaining five joints crowded, each broadened laterally in a broad lamina, the apices of which are about even with each other, the entire antennae not longer than width of head.

Pronotum very short, transverse band-like. Mesonotum a little longer, also band-like. Elytra pedunculate spatulate, sensitive, pubescent. Metanotum with praescutum rounded, keystone-shape, truncate, sinuate at apex, longer than scutellum and postlumbium together; scuti oblique, considerably surpassing praescutum at outer angles and supporting it by a tiny projection at inner angles; scutellum broad, irregular in outline, narrower at base than praescutum, broadening in a concave line behind scuti, with anterior angles rounded, almost rectangular, and posterior angles diagonally produced as quadrate peduncles, apex otherwise truncate; postlumbium short, transverse, fitting in between and scarcely surpassing the posterior peduncles of the scutellum; postscutellum large, convex, broadly rounded.

Tarsi three-jointed, the first joint mucronate; claws absent. Eighth ventral segment acutely produced beneath ninth. Anal segment small, flap-like. Oedeagus strongly bent, broad near base, rectangularly bent near apex, apical process slender and very acute.

The generic name is derived from *Pyrilla* (the host genus) + *Xenos* (the typical Strepsipterous genus) signifying a Strepsipterous parasite of *Pyrilla*.

Type of the genus.—*Pyrilloxenos compactus* Pierce, from India.

PYRILLOXENOS COMPACTUS Pierce.

Plate 77.

Pyrilloxenos compactus Pierce, Proc. Ent. Soc. Wash., 1914, vol. 16, p. 129.

Described from a type female and allotype male and two paratype females from Pusa, Bihar, India, collected by C. S. Misra.

The original description is as follows:

The material was collected in August, 1907; March 15, 1913; and May 23, 1914. The specimens collected in August, 1907, consist of allotype male, pupal cephalothorax, and three paratype females with triungulinids. This material is the property of the Entomological Section, Agricultural Research Institute, Pusa. The type is deposited in the United States National Museum, and a paratype female is in the author's collection. The author is indebted to Mr. T. Bainbridge Fletcher, imperial entomologist, for the material. The specific name is intended to draw attention to the compact appearance of the antennae.

Male.—Length, 1.5 mm. The tarsi are very small. The anterior tibiae are very robust and shorter than on the other legs. The antennae are much more compact than is usual in this family. The mandibles can not meet. The remainder of the description is to be drawn from the generic description. The specimen was, unfortunately, boiled in caustic potash and is therefore very hard to study.

Female.—Cephalothorax golden yellow to brownish, broader than long; constricted behind spiracles; sides quite evenly rounded; apex sinuate. Mandibles obtuse, separated by almost three times their width. Front convex. Spiracles just touching margin.

Type.—Cat. No. 18814, U.S.N.M.

The illustrations in plate 77 bring out a number of features not covered by the original descriptions.

The prosternum is composed of a narrow transverse eusternum and the medially divided sternellum which forms a half ring for attachment of the coxae. This ring is undoubtedly composed of sternellum, precoxale, and trochantin. At the lateral horn this piece, together with the epimeron and episternum, separated by the pleural suture, meet the coxa. The coxa is a small piece at the base of the elongate trochanter (pl. 77, fig. 2). The pronotum is largely of one piece, with small lateral pieces, probably scuti.

The mesonotum is shorter on the median line than at the sides. A semilunar piece in front is apparently the praescutum, the remainder is the scutoscutellum. The sternum is the most perfectly formed of any yet seen in the order. The eusternum is triangular. The antecoxal ring is composed of three distinct pieces. The inner pieces of the ring are the sternellar pieces longitudinally separated; the median piece is the precoxale. The coxale attachment is at the outer horn, where three pieces—trochantin, episternum, and epimeron—meet. The coxa is a minute piece at the base of the elongate trochanter (pl. 77, fig. 3).

The metasternum has eusternum separated from sternellum by a sinuate line. Episternum does not reach the coxa, although the pleural suture does. The epimera are very large and almost surround the coxae, which are more closely connected to the sternellum than in the anterior segments (pl. 77, fig. 4).

31. Genus PENTACLADOCERA Pierce.

1. *P. schwarzi* Perkins; parasite of *Agallia*, species; New South Wales.

1. PENTACLADOCERA SCHWARZII Perkins.

Errata: Gen. Insect., p. 37, line 6, change "p. 6" to read "pl. 4."

32. Genus NEOCHOLAX Pierce.

1. *N. jacobsoni* Meijere; parasite of *Ossoides lineatus* Bierman; Java.

33. Genus MUIRIXENOS, new genus.

Named in honor of Frederick Muir, the collector of the species on which this genus is founded, and of many other species in the author's collection to be described later. Probably no collector has ever shown a greater aptitude for collecting species of this order than Mr. Muir, whose travels have taken him to many parts of the world.

The genus is characterized by its elongate narrow body, arcuate head, antennae with the last two joints attached far from the base of the preceding (pl. 76, figs. 1, 2); prothorax band-like, transverse above but laterally strongly diagonally flexed forward; mesothorax distinctly composed of three transverse pieces; metathorax with praescutum reaching scutellum and almost twice as long, scuti divided; eighth segment ventrally produced beneath ninth; wings lacking cubitus and one anal vein, medius not broken.

Type of the genus.—*Muirixenos dicranotropidis* Pierce, from Java.

The genus is easily separable from the other Javan genera *Neocholax* and *Cyrtocaraxenos* by the characters given above and in the table of genera.

1. MUIRIXENOS DICRANOTROPIDIS, new species.

Plate 76, fig. 1.

Described from a male bred from *Dicranotropis muiri* Kirkaldy collected in Java by F. Muir under the number 333.

Length, 1 mm. Color, light brown. Head strongly arched. Prothorax dorsally transverse but with pleurae diagonal, carrying the dorsum far anterior to the sternum. Mesothorax with praescutum semilunar, scutum transverse, and scutellum transverse. The metathoracic parts are well illustrated in figure 1, plate 76.

Type.—Cat. No. 21450, U.S.N.M.

2. MUIRIXENOS PERKINSIELLAE, new species.

Plate 76, figs. 2–5.

Described from a male bred from *Perkinsiella saccharicida* Kirkaldy collected in Java by F. Muir under the number 316.

Length slightly under 1 mm. Lighter in color, almost yellowish. It differs very slightly from the preceding. The oedeagus, antenna, tarsus, and side view of thorax are illustrated.

The episternum reaches closer to the coxal cavity than in any other species yet seen, but does not reach it.

Type.—Cat. No. 21451, U.S.N.M.

34. Genus ANTHERICOMMA Pierce.

1. *A. barberi* Pierce; host unknown, New Mexico.

1. ANTHERICOMMA BARBERI Pierce.

Errata: Gen. Insect. p. 36, line 25, add "Pl. 3, unnumbered figure."

35. DACYRTOCARA, new genus.

Name derived from δα (strongly) + κυρτὸς (curved) + κάρα (head), meaning strongly arched head.

Male.—Head strongly arched, inclosing the pronotum and part of mesonotum; antennae typical five-branched, the branches subequal, the bases of the joints short. Mesonotum distinctly divided into three transverse sclerites. Metapraescutum not reaching and not greatly longer than scutellum. Wings with seven principal veins, two detached veins between radius and medius, and with the medius broken. Oedeagus nearly straight, flexed near apex with outer angle prolonged almost as long as the prong.

Type of the genus.—*Dacyrtocara oncometopiae*, new species.

Species: 1. *D. oncometopiae*, from *Oncometopia lateralis* Fabricius; Egypt, Georgia.

2. *D. undata*, from *O. undata* Fabricius; Thomasville, Georgia.

1. DACYRTOCARA ONCOMETOPIAE, new species.

Plate 74, figs. 1–4.

Described from one male and two puparia extracted from a single *Oncometopia lateralis* Fabricius, determined by the late Otto Heidemann, collected by W. H. Finn at Egypt, Georgia, from the Uhler collection in the United States National Museum. The male was in perfect condition and ready to emerge when killed.

Male.—Length, 3.3 mm.; wing expanse at least 5 mm. Color brown. Head emarginate above for reception of prothorax, not emarginate below. Eyes on broad stalks, not very closely fascicled. Antennae with flabellae closely appressed. Mandibles short, not reaching mouth opening. Maxillae 2-jointed, the joints about equal.

Pronotum semilunar with pleurae extending diagonally backward; prosternum composed of two pieces medianly separated, which correspond to the sternellum+precoxale+trochantin; coxae minute, trochanters elongate, femora very little longer, tibiae shorter and enlarged at apex, tarsi 3-jointed, with first joint very broad and remaining joints elongate. Mesonotum with a semilunar praescutum, transverse scutum and scutellum; elytra clavate; pleural spiracles protected by an episternal lobe beneath elytra; epimeron, episternum and trochantin forming hook for attachment of coxa; trochantin, precoxale and sternellum forming open ring around coxal cavity; eusternum large and triangular; sternellum bilobed; coxa minute at base of elongate trochanter, femur longer, tibia still longer, tarsus with first joint mucronate, others pulvillate. Metanotum with keystone-shaped praescutum, connected scuti, diagonal parascutellum, transverse, anteriorly sinuate scutellum, membranous postlumbium, and very long postscutellum; wings normal; episternum not reaching coxa; epimeron reaching coxa; eusternum separated from sternellum by a line diverging posteriorly from median line; coxa very large; trochanter smaller and cup shaped; femur, and tibia elongate; tarsus as in middle leg. Oedeagus straight to angle of reflexion, outer angle produced downward as illustrated (pl. 74, fig. 4).

Type.—Cat. No. 21452, U.S.N.M.

2. DACYRTOCARA UNDATA, new species.

Plate 74, figs. 5, 6.

Described from two females found in the fourth and fifth segments of a female *Oncometopia undata* Fabricius, captured by George D. Smith at Thomasville, Georgia, in May, 1915. The host died May 10.

Length, 7 mm. Color of cephalothorax dark brown with large rounded brown spot on first ventral segment; brood canal slightly darkened; abdomen otherwise white until mature, when it becomes brown.

Cephalothorax elongate, apically rounded, slightly sinuate in front of mandibles and laterally slightly compressed opposite opening of brood canal, which is behind the middle. Mandibles broad, obtuse. Brood canal opening a transverse narrow slit on the venter. Base of cephalothorax strongly constricted. Thoracic spiracles lateral and inconspicuous.

The brood canal extends back only four segments, and there are only two median genital tubes opening into it, on the second and third segments. At the edge of the brood canal at the posterior margin of the first, second, and third segments are simple spiracles consisting of mere slitlike openings. The tracheae can be seen leading from them. The first abdominal segment within the body of the host extends far beyond the tip of the cephalothorax.

Type.—Cat. No. 21453, U.S.N.M.

36. Genus PENTOZOE Pierce.

1. *P. peradeniya* Pierce; parasite of *Thompsoniella arcuata* Motschulsky; Ceylon.

1. PENTOZOE PERADENIYA Pierce.

Errata: Gen. Insect. p. 38, line 6, change "Fig. 40" to read "Fig. 44."

37. Genus PENTOZOCERA Pierce.

1. *P. australensis* Perkins; parasite of *Tetigonia parthaon* Kirkaldy; Queensland.

2. *P. phaeodes* Perkins; parasite of *Hecalus immaculatus* Kirkaldy.
3. *P. stenodes* Perkins; parasite *Paradorydium menalus* Kirkaldy; Queensland.
4. *P. schwarzi* Pierce; parasite of *Diedrocephala sanguinolenta* Coquibar; Guatemala.

38. CYRTOCARAXENOS, new genus.

Name derived from *κυρτὸς* (curved) + *κάρα* (head) + *Xenos*.

Characterized by a very large head, emarginate behind, with tremendous eyes; antennae with branches closely appressed, not surpassing one another. Prothorax quadrate invisible at sides. Metanotum with only two transverse areas. Metapraescutum broadly separated from scutellum but considerably longer than the same. Eighth abdominal segment greatly produced beneath the ninth. Oedeagus barbed at apex.

Type of the genus.—Cyrtocaraxenos javanensis, new species; Java.

CYRTOCARAXENOS JAVANENSIS, new species.

Plate 78, figs. 1–6.

Collected at light, 800 feet altitude, at Buitenzorg, West Java, December, 1908, by W. Terry, and presented by Mr. F. Muir.

Length about 2 mm.; dark brown. Head emarginate from dorsal and anterior views for reception of pronotum. Mandible short, but reaching mouth. Maxillae short, 2-jointed, the joints very broad and subequal. Pronotum trapezoidal. Mesonotum transversely divided, posteriorly produced at angles. Metanotum with praescutum keystone shaped, broad at apex, broadly separated from scutellum by scutum; parascutellum diagonal; scutellum transverse; sinuate in front; postlumbium short and transverse; postscutellum very large. Legs normal, first tarsal joints mucronate. Oedeagus slightly curved, with apex sharply reflexed, the inner and outer angles being very acute. Wings with seven principle veins, and with two detached beins between radius and medius; medius not broken.

Type.—Cat. No. 21454, U.S.N.M.

39. DELPHACIXENOS, new genus.

The generic name is derived from *Delphax* (the host genus) + *Xenos* (the typical Strepsipterous genus), signifying a strepsipterous parasite of Delphax.

Male.—Head excavated behind, seen from above consisting of a narrow arcuate rim supporting the eyes and produced somewhat in front of these to form the apex of the frontal projection, at the sides of which the antennae are inserted. Eyes large, convex, reaching the base of the elytra when the body is compressed; facets large and separate. Mandibles reaching to the mouth opening, about three times as long as broad, acute. Maxillae longer, two jointed, cylindrical, the first joint shorter and subclavate; the second joint, or palpus almost twice as long as first and tapering, longer than mandibles. Antennae elongate, seven jointed, foliaceous with sensory pits: first two joints simple, the first shortest; third about as long as first with long lateral sensitive flabellum; fourth longer than second in apical half laterally produced into a flabellum about half as long as that of the third; fifth joint longer than fourth with a short apical lateral projection not much longer than the width of the joint, sixth joint about as long as fourth merely with a tooth-like enlargement at tip: seventh joint longest of all. Pronotum merely a small transverse plate set into the emargination of the head. Mesonotum with two plates the first in the emargination of the head and the second band-like, not covered by head. Elytra elongate, clavate. Metanotum with praescutum rounded keystone-shaped: scuti oblique slightly surpassing praescutum: scutellum transverse laterally pedunculate at apex on each side; postlumbium semicircular of different consistency from other parts; postscutellum elongate, broad; epimeron (femoralium) reaching almost to tip of postscutellum. Wings with costa very short and basal, closely united with subcosta which braces the costal margin to the middle of the wing: radius and medius at base are closely connected with the subcosta, the radius being very weak and indistinct except as detached portions in the nodal region; medius strong in its basal half, distinct, and thence forked in two infuscated branches which reach the outer margin; cubitus missing: first anal merely an infuscation: second anal strong: third anal missing. Tarsi 3-jointed, the first joint on the meso- and meta-tarsi differently shaped from the following joints. Oedeagus strongly bent, basally inflated; the under side being twice bent and the upper twice; the last bend being a strong reflexion near the slender acute apex.

Type of the genus.—*Delphacixenos anomalocerus*, new species; parasitic on *Delphax striatella* Fabricius; Russia.

1. DELPHACIXENOS ANOMALOCERUS, new species.

Plate 75, figs. 1–6.

Described from five males mounted on a single slide, which were bred May 4–7 from *Delphax striatella* Fabricius by A. A. Ogloblin at Poltava, Russia, and presented to the writer by Prof. N. Kourdumoff.

Male.—Length, 1.2 mm.; wing expanse, about 2.5 mm. Color, brown; with postlumbium, abdomen, except two last segments and venter, anterior portion of epimeron (femoralium), and anterior portion of sternum, yellow: appendages very light yellowish brown.

The buccal area is inflated with a tiny mouth opening. The anterior and median coxae are elongate and grooved on the inner side; the posterior coxae are only half as long as the others and so attached that, from a straight ventral view, the attachment can not be seen. The femora and tibiae are subequal, the anterior pair being shortest; the median and posterior tibiae are dorsally grooved. The median and posterior tarsi have the first joint mucronate at tip; all tarsal joints are pulvillate beneath.

The prothorix consists of a single notal sclerite and two small sternal pieces (each composed of sternellum+precoxale+trochantin) to which the coxae are attached. The mesonotum has two dorsal sclerites, a diagonal pleurum and a small sternum. The praescutum is subtriangular; the scuti are narrowly connected by a separate scutal area; scutellum is transverse quadrate with pedunculate posterior angles. In front of the praescutum is evidence of a small piece, probably the pretergite. In front of the wing is the oval prealare area. Lying over the posterior edge of this is one of the tiny sclerites to which the wing is attached. The parascutellum is oval, oblique. The tiny wing sclerites visible between this and the prealare are rather too difficult to differentiate at present. Below the postscutellum is the elongate pleurotergite, which is hooked at the front where it touches the parascutellum. The epimeron consists of a nonchitinized area beneath the parascutellum and a more or less faintly divided chitinized area behind this, with a heavily chitinized crescentiform area at the apex, to which the coxae are attached. Beneath the prealare and front part of the epimeron is the episternum, which is diagonally divided. The sternum consists of a narrow presternum and a very large elongate sternal area irregularly divided into an anterior partly chitinized yellow eusternum and a posterior chitinized sternellum, the posterior edge of which covers the insertion of the coxae. The sternellum is medianly divided almost to base.

The eighth abdominal segment is greatly prolonged beneath the ninth. The ninth segment is prolonged as usual beneath the tenth, with the oedeagus at its tip. The tenth segment is a small flap arising from the cup of the ninth in front of the oedeagus.

Type.—Cat. No. 21455, U.S.N.M.

40. Genus STENOCRANOPHILUS Pierce.

Stenocranophilus PIERCE, 1914, Proc. Ent. Soc. Wash., vol. 16, pp. 126–127.

The original description is as follows:

Male.—Head excavated behind, seen from above consisting of a narrow arcuate rim supporting the eyes and produced considerably in front of these to form the tip of the sulcate frontal projection, at the sides of which the antennae are inserted. Eyes very large, convex, reaching and touching the base of the elytra. Mandibles very short, broad and blunt, not reaching within their own length of each other. Maxillae a little longer, two-jointed, cylindrical, the first joint almost twice as thick as the second, and neither quite as long as the mandibles. Antennae elongate, seven-jointed, flattened foliaceous, with large sensory pits; first two joints simple, third to sixth moderately elongate, each produced just before the attachment of the succeeding joint into a broad flattened lamina not much more than twice as long as the main stem; seventh joint also produced, laminate. Pronotum subquadrate, cut off at sides by head. Mesonotum band-like, also included within the cavity of the head. Elytra elongate, metanotum with praescutum elongate, convex at base, sides roundingly approximate toward apex, where they almost meet; scuti narrow, elongate, only a little longer than praescutum; scutellum broad, quadrate, basally convex, apically bisinuate, not much longer than postlumbium; postlumbium at least two-thirds as long as wide; postscutellum long, broad; epimeron [femoralium] reaching to middle of postscutellum. Wings with radial vein meeting the costal margin beyond the middle, a small detached cloudy vein behind the tip of the radius, medius strong, with a long anterior cloudy branch, cubitus missing; first anal merely a cloudy vein, second anal strong, third anal missing. Tarsi three-jointed, the first joint of different shape from the following; claws absent. Oedeagus strongly bent, the under side being twice bent and the upper thrice, the last bend being a very strong reflection at apical fourth; apex very acute.

The generic name is derived from *Stenocranus* (the host genus) +φίλος (loving), signifying a parasite of *Stenocranus*.

Type of the genus.—Stenocranophilus quadratus Pierce.

1. STENOCRANOPHILUS QUADRATUS Pierce.

Stenocranophilus quadratus Pierce, 1914, Proc. Ent. Soc. Wash., vol. 16, pp. 127, 128.

Described from one type and five paratype males bred by T. H. Jones, October 19, 1912, from two females and four nymphal *Stenocranus saccharivorus* Westwood collected October 14 and 16, 1912, from sugar cane at Rio Piedras, Porto Rico, and bearing the Porto Rico Sugar Planter's Association accession number "847–1912." One paratype was returned to the association. The specific name is intended to draw attention to the quadrate form of the pronotum and the scutellum. This form of scutellum has not heretofore been found in the Halictophagidae.

Male.—Length, 0.9 mm.; wing expanse, 2 mm. Color golden brown. A few points not given in the generic description remain to be noted. The first tarsal joint is broad, apically broadest and somewhat acute on outer angle; the point of attachment of the second is subapical at the inner angle; the point of attachment on the second joint is dorsal and very near its base; this joint and the third are both slender at base, gradually enlarged, pulvillate beneath, apically truncate. The antennae are quite long, the stem portions of the joints being longer than usual. The last joint reaches as far back as the scutellum. The length of the praescutum and scutellum about equals that of the postlumbium and postscutellum.

Female.—Cephalothorax about 0.2 mm. long, golden yellow, not much darker behind the opening of the brood canal; almost one-quarter longer than wide; sides constricted at base, parallel at middle, angulate and convergent from anterior third, sinuate at apex. Mandibles large, obtuse with outer edges marginal; front convex extending beyond mandibles and separating them by a little more than their width. Opening of brood canal broad, trapezoidal. Spiracles ventral, close to margin.

Type.—Four paratype males, and allotype female, Cat. No. 18813, U.S.N.M.

41. Genus AGALLIAPHAGUS Pierce.

1. *A. americana* Perkins; parasite of *Agallia quadrinotata;* Ohio.

2. AGALLIAPHAGUS UHLERI, new species.

Plate 73.

Described from a female from *Agallia uhleri* Van Duzee collected at Rocky Ford, Colorado.

Female.—Cephalothorax transverse. Head occupying over one-half the length, and broadly, narrowly emarginate behind, slightly convergent on sides, slightly emarginate at base of mandibles, which are closer to the oral orifice than their widths; oral orifice large and transverse. Spiracles reaching lateral margin, but not prominent. The opening of the brood canal is short and transverse.

The measurements, using the same scale as in Andrena are as follows:

Specimen	1	2	3	4	5	6	Index total.
Type	14	13	9	7	8	13	....
Relative proportions to breadth at spiracles	1.00	0.92	0.64	0.50	0.57	0.92	4.55

This species is quite different in form from *A. americana*, differing especially in the lesser emargination of the head.

Type.—Cat. No. 21456, U.S.N.M.

42. Genus COLACINA Westwood.

This genus has been transferred to the Halictophaginae because of the nearness of its habitat and host to those of *Neocholax*.

1. *C. insidiator* Westwood; parasite of *Epora subtilis* Walker, Borneo.

43. Genus MEGALECHTHRUS Perkins.

1. *M. tryoni* Perkins; parasite of *Platybrachys*, species; Queensland.

V. Superfamily ELENCHOIDEA Pierce.

XI. Family ELENCHIDAE Pierce.

Considerable unstudied material in this family is at hand, but must remain for future consideration. Until that time it is unnecessary to prepare a table of genera.

44. Genus ELENCHUS Curtis.

1. *E. tenuicornis* Kirby; parasites of *Liburnia*, species; England.
2. *E. walkeri* Curtis; host unknown; England, Ireland.
3. *E. templetonii* Westwood; host unknown; Mauritius.
4. *E. melanias* Perkins; parasite of a Delphacid; Hawaii.

4*a*. *E. m. silvestris* Perkins; parasite of a Delphacid; Hawaii.

It is quite probable that this is a composite genus, but nothing can be done with it until the species can be studied.

Errata: Gen. Insect., p. 43, line 35, for "p. 385" read "pl. 385."

2. ELENCHUS WALKERI Curtis.

Errata: Gen. Insect., p. 44, line 20, for "p. 385" read "pl. 385."

Dale (1841) records collecting males at Glenville's Wooton, England, on June 27 and July 1, 1841.

4. ELENCHUS MELANIAS Perkins.

Elenchus melanias PERKINS, 1910, Fauna Hawaiiensis, vol. 3, pt. 6. Dec. 17, p. 667.

Following is the original description:

Thorax dull brown or pitchy, head black or nearly so, abdomen black, tips of the joints of anterior tarsi pallid. Lateral branch of antennae extending nearly to their tip, second joint subglobose or subquadrate in different aspects, paler generally than the following. Wings very dark smoky black, apical dilatation of elytra deep black. Abdominal segments with interrupted white apical margins. Genital segment more or less pale within, rather broad where the sides are well angulated in front of the middle, chitinous recurved hook dilated apically and terminated in a very minute pale upturned spine. Expanse, 3.3 mm.; length, 1.5 mm. Male.

Errata: Pierce, Gen. Insect., p. 44, line 7, after "pt. 6" add "p. 667."

4*a*. ELENCHUS MELANIAS SILVESTRIS Perkins.

Very like the above, but with the wings less deeply smoke colored, and the genital segment more elongate in proportion to its width. This variety also appears to be slightly smaller than the type.

Hab. Oahu, Hawaii, and females on all the other islands. The typical form described has been taken in more open country and the var. *silvestris* in very dense, wet forests. It infests Delphacid leaf hoppers of many species and of different genera. The var. *silvestris* approaches most nearly to *E. tenuicornis*, but the difference between the Hawaiian specimens and the examples I refer to the latter from Europe, America, Fiji, and Australia is much greater than any distinction between the individuals of *E. tenuicornis* from the above named, widely separated regions.

45. Genus DEINELENCHUS Perkins.

1. *D. australenis* Perkins; paratype of *Platybrachys*, species; Queensland.

46. Genus LIBURNELENCHUS, new name.

Mecynocera Pierce, 1908, not J. C. Thompson in Crustacea, 1888.

1. *L. koebelei* Pierce; parasite of *Liburnia campestris* Van Duzee and *L. lutulenta* Van Duzee; Ohio.
2. *L. heidemanni*, new species; parasite of *Liburnia*, species; Maryland.

1. LIBURNELENCHUS KOEBELEI Pierce.

Mecynocera koebelei PIERCE, in all previous works.

Errata: Gen. Insect., p. 44, line 43, add "Pl. 3, unnumbered figure."

2. LIBURNELENCHUS HEIDEMANNI, new species.

Plate 78, figs. 8. 9.

Described from a specimen extracted from a *Liburnia* collected at Bay Ridge, Maryland, September 1, 1902, by the late Otto Heidemann, and named in his honor.

The thorax is in general as in *L. koebelei*, but the oedeagus differs greatly, as shown in the illustrations.

Type.—Cat. No. 21457, U.S.N.M.

47. Genus ELENCHINUS, new genus.

Male.—Elongate, with slender enlongate antennae, the last joint of which would reach beyond the postlumbium. Mandibles stout, acute, over half as long as breadth between eyes; maxillae 2-jointed, the second joint longer than first. Metapraescutum, broad at base, acute at apex, not reaching the transverse scutellum. Scuti not reaching humeri, united behind praescutum. Parascutellum at sides of scutellum and diagonal. Scutellum truncate in front, with anterior angles diagonally truncate, posterior angles pedunculate, and base bisunuate. Postlumbium semilunar, membranous. Postscutellum elongate. Elytra very long, slender, clavate.

Type of the genus.—*Elenchinus heidemanni*, new species, from *Megamelanus* species; Maryland.

1. ELENCHINUS HEIDEMANNI, new species.

Plate 78, figs. 10–12.

Described from one male extracted from a *Megamelanus*, species collected at Bay Ridge, Maryland, September 1, 1902, by the late Otto Heidemann, in whose honor the species is named.

The description contained in the generic diagnosis is sufficient to delineate this species. The mandible, maxilla, and oedeagues are illustrated.

The oedeagus is quite distinct from that of *Liburnelenchus*.

Type.—Cat. No. 21458, U.S.N.M.

48. Genus ELENCHOIDES Pierce.

1. *E. perkinsi* Pierce; parasite of *Perkinsiella vitensis* Kirkaldy, Fiji.

49. Genus PENTAGRAMMAPHILA Pierce.

1. *P. uhleri* Pierce, parasite of *Pentagramma vittatifrons* Uhler; "Dacota."

GEOGRAPHIC DISTRIBUTION OF THE STREPSIPTERA.

In Bulletin 66, on pages 171–173, the writer presented a tabulation of the distribution of the host species according to the faunal regions described by Wallace. There were at that time records of parasitism by Strepsiptera on 50 genera and 238 species of hosts, distributed as follows:

	Species.
Nearctic, subdivision—	
1	7
2	14
3	69
4	0
Total	90
Neotropical, subdivision—	
1	3
2	10
3	3
4	3
Total	19
Palaearctic, subdivision—	
1	70
2	19
3	0
4	2
Total	91
Ethiopian, subdivision—	
1	2
2	0
3	1
4	0
Total	3

Oriental, subdivision—

1	3
2	5
3	4
4	2
Total	14

Australian, subdivision—

1	3
2	17
3	3
4	0
Total	23

In the following table the distribution of described parasites is tabulated for comparison. It is interesting to note that species are now described from all the geographical faunal subdivisions except four, South Africa, Central Asia, Southwest South America, and New Zealand. These regions have been the least studied entomologically, but it is to be expected that they will some day furnish many interesting species.

Table of distribution of the described species of Strepsiptera according to the geographical regions of Wallace.

	Neartic.				Neotropical.				Palaeartic.				Ethiopian.				Oriental.				Australian.			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Mengeoidea																								
Mengeidae																								
Mengea									1															
Triozocera		1					1																	
Mengenillidae																								
Mengenilla										1														
Austrostylops																						1		
Tetrozocera										1														
Stichotrematoidea																								
Stichotrematidae																								
Stichotrema																					1			
Xenoidea																								
Callipharixenidae																								
Callipharixenos																					1			
Chrysocorixenos																			1					
Myrmecolacidae																								
Myrmecolax																		1						
Caenocholax							1																	
Stylopidae																								
Stylops	5	5	22	1					11															
Katastylops		1																						
Prostylops												1												
Neostylops	1	1	1						1															
Parastylops																				1				
Hylecthridae																								
Hylecthrus										3														
Xenidae																								
Halictoxenos			7																					
Halictophilus																				2				
Halictostylops									1															
Augochlorophilus			1																					
Apractelytra			1																					
Crawfordia	1	1	4																					
Xenos	1		12			1			1															
Vespaexenos																				1	2			
Belonogastechthrus														1										
Pseudoxenos		1	11							4														
Monobiaphila			1																					
Tachytixenos																	1							
Eupathocera		2	3						2															

Opthalmochlus			1																					
Homilops			1			1		1											1					
Isodontiphila			1																					
Sceliphronechthrus								1																
Paraxenos										1														
Halictophagoidea																								
Diozoceridae																								
Diozocera								1																
Halictophagidae																								
Halictophagus									1															
Tettigoxenos															1									
Pyrilloxenos																	1							
Pentacladocera																						1		
Neocholax																				1				
Muirixenos																				2				
Anthericomma		1																						
Pentozoe																		1						
Pentozocera							1															3		
Cyrtocaraxenos																				1				
Delphacixenos									1															
Stenocranophilus								1																
Agalliaphagus			2																					
Colacina																				1				
Megalechthrus																						1		
Elenchoidea																								
Elenchidae																								
Elenchus									2							1							1	
Deinelenchus																						1		
Liburnelenchus			2																					
Elenchinus			1																					
Elenchoides																							1	
Pentagrammaphila		1																						
Subdivision totals	8	14	71	1	....	2	3	4	21	10	....	1	....	1	1	1	2	2	3	10	2	7	2	....
Regional totals	94				9				32				3				17				11			
Grand total for world	166																							

The knowledge of the distribution of host species has been greatly increased since Bulletin 66 was published, and we may therefore present a revised summary for contract with the list of described species:

Distribution of host species and described parasite species according to regions.

Region.	Subdivision.	Host species. Subdivisional totals.	Host species. Regional totals.	Described parasites. Subdivisional totals.	Described parasites. Regional totals.
Nearctic	1	13		8	
	2	33		14	
	3	113		71	
	4	1	160	1	94
Neotropical	1	3		0	
	2	11		2	
	3	3		3	
	4	4	21	4	9
Palaearctic	1	73		21	
	2	23		8	
	3	0		0	
	4	3	99	1	30
Ethiopian	1	5		0	
	2	1		1	
	3	1		1	
	4	0	7	1	3
Oriental	1	7		2	
	2	6		2	
	3	5		3	
	4	9	27	10	17
Australian	1	4		2	
	2	20		7	
	3	3		2	
	4	0	27	0	11
Total for world			341		174

It will be seen from the foregoing table that only half of the recorded parasites are described. About 30 of the undescribed species are in the possession of the author and will furnish material for further studies. The indications are that tropical regions will ultimately yield more species than the temperate regions, which now stand highest because of the more intensive collecting done in them.

HOST LIST.

The following additions to the host list may be made:

HOMOPTERA.

Superfamily CICADOIDEA.

Family CICADELLIDAE (TETIGONIIDAE).

Tribe CICADELLINI (TETIGONIINI).

Cicadella Latreille (*Tettigoniella* Bergroth): *spectra* Distant, Ceylon (E. E. Green, 1912).

ZOOGEOGRAPHICAL REGIONS (AFTER WALLACE 1876)

Oncometopia Stål.

lateralis Fabricius (determined by O. Heidemann), Egypt, Georgia (W. H. Finn): (male, male puparia, larva); *Dacyrtocara oncometopiae* Pierce.

undata Fabricius (determined by O. Heidemann)—

1. Shreveport, Louisiana (F. W. Mally); (male exuvium).
2. Thomasville, Georgia, (G. D. Smith); (females); *Dacyrotocara undata* Pierce.

Tribe PHRYNOMORPHINI.

Deltocephalus Burmeister:

sandersi, Clarksville, Tennessee, November 10, 1915 (S. E. Crumb).

Tribe EURYMELINI.

Agallia Curtis:

species, Virginia Beach, Virginia, commonly parasitized. (E. S. Schwarz, E. S. G. Titus.)

uhleri Van Duzee (determined by O. Heidemann)—

1. Santa Cruz Mountains, California; (male exuvium).
2. Rocky Ford, Colorado, (H. O. Marsh), July 26, 1912 (male pupa and exuvium): August 24, 1912 (male exuvium); August 26, 1912 (females); September 1. 1909 (male exuvium); September 22, 1909 (female, triungulinids, male exuvium; *Agalliaphagus uhleri* Pierce.

Superfamily FULGOROIDEA.

Family ASIRACIDAE.

Perkinsiella Kirkaldy:

saccharicida Kirkaldy, Java, F. Muir (male); *Muirixenos perkinsiellae* Pierce.

Phenice Westwood:

modesta Westwood, Java, F. Muir.

Dicranotropis Fieber:

muiri Kirkaldy, Java, F. Muir (male); *Muirixenos dicranotropidis* Pierce.

Liburnia Stål:

campestris Van Duzee, Columbus, Ohio, August 11 (males), August 17 (females); *Liburnelenchus koebelei* Pierce (*Mecynocera*) (Collection U. S. National Museum), (Pierce 1909, Bull. 66, p. 178).

lutulenta Van Duzee. 1. Columbus, Ohio, August 11 (male); *Liburnelenchus koebelei* Pierce. (*Mecynocera*), (*Elenchus tenuicornis* Perkins), (Perkins 1905; Pierce 1909; Bull. 66, p. 178).

Stenocranus Fieber:

saccharivora Westwood, Rio Piedras, Porto Rico, on sugar cane, October 14–19, 1912 (T. H. Jones), (males); November, 1913 (T. H. Jones), (males and females); *Stenocranophilus quadratus* Pierce (Pierce 1914).

Delphax Latreille:

striatella Fabricius, Poltava, Russia, May, 4–7; (males, females): *Delphacixenos anomalocerus* Pierce.

Family POEKILLOPTERIDAE.

Subfamily TROPIDUCHINAE.

Ossoides Bierman:

lineatus Bierman, Semarang, Java, June and July, 1905 (Edward Jacobson), (male); *Neocholax jacobsoni* Meijere (Meijere 1911).

Family LOPHOPIDAE.

Pyrilla Stål:

aberrans Distant, Pusa, Bihar, India, on sugar cane, August, 1907, March 15, 1913, May 23, 1914. (C. S. Misra), (males and females); *Pyrilloxenos quadratus* Pierce (Pierce 1914).

pusana Distant, Pusa, Bihar, India, on sugar cane (C. S. Misra).

Family EURYBRACHYDIDAE.

Platybrachys Stål (?):

species (determined by O. Heidemann as *Eurybrachys*), Cairns, Queensland; *Deinelenchus australensis* Perkins (Perkins 1905) (Correction to Bulletin 66).

genus, new:

species, Queensland; July, 1904, *Megalechthrus tryoni* Perkins (Perkins 1905) (Correction to Bulletin 66).

HETEROPTERA.

Family PENTATOMIDAE.

Subfamily SCUTELLARINAE.

Chrysocoris Hahn:

grandis Thunberg, Siam, (received from F. Muir); (females) *Chrysocorixenos siamensis* Pierce.

Calliphara Amyot and Serville:

billiardierei Fabricius, (male and female) Amboina (F. Muir); (females and triungulinids); *Callipharixenos muiri* Pierce.

HYMENOPTERA.

Superfamily VESPOIDEA.

Family EUMENIDAE.

Eumenes Latreille:

fenestralis Saussure, Abyssinia, (female), (L. von Heyden 1867).

maxillosa DeGeer, (*tinctor* Christ), Abyssinia, (female), (L. von Heyden 1867).

flavopicta Blanchard, (determined by S. A. Rohwer) Larat, (females, males), (F. Muir), (females, male pupa, exuvium, triungulinids).

species No. 2, Larat, (male), F. Muir, (female, triungulinids).

species No. 3, Larat, (male), F. Muir, (female).

Odynerus Latreille:

chloroticus Spinola, Abyssinia, (female), (L. von. Heyden 1867).

(*Stenodynerus*) *toas* Cresson variety (determined by Rohwer), Albuquerque, New Mexico, (No. 2934), (male) *Pseudoxenos neomexicana* Pierce.

firmus Cresson (determined by Rohwer) Cedar Point, Ohio, June 19, 1913, (J. B. Parker), (female).

species, new, Tucson, Arizona, August 24, 1913, on cotton (W. D. Pierce), (females).

Family VESPIDAE.

Vespa Linnaeus:

acuta (sic) Germany (Ann. Soc., Ent. Fr., 1835, vol. 4, p. xlv.).

Vespula Thomson:

carolina Linnaeus (male), (determined by Rohwer), Clarksville, Tennessee, October 19, 1915, (S. E. Crumb), (puparium).

Polistes Latreille:

anaheimensis Provancher (male), (determined by Rohwer), Auburn, California. July 23, 1915 (L. Bruner), (female), *Xenos californicus* Pierce.

annularis Linnaeus 10. Louisville, Nebraska (7 females). August 2, 1914 (H. A. Jones, E. G. Anderson), (males), *Xenos pallidus* Brues.

11. Omaha, Nebraska (female), August 20, 1913 (L. T. Williams), (females), *Xenos pallidus* Brues.

12. New Orleans, Louisiana (Ed. Foster).

aurifer Saussure, (determined by Rohwer), Auburn, California (female), August 14, 1915, (L. Bruner), (female), *Xenos auriferi* Pierce.

bellicosus Cresson, Stone Cabin Cañon. Santa Rita Mountains, Arizona, August 24, 1913, on *Thurberia* (W. D. Pierce, (puparia).

canadensis Linnaeus, Paraguay, (Bohls), (male, female, triungulinids); *Xenos bohlsi* Hoffman.

crinitus Felton (*americanus* Fabricius). 3. New Orleans, Louisiana (Ed. Foster).

hebraeus Fabricius. 2. Pusa, Bihar, India, April 12, 1911 (G. R. Dutt), (female, males).

major P. B. (determined by Rohwer), District Federal, Mexico (J. R. Inda), (4 male exuviae, 4 male pupae).

minor Beauvais. New Orleans, Louisiana (Ed. Foster).

rubiginosus Lepeletier. 12. New Orleans, Louisiana (Ed. Foster).

variatus Cresson (determined by Rohwer), 4. Clarksville, Tennessee, November 10, 1915 (S. E. Crumb), (4 male exuviae). 5. Lanham, Maryland, November 24, 1915 (H. F. Loomis), (females, male pupa).

Meganthopus Ducke (*Polybia* Lepeletier):

flavitarsis Saussure, Stone Cabin Cañon, Santa Rita Mountains, Arizona, taken at its nest, August 25, 1913 (W. D. Pierce).

Superfamily SPHECOIDEA.

Family SPHECIDAE.

Sphex Linnaeus (Ammophila, Psammophila):

heydeni Dahlbom (Morice, 1913).

pictipennis Wahbom (determined by Rohwer), Falls Church, Virginia, August 14, 1914 (G. M. Greene).

tydei Guillon 2. (Morice, 1913).

yarrowi Cresson. Tucson, Arizona, August 24, 1913 (W. D. Pierce), (male, female).

Priononyx Dahlbom:

utrata Lepeletier. 2. New Orleans, Louisiana (Ed. Foster).

Ammobia Billberg. 1820 replaced *Proterosphex* Fernald 1905 according to S. A. Rohwer.

Family BEMBICIDAE.

Stizus Latreille (*Bembecinus* Costa, *Stizomorphus* Costa):

peregrinus Smith, Corcyra; *Paraxenos erberi* Saunders (S. S. Saunders, 1872) (correction to Bulletin 66).

ruficornis Fabricius (female) (determined by Rohwer) (*S. distinguendus* Handlirsch). Jericho, Palestine. April 3, 1909 (F. D. Morice, 1913).

species, (Perez, 1886) (correction to Bulletin 66).

species, Australia (Perkins, 1905, 91) (correction to Bulletin 66).

Bembix Fabricius:

species, Australia (Perkins, 1905, 91; 1906 in letter) (correction to Bulletin 66).

texana Cresson; New Orleans, Louisiana (Ed. Foster).

Family MUTILLIDAE.

Sphaerophthalma Blake:

fenestrata Lepeletier; New Orleans, Louisiana (Ed. Foster).

Family LARRIDAE.

Tachysphex Kohl:

maculicornis Saunders (female), Biskra, Algeria, June 19, 1907 (in Saunders Coll., Natural History Museum, South Kensington, England), (F. D. Morice, 1911, 1913).

Family PROSOPIDAE.

Pälaeoriza Perkins:

eboracina Cockerell, Australia (Perkins, 1912).

turneriana Cockerell, Australia (Perkins, 1912).

Prosopis Fabricius:

mesillae Cockerell, Arizona (C. F. Baker 2522); Colorado (1414; 304 Metz).

Family ANDRENIDAE.

Nomia Latreille:

stylopicta Strand, Tanganika-See, Africa (Strand 1911).

Andrena Fabricius:

bisalicis Viereck (determined by H. L. Viereck) Alabama (female); *Stylops bisalicidis* Pierce.

bisalicis Viereck variety (determined by H. L. Viereck), Devils Lake (6 miles southwest), North Dakota, May 5, 1916, on Amelanchier (J. Silver) (female); *Stylops diabola* Pierce.

ceanothi Viereck (Trachandrena) (male), Montgomery County, Maryland, June 12, 1916, on *Ceanothus americanus* (J. C. Crawford); (male and female in copula).

cressoni Robertson, variety (determined by H. L. Viereck).

2. Ogden, Utah, May 16, 1915 (A. Wetmore), (female).

erigeniae Robertson.

3. (determined by J. C. Crawford), Plummer's Island, Maryland, March 29, 1915, on *Erythronium americanum* (J. C. Crawford) (females); *Stylops erigeniae* Pierce, type.

4. (determined by H. L. Viereck), Maryland, near Plummer's Island, March 21, 1915 (J. C. Crawford) (female), *Stylops erigeniae* Pierce.

5. (determined by H. L. Viereck), same place and date, on *Claytonia virginica* (Crawford, No. 4025) (female); *Stylops erigeniae* Pierce.

grandior multiplicatiformis Viereck (determined by H. L. Viereck), Big Fork, Montana, June 21, 1904 (females); *Stylops grandior* Pierce.

imitatrix fenningeri Viereck (determined by H. L. Viereck), Falls Church, Virginia, April 14 (N. Banks) (female).

imitatrix texana Cresson (determined by H. L. Viereck). 2. Texas (female).

medionitans Cockerell (determined by T. D. A. Cockerell), Florissant, Colorado, June 24, on *Cerasus melanocarpa* (T. D. A. Cockerell) (females); *Stylops medionitans* Pierce.

moësta Smith (determined by H. L. Viereck) (male) Govan, Washington, March 29, 1911 (J. A. Hyslop) (females); *Stylops moëstae* Pierce.

nasoni Robertson (determined by H. L. Viereck). 3. Maryland, near Plummers Island, April 16, 1916, on *Salix humilis*, H. L. Viereck (female).

neonana Viereck (paratype), Georgia (collection Philadelphia Entomological Society) (female); *Stylops neonanae* Pierce.

vicina Smith (determined by H. L. Viereck).

3. Plummer's Island, Maryland, April 20, 1916, on *Dentaria laciniata* (A. H. Pottinger) (females); *Stylops vicinae* Pierce.
4. Lahaway, Ocean County, New Jersey, on *Gaylussacia frondosa* (female and triungulinids); *Stylops vicinae* Pierce.
5. (determined by J. C. Crawford), Cabin John Bridge, Maryland, May 16, 1916, on *Barbarea barbarea* (A. H. Pottinger) (female), *Stylops vicinae* Pierce.
6. (determined by T. D. A. Cockerell) Salina, Colorado, April 14, on *Berberis repens* (W. P. Cockerell) (female); *Stylops vicinae* Pierce.
7. (determined by T. D. A. Cockerell), Boulder, Colorado, April 17, 1908, on *Crataegus coloradensis* (S. A. Rohwer) (female); *Stylops vicinae* Pierce.
8. determined by H. L. Viereck), Plummer's Island, Maryland, April 16, 1915 (J. C. Crawford) (females); *Stylops vicinae* Pierce.

Halictus Latreille:

sparus Robertson (determined by Crawford).

3. Vienna, Virginia, April 18, on *Salix tristis* (R. A. Cushman) (Crawford, No. 4592) (female).

4. Camps Springs, Maryland, May 11, 1916, on *Potentilla pumilo* (A. H. Pottinger).

Family PANURGIDAE.

Panurginus Nylander:

innuptus Cockerell, West Point, Nebraska, August 10 (male, female); *Crawfordia pulvinipes* Pierce (Pierce 1904 records as *Panurginus*, new species).

californicus Cresson (determined by J. C. Crawford), Los Angeles County, California (D. L. Coquillett) (females); *Crawfordia californica* Pierce.

Panurgus Panzer:

cavannae Gribodo, Jericho, Palestine, April, 1889; April 7, 1909 (Morice, 1913).

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This is a correction of the reference in Bulletin 66, p. 216.

TERRY.

* 1912. Note in Proc. Hawaiian Ent. Soc., 1910, vol. 2, pt. 4, p. 163, April.

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The first figures of the triungulinids showing mouth parts.
This is a correction of the reference in Bulletin 66, p. 217.

EXPLANATION OF ILLUSTRATIONS.

C.=coxa.
E.=elytron.
em.=epimeron.
es.=episternum.
F.=femur.
H.=head.
hem.=hypoepimeron.
Mes.=mesothorax.
Mes. em.=mesoepimeron.
Mes. ep.=mesepimeron.
Mes. es.=mesepisternum.
Mes. sl.=mesoscutellum.
Mes. st.=mesosternum.
Met.=metathorax.
Met. em.=metepimeron.
Met. ep.=metepimeron.
Met. es.=metepisternum.
Met. pr.=metapraescutum.
Met. preal.=metaprealare.
Met. sl.=metascutellum.
Met. st.=metasternum.
P.=prothorax.
palp.=maxillary palpus.
pas.=parascutellum.
P. em.=proepimeron.
P. l.=postlumbium.
pr.=praescutum.
preal.=prealare.
psl.=postscutellum.
P. st.=prosternum.
pt.=pleurotergite.
sc.=scutum.
sl.=scutellum.
st.=sternum.
T.=trochanter.
W.=wing.
1st A.=first abdominal segment.
2nd A.=second abdominal segment.
9=ninth abdominal segment.
10=tenth abdominal segment.

PLATE 64.

Mengeoidea. Mengeidae.

FIG. 1. *Mengea tertiaria*, male, author's interpretation of Menge's drawing.
2–10. *Triozocera texana*, male, collected at light, at Victoria, Texas, July 4, 1908, by J. D. Mitchell. 2.—Venter of thorax, showing only basal portions of one wing and one of each pair of legs. 3.—Dorsal view of half of prothorax and mesothorax, with elytron removed, to illustrate protuberance over spiracle. 4.—Dorsal view of half of prothorax and mesothorax, with elytron in position. 5.—Ventral view of half of mesothorax showing spiracle and base of trochanter. 6.—Outline

of same showing direction of trachea. 7.—Side view of posterior portion of metathorax and base of abdomen to show position of first abdominal spiracle. 8.—Side view of oedeagus. 9.—Side view of posterior tarsus. 10.—Dorsal view of male.

Author's illustrations.

PLATE 65.

Mengeoidea. Mengeidae.

Triozocera mexicana collected at Cordoba, Vera Cruz, Mexico, by A. Fenyes.

FIGS. 1–10. 1.—Dorsal view of male. 2.—Profile of eye. 3.—Structure of antenna at junction of fourth and fifth joints. 4.—Mandible and maxilla. 5.—Another view of maxilla. 6.—Dorso-lateral view of male. 7.—Ventro-lateral view of metathorax, showing especially the form of the episternum, the coxae, and trochanters. 8.—Portion of metathorax, same view as 6, to show relations of scutum to adjoining parts. 9.—Side view of posterior portions of metathorax and base of abdomen, showing position of first abdominal spiracle. 10.—Oedeagus.

Author's illustrations.

PLATE 66.

Mengenillidae.

FIGS. 1–4. *Tetrozocera santchii* collected at Kairouan, Algeria, August, 1907, by F. Santchi. 1.—Dorsal view of male. 2.—Ventral view of head and thorax, showing portions of one leg of each pair. 3.—Lateral view. 4.—Enlarged lateral view on opposite side of anterior portions.

5. *Austrostylops gracilipes*, from Australia. Author's interpretation of Lea's drawing.

6, 7. *Mengenilla chobautii* collected at Ain Sefra, Algeria, in 1896, by A. Chobaut. Drawn from Hofeneder's original illustrations. 6.—Dorsal view of head and thorax. 7.—Lateral view.

Author's illustrations.

PLATE 67.

Stichotrematoidea. Stichotrematidae.

FIGS. 1–5. *Stichotrema dallatorreanum* collected in the Schouten Islands. 1.—Dorsal view of first larva. 2.—Ventral view of first larva. 3.—Side view of head and thorax of same. 4.—Mouth parts of a first larva. 5*a*.—Mouth parts of another individual. 5*b*.—Outline of inner pieces of pharyngeal skeleton.

Author's illustration.

PLATE 68.

Xenoidea. Callipharixenidae.

FIG. 1. *Chrysocorixenos siamensis* from *Chrysocoris grandis* collected in Siam. Cephalothorax of female.

2–7. *Callipharizenos muiri* from *Calliphara billiardierei* collected in Amboina by F. Muir. 2.—Cephalothorax of female. 3.—Ventrolateral view of edge of cephalothorax showing spiracles. 4.—Triungulinid, ventral view. 5.—Cluster of four ocelli seen from a ventrolateral view of triunguilinid. 6.—Dorsal view of head of triungulinid showing three pairs of the ocelli. 7.—Dorsal view of last four abdominal segments of triungulinid.

Author's illustrations.

PLATE 69.

Xenoidea. Myrmecolacidae.

FIGS. 1–3. *Caenocholax fenyesi*, Cordoba, Vera Cruz, Mexico, collected by A. Fenyes. 1.—Adult male, dorsal view. 2.—Lateral view. 3.—Ventral view.

Coleoptera. Rhipiphoridae.

FIGS. 4, 5. *Myodites solidaginis*, Lincoln, Nebraska. 4.—Lateral view. 5.—Dorsal view.

Author's illustrations.

PLATE 70.

Xenoidea. Stylopidae.

FIGS 1, 2. *Neostylops shannoni*, collected at Plummer's Island, Maryland, April 7, 1915, by R. C. Shannon. 1.—Dorsal view of male. 2.—Lateral view of male.

3, 4. *Neostylops crawfordi*, from *Andrena crawfordi*, collected at Dallas, Texas, April 28, 1906. 3.—Lateral view of prothorax and part of mesothorax, showing spiracle at base of elytron. 4.—Lateral view of male, except legs.

5, 6. *Stylops championi*, collected at Woking, England, by G. C. Champion. 5.—Scuto-scutellar area of metathorax. 6.—Side view of elytron showing alar lobe.

Author's illustrations.

PLATE 71.

FIGS. 1, 2. *Stylops bruneri, female.* 1.—Cephalothorax, ventral. 2.—Right mandible, ventral.

3, 4. *Stylops bipunctatae*, female. 3.—Right mandible, ventral. 4.—Cephalothorax, ventral.

5, 6, 7. *Stylops californica.* 5.—Right mandible of female, ventral. 6.—Female cephalothorax, ventral. 7.—Triungulinid, ventral.

8, 9, 10. *Stylops bruneri*, female. 8.—Right mandible, ventral. 9.—Cephalothorax, ventral. 10.—Cephalothorax showing female within, ventral.

11, 12. *Stylops advarians*, female. 11.—Right mandible, ventral. 12.—Cephalothorax, ventral.

13. *Stylops swenki*, female. Cephalothorax, ventral.

Author's illustrations.

PLATE 72.

Xenoidea. Xenidae.

FIG. 1. *Xenos vesparum* from *Polistes gallica diadema*, collected at Innsbruck, Austria, by Karl Hofeneder. Side view of male.

2–7. *Pseudoxenos neomexicana* from *Odynerus toas*, collected at Albuquerque, New Mexico. 2.—Dorsal view of head and thorax of male. 3.—Antenna. 4.—Wing. 5.—Mandible and maxilla. 6.—Side view of last abdominal segments. 7.—Oedeagus.

PLATE 73.

FIGS. 1–4. Wings of *Agallia uhleri* parasitized by *Agalliaphagus uhleri*, collected at Rocky Ford, Colorado, in 1909 and 1912. 2 is almost normal. The others are very abnormal, and undoubtedly due to parasitism.

Author's illustrations.

PLATE 74.

Halictophagoidea. Halictophagidae.

FIGS. 1–4. *Dacyrtocara oncometopiae* from *Oncometopia lateralis*, collected at Egypt, Georgia. 1.—Adult male, dorsal view. 2.—Ventral view of male head and thorax. 3.—Side view of last three abdominal segments. 4.—Oedeagus.

5, 6. *Dacyrtocara undata* from *Oncometopia undata*, collected at Thomasville, Georgia, May 10, 1915, by G. D. Smith. 5.—Female, ventral view, or outer view with respect to position in host. 6.—Female, lateral view.

Author's illustrations.

PLATE 75.

Halictophagoidea. Halictophagidae.

FIGS. 1–6. *Delphacixenos anomalocerus* from *Delphax striatella*, collected at Poltava, Russia. 1.—Dorsal view of male. 2.—Side view of head and thorax. 3.—Venter of metathorax. 4.—Side view of last four abdominal segments. 5.—Mandible and maxilla. 6.—Oedeagus.

7. *Pentozoe peradeniya* from *Thomponiella arcuata*, collected at Peradeniya, Ceylon, by E. E. Green.

Author's illustrations.

PLATE 76.

Halictophagoidea. Halictophagidae.

FIGS. 1. *Muirixenos dicranotropidis* from *Dicranotropis muiri*, collected in Java by F. Muir. Diagramatic sketch of male, dorsal view.

2–5. *Muirixenos perkinsiellae* from *Perkinsiella saccharicidae*, collected in Java by F. Muir. 2.—Antenna. 3.—Front tarsus, side view. 4.—Oedeagus, side view. 5.—Thorax, side view.

6, 7. *Stenocranophlus quadratus* from *stenocranus saccharivorus*, collected at Rio Piedras, Porto Rico. 6.—Ventral view of head and thorax. 7.—Diagramatic sketch of male, dorsal view.

Author's illustrations.

PLATE 77.

Halictophagoidea. Halictophagidae.

FIGS. 1–8. *Pyrilloxenos compactus* from *Pyrilla aberrans*, collected at Pusa, India. 1.—Dorsal view of male. 2.—Venter of prothorax. 3.—Venter of mesothorax. 4.—Venter of metathorax. 5.—Dorsum of prothorax and mesothorax and front part of metathorax. 6.—Face. 7.—Wing. 8.—Oedeagus, side view.

Author's illustrations.

PLATE. 78.

Halictophagoidea. Halictophagidae.

FIGS. 1–6. *Cyrtocaraxenos javanensis*, collected at Buitenzorg, West Java, December, 1908, by Terry. 1.—Dorsal view of male. 2.—Front view of head and prothorax; *P*=prothorax. 3.—Side view of male. 4.—Side view of mandible and maxilla. 5.—Side view of oedeagus. 6.—Ventral view of oedeagus.

Halictophagoidea. Diozoceridae.

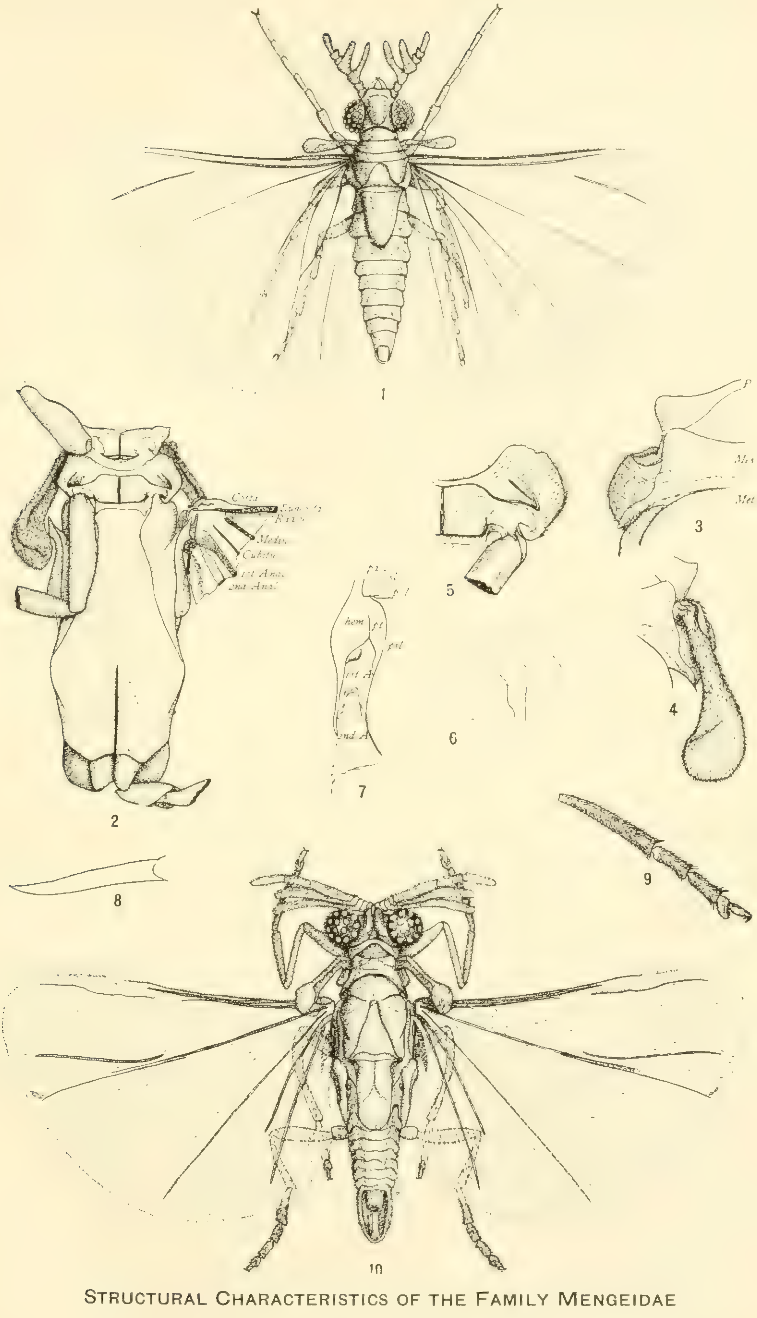
7. *Diozocera insularum* from *Xerophloea insularum*, collected at St. George, Grenada.

Elenchoidea. Elenchidae.

8, 9. *Liburnelenchus heidemanni* from *Liburnia*, species, Bay Ridge, Maryland, collected September 1, 1902, by O. Heidemann. 8.—Last ventral segments from side. 9.—Oedeagus.

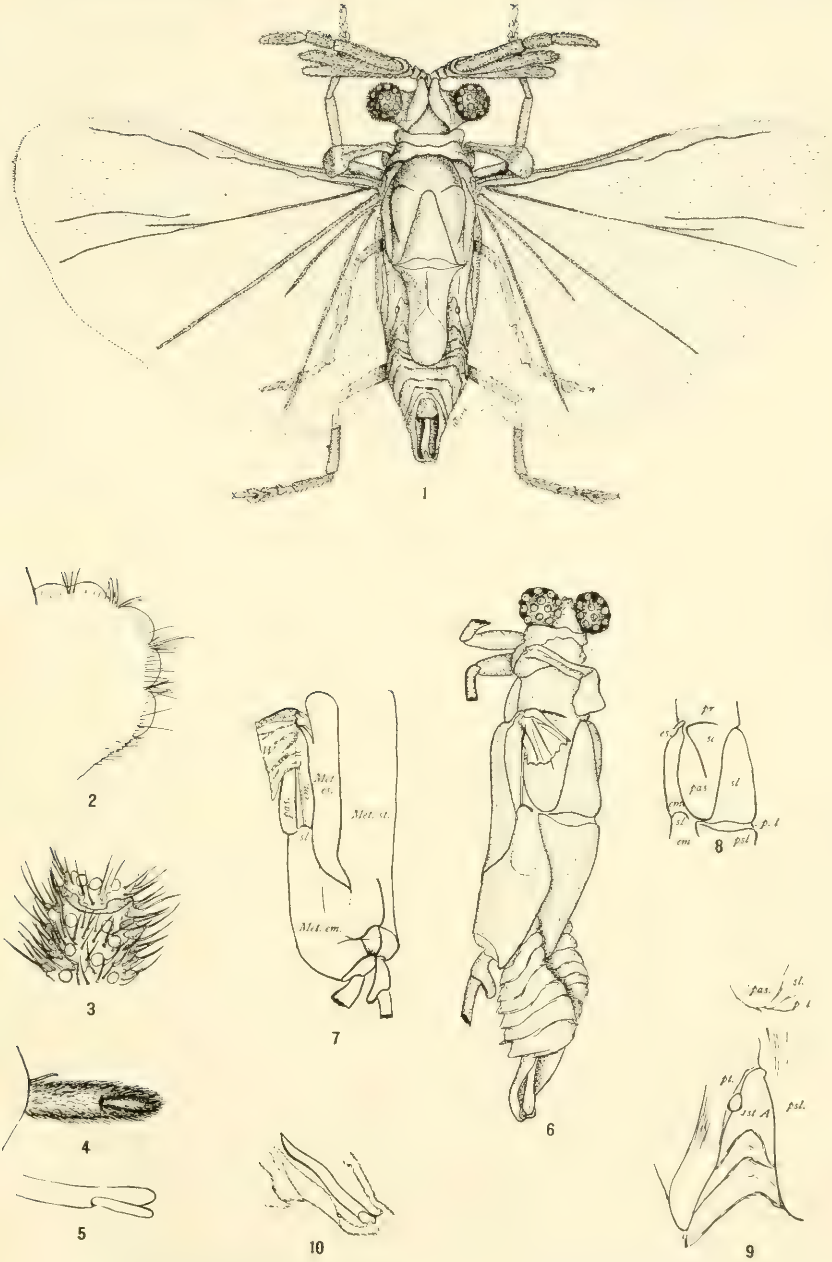
10–12. *Elenchinus heidemanni* from *Megamelanus*, species, Bay Ridge, Maryland. 10.—Under view of right mandible. 11.—Under view of right maxilla. 12.—Oedeagus.

Author's illustrations.



STRUCTURAL CHARACTERISTICS OF THE FAMILY MENGEIDAE

FOR EXPLANATION OF PLATE SEE PAGES 497, 498



STRUCTURAL CHARACTERISTICS OF THE FAMILY MENGEIDAE

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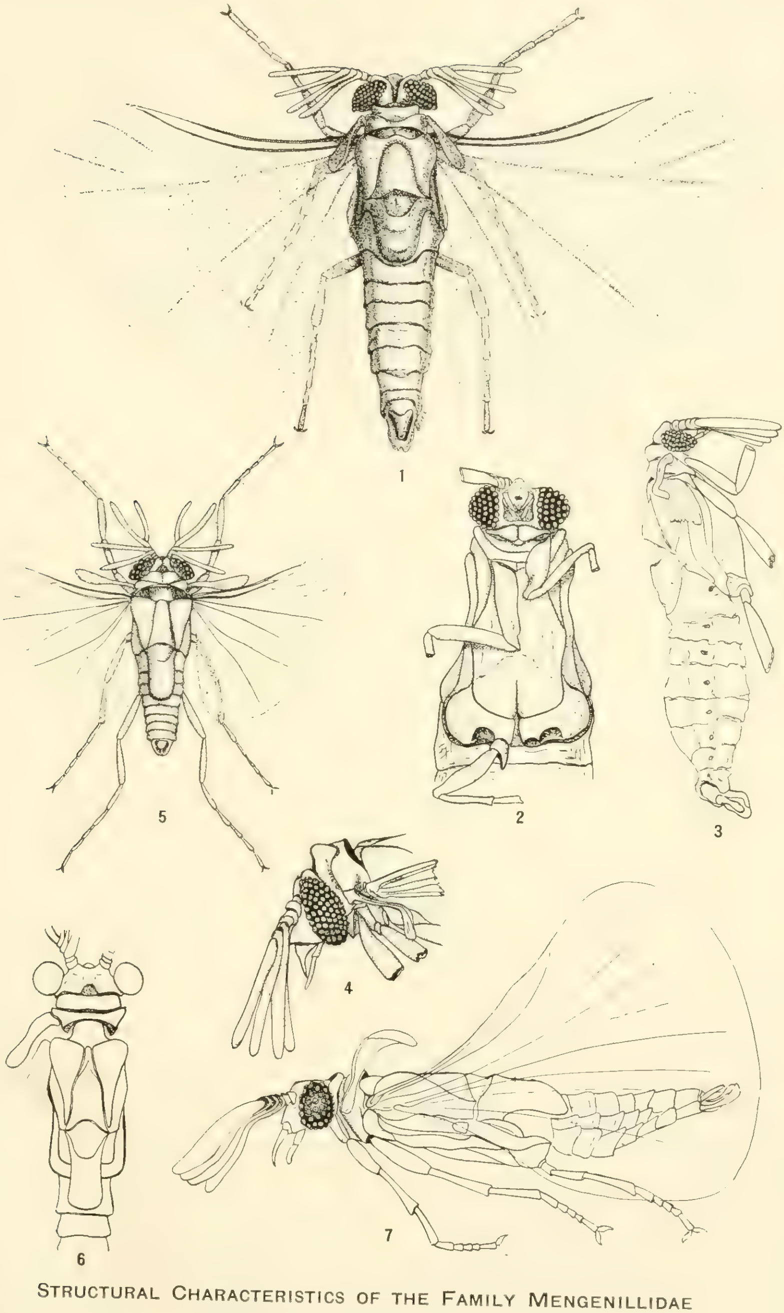

STRUCTURAL CHARACTERISTICS OF THE FAMILY MENGENILLIDAE

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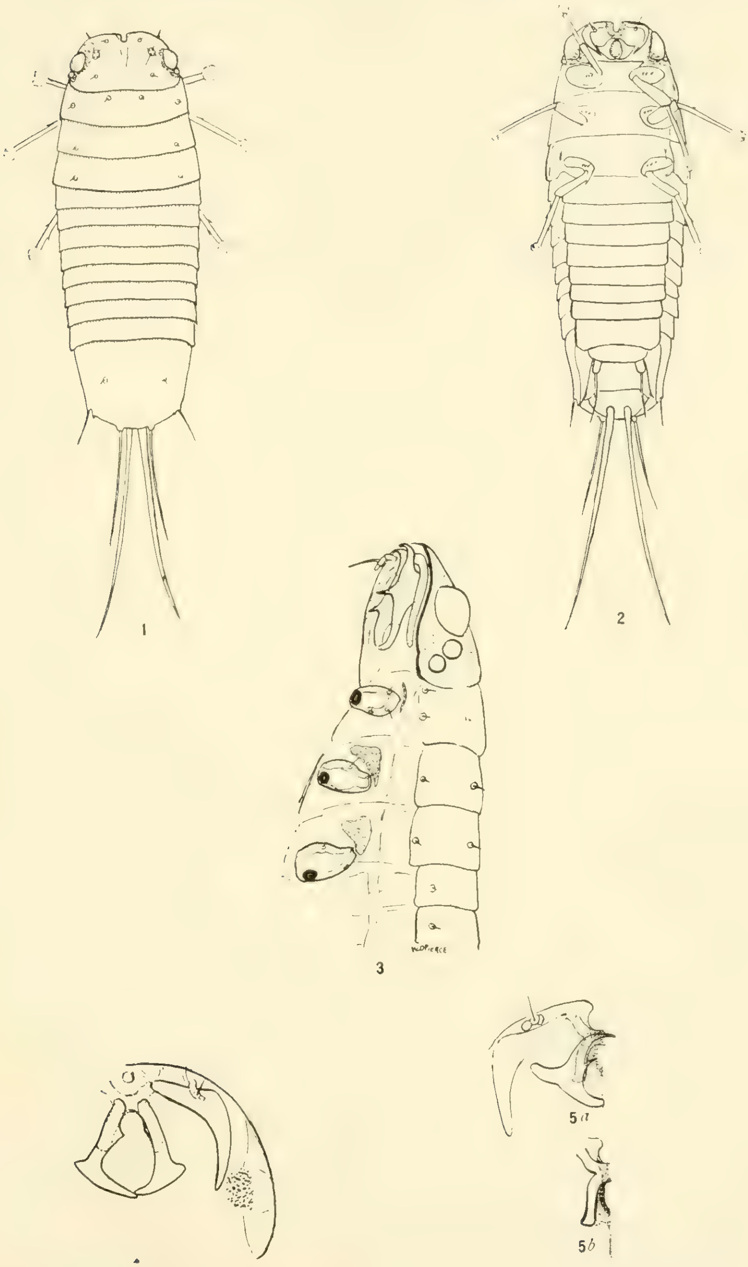

STRUCTURE OF THE FIRST LARVA OF THE FAMILY STICHOTREMATIDAE

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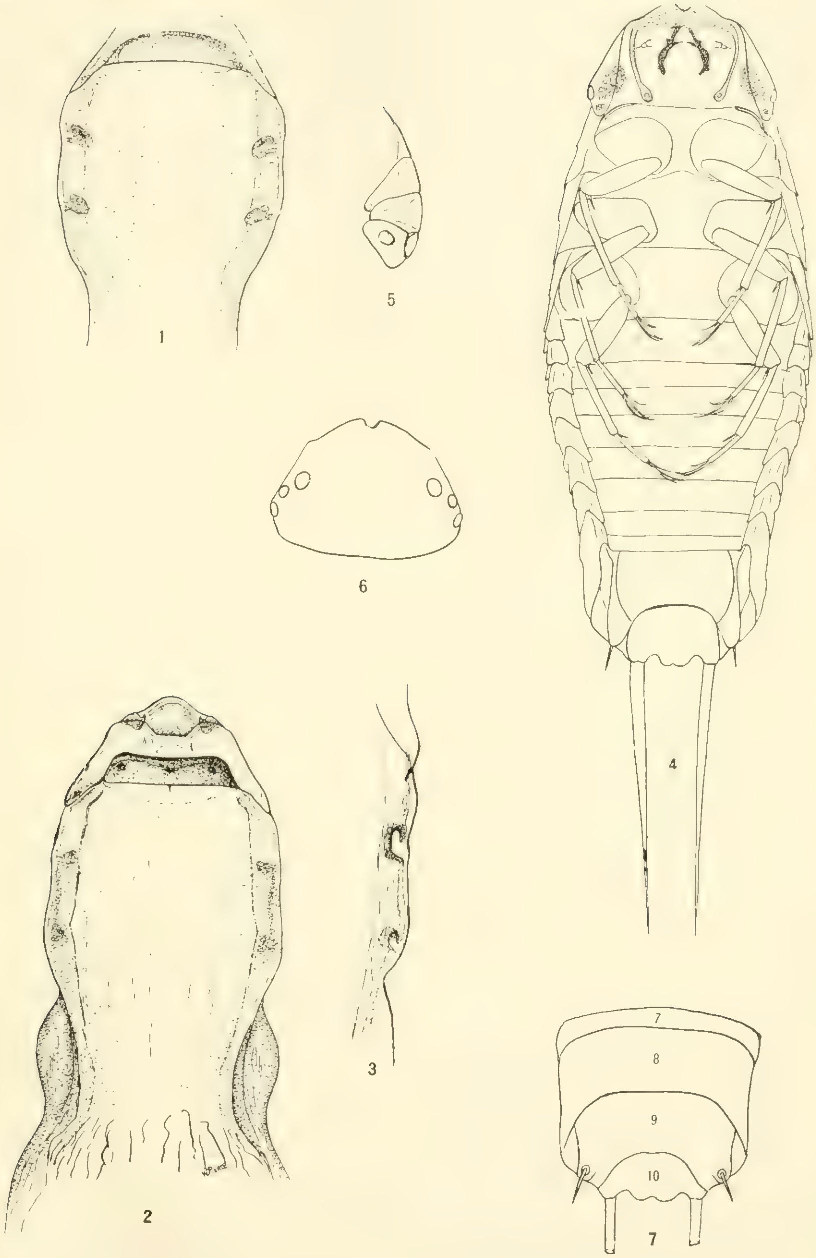

STRUCTURAL CHARACTERISTICS OF THE FAMILY CALLIPHARIXENIDAE

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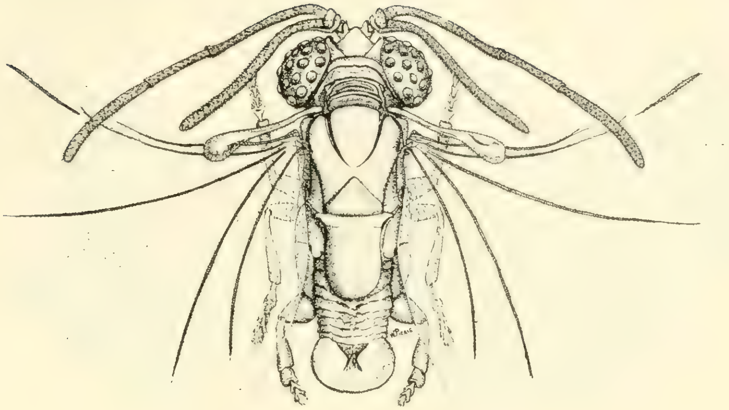

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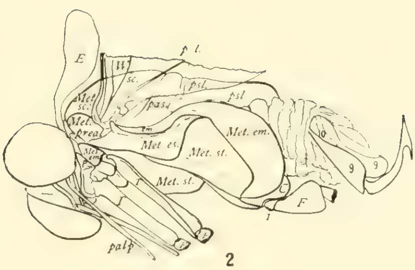

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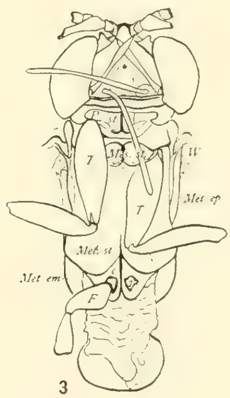

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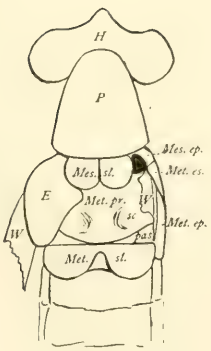

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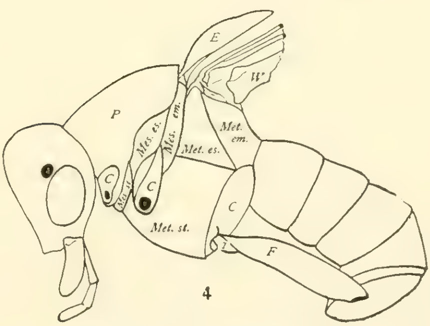

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COMPARISON OF THE STRUCTURE OF THE FAMILY MYRMECOLACIDAE AND THE COLEOPTEROUS FAMILY RHIPIPHORIDAE

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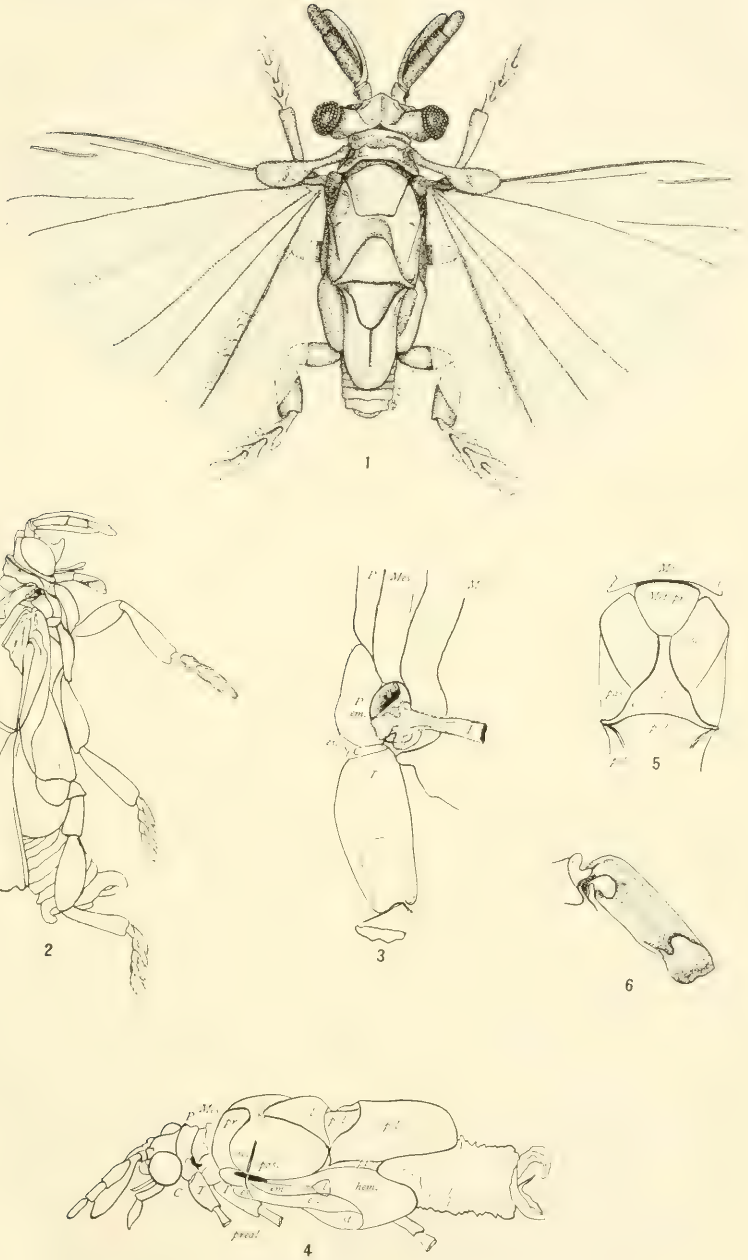

STRUCTURAL CHARACTERISTICS OF THE FAMILY STYLOPIDAE

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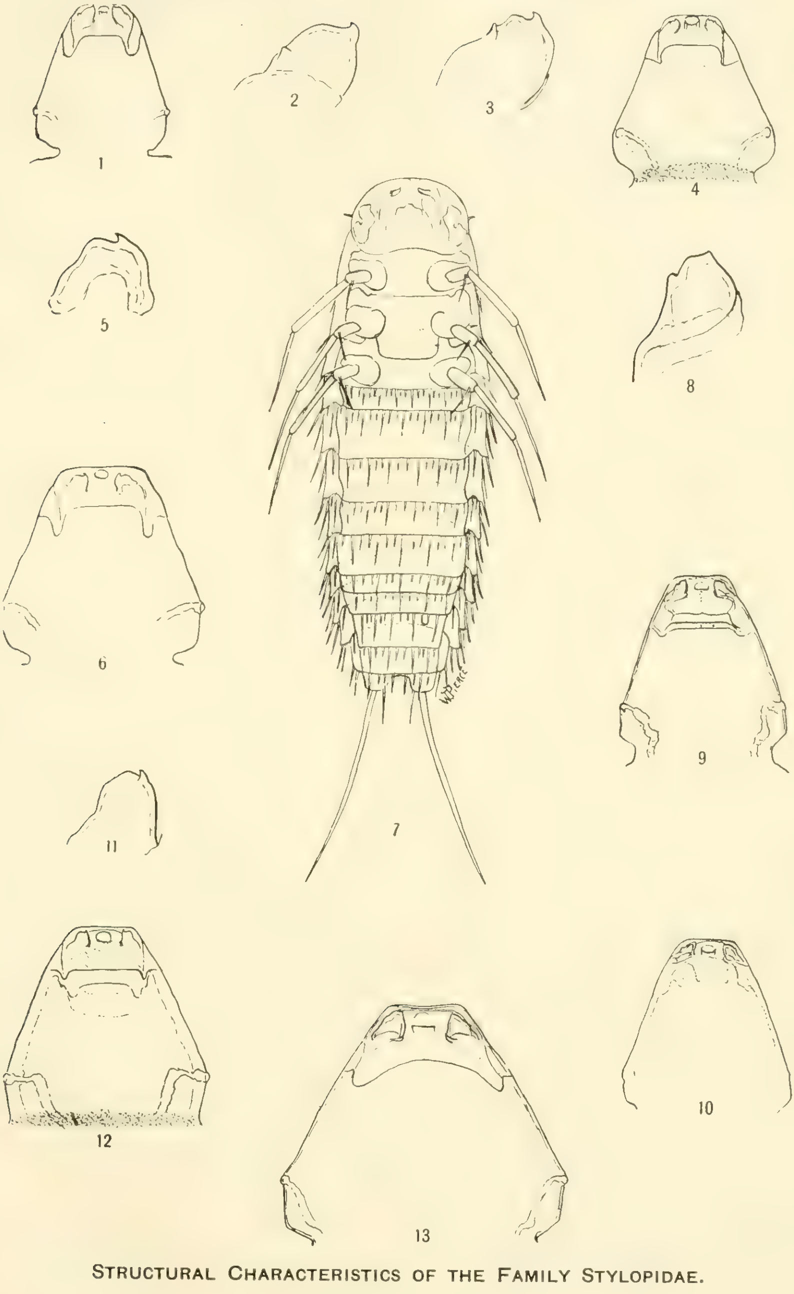
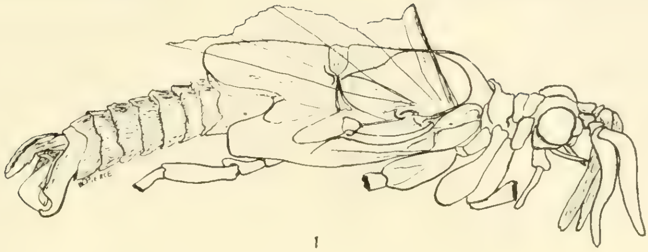


STRUCTURAL CHARACTERISTICS OF THE FAMILY STYLOPIDAE.

FOR EXPLANATION OF PLATE SEE PAGE 499



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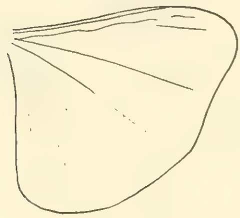

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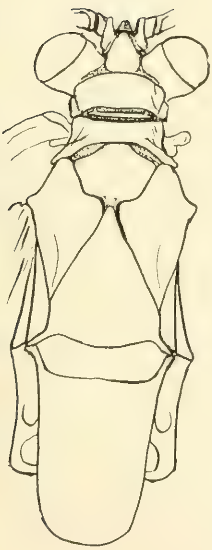

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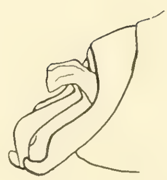

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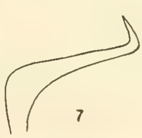

7

STRUCTURAL CHARACTERISTICS OF THE FAMILY XENIDAE

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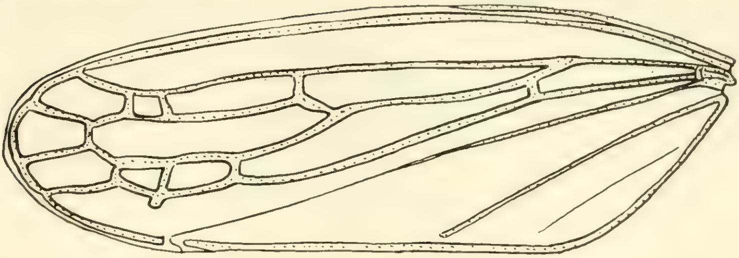

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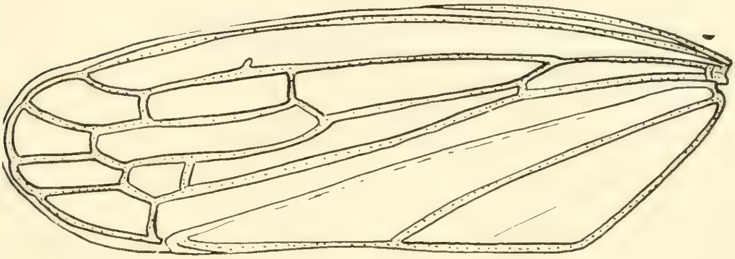

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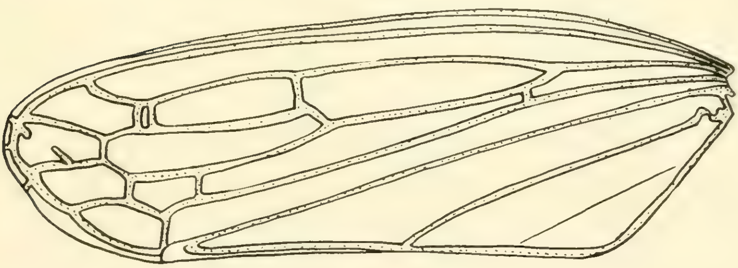

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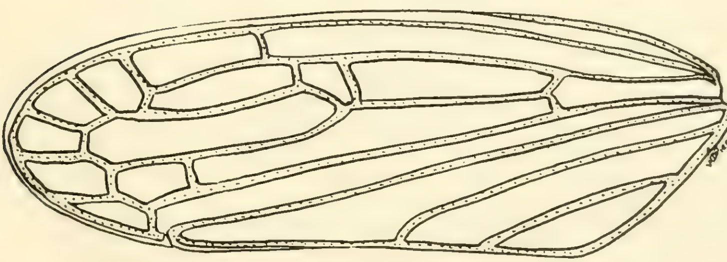

4

WINGS OF STYLOPIZED LEAF-HOPPERS

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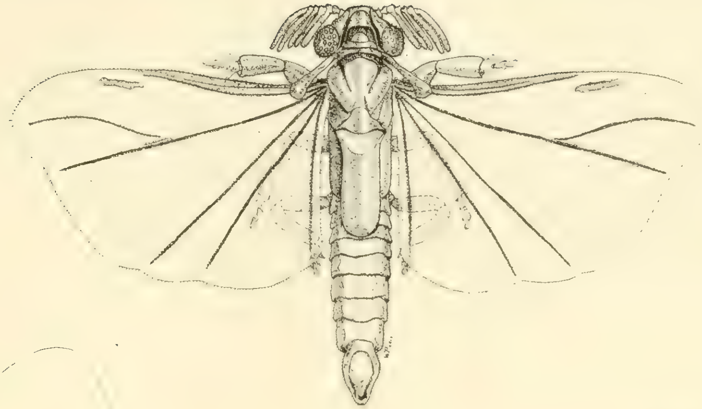

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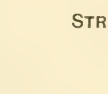

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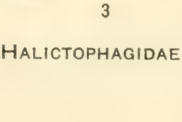

3

STRUCTURAL CHARACTERISTICS OF THE FAMILY HALICTOPHAGIDAE

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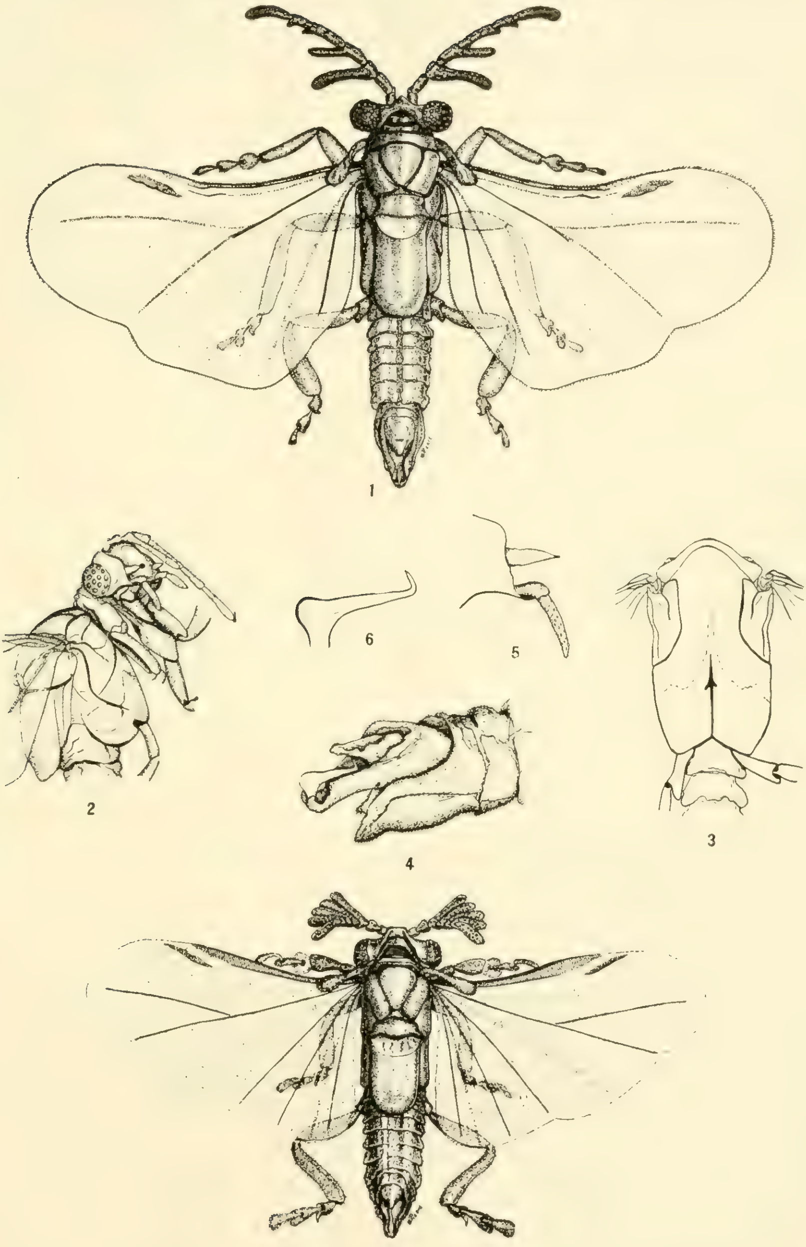

STRUCTURAL CHARACTERISTICS OF THE FAMILY HALICTOPHAGIDAE

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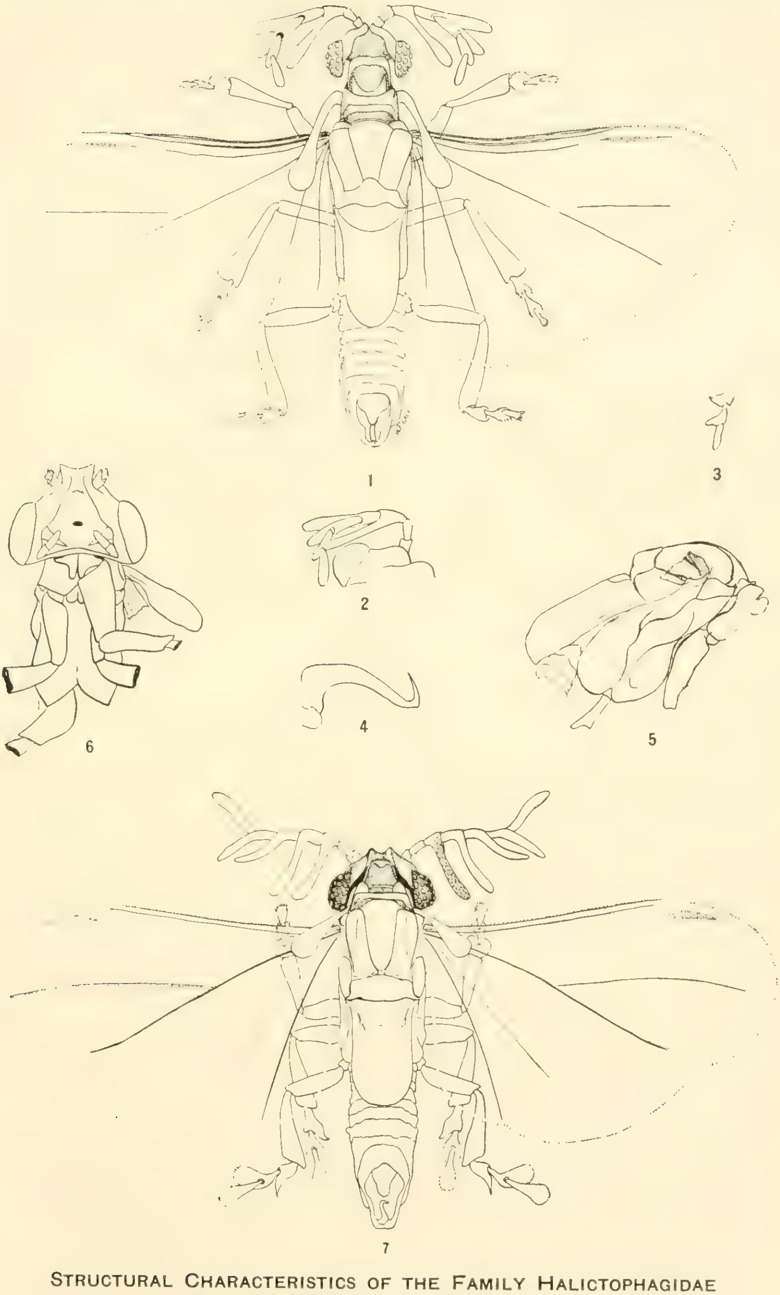

STRUCTURAL CHARACTERISTICS OF THE FAMILY HALICTOPHAGIDAE

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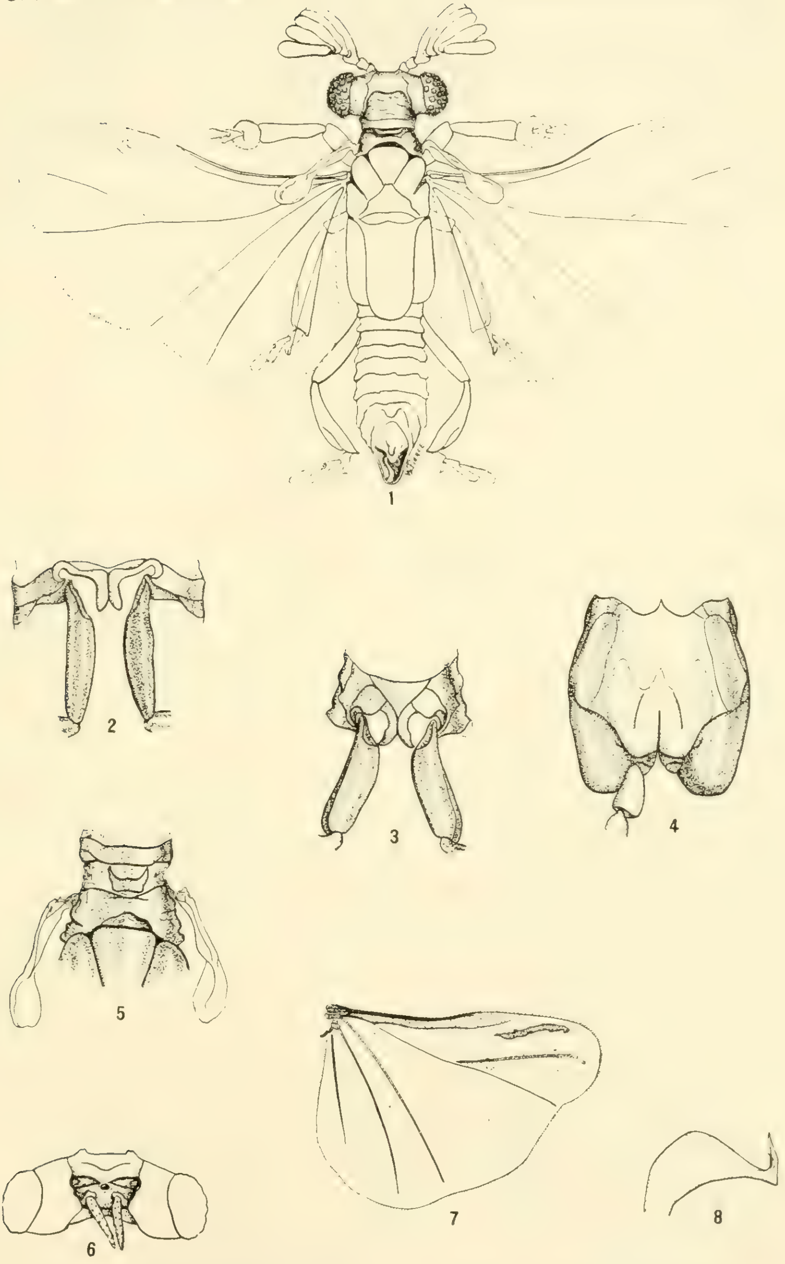
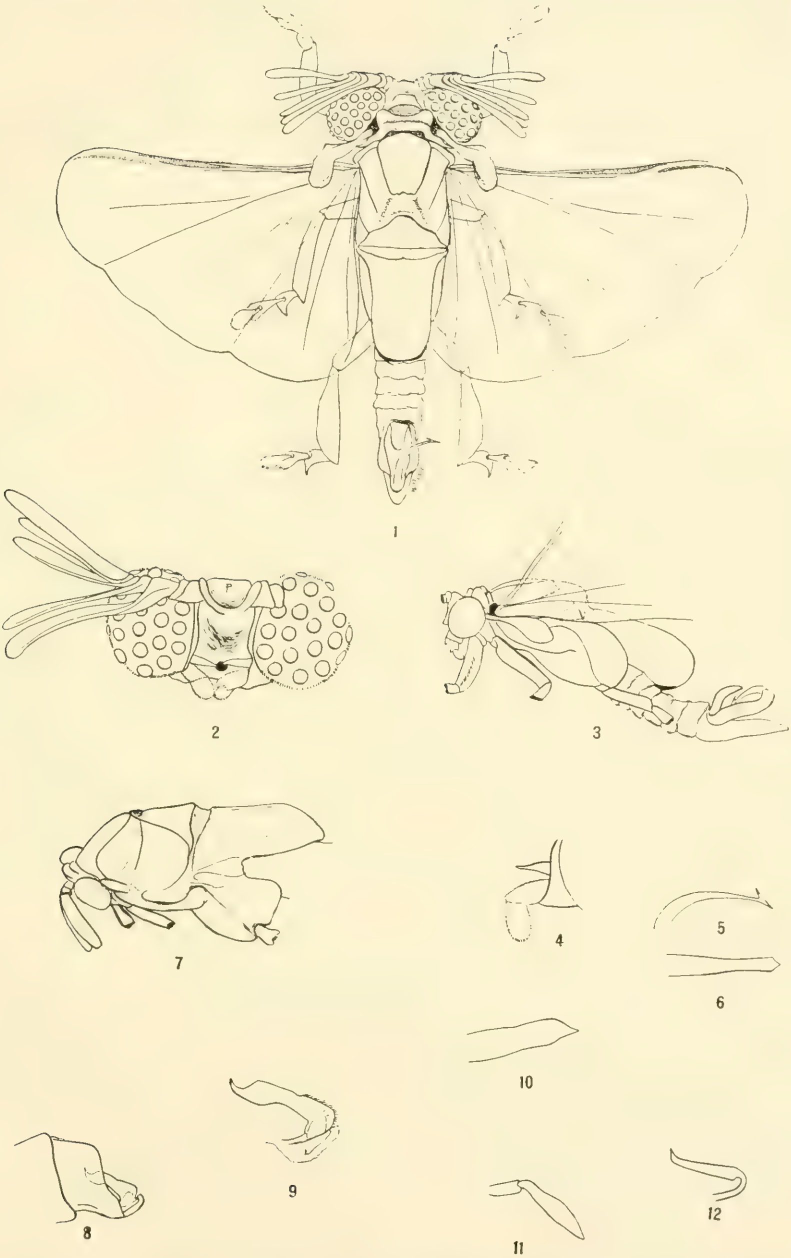


STRUCTURAL CHARACTERISTICS OF THE FAMILY HALICTOPHAGIDAE

FOR EXPLANATION OF PLATE SEE PAGE 530



STRUCTURAL CHARACTERISTICS OF THE FAMILIES HALICTOPHAGIDAE, DIOZOCERIDAE, AND ELENCHIDAE

FOR EXPLANATION OF PLATE SEE PAGE 500-501

FURTHER NOTES ON THE PLAINVIEW, TEXAS, METEORITE.

By George P. Merrill.

Head Curator, Department of Geology, United States National Museum.

In my paper descriptive of this find,[1] I called attention to an apparent brecciated structure, the certainty of which could be determined, if at all, only when one of the larger masses could be cut in halves and give opportunity for study of unweathered portions. Since that writing, through the liberality of Mr. C. S. Bement, of Philadelphia, the Museum has come into possession of two more of these stones. (Nos. 2 and 3 of pl. 35 of my paper.) This generous gift has enabled me to sacrifice one of the larger individuals already in our possession, No. 4 of the same plate, to the extent of slicing it through the center in a plane parallel to the face there shown. The results of the studies on this and further thin sections are in every way corroborative of the first, which are reviewed below, and the new data likewise presented.

As descriptive of the appearance of a cut and polished surface, I can not do better than quote the following from the addendum of the first paper:

When the possibility of brecciation was realized, the smallest (870-gram) fragment of the first find was cut in halves and polished. The resultant surfaces showed a ground of about equal parts light gray, mainly oxidized to reddish, and darker gray more or less angular areas. Both portions are equally injected with small, but abundant points of metallic iron and iron sulphide. There are also occasional light-gray fragments, some 2 to 4 mm. in length, which are evidently pyroxenic. To the unaided eye both portions are chondritic, though this structure is much more pronounced in the dark areas. It was at first thought that this difference might be merely apparent and due to the obscuring of the structure in the lighter portions through oxidation. Further investigation has, however, shown that this conclusion will not hold. Under the microscope the lighter portion is chondritic and consists wholly of olivine and enstatite with the metallic iron and iron sulphide. None of the twin pyroxenes so characteristic of the dark portion, which was the material described in the first part of this paper, are present. Further than that, the

[1] Proc. U. S. Nat. Mus., vol. 52, 1917, pp. 419–422.

chondrules in the light portion are almost wholly very light gray and nearly white, while those in the dark portions are in part of a dark-gray color, although there are white chondrules here also. By reflected light the polished surface shows a structure distinctly brecciated, and in one or two cases it is possible to trace the outlines of a fragment of the darker rock inclosed in the lighter gray, but in the majority of cases this is impossible, and the darker material is so commingled with the lighter that for a long time considerable uncertainty existed in the mind of the writer as to the true nature of the stone.

* * * * * * *

The strongest argument in favor of the brecciated nature of the stone seems to lie in the presence of the polysynthetically twinned pyroxenes in the dark-gray chondrules and their absence in the lighter portions. In one instance the line of demarkation between the light and dark portions could be plainly traced in thin section, and the metallic sulphides were found elongated along this line to indicate that it had been an open cleft at the time of their deposition.[1]

It remains to be stated that in the newly cut stone the dark portions are plainly not entirely a result of oxidation through weathering, as they are distributed regardless of surface contours and are as abundant in the center as about the periphery. By holding the stone so that the polished surface catches the light, lines of demarkation between the lighter and darker portions can in many instances be very readily made out. But, again, there are places where it would seem most certain that the darker portion is but an oxidized zone about a fragment of the lighter. In short, it does not seem possible to decide the question of brecciation, if one must rely on examination of a polished surface alone. Thin sections were therefore prepared of two portions affording structural differences even to the unaided eye, from which the photomicrographs reproduced in plate 79 were made, figure 1 being of the dark portion and figure 2 of the light. It is scarcely necessary to call attention to the marked difference in structure, which is all that was suggested in the first paper. To further illustrate the difference, sections were prepared showing the contact between the two portions, a photomicrograph of one of which with the same degree of enlargement is shown in figure 1, plate 80.

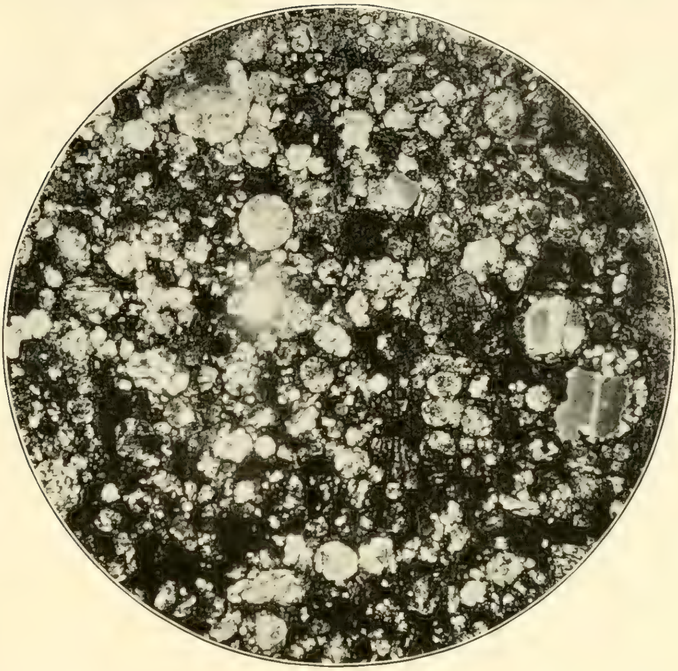
To assure myself that the apparent greater abundance of chondrules in the dark portion was not due to their being thrown out in relief by the deposition of interstitial iron oxides, a second like section was prepared, which, without cover, was then placed section side down over a narrow-mouthed vessel containing a few cubic centimeters of strong nitric acid, where it was allowed to remain for 36 hours, when it was carefully washed and remounted. There was effected an almost complete leaching out of the iron oxide, and of course a portion of the metal and sulphide; the olivine was also somewhat attacked but not enough so to vitiate the wished-for results.

[1] Proc. U. S. Nat. Mus., vol. 52, 1917, p. 422.

A photomicrograph from this is shown in figure 2 on plate 80, figure 1 being of the same magnification as those on plate 79 and figure 2 more highly magnified.

The above-mentioned facts, together with the presence of abundant chondrules of polysynthetic pyroxene in the dark portion and their absence in the light, lead me to the conclusion that the stone is a true breccia composed of fragments of a spherical chondrite and a veined intermediate chondrite like that of Dhurmsala. The confused, obscure character of the brecciation may have been due to the friable, sandy nature of one of the stones and the compression to which the mass has been subjected. If not a true breccia, the stone certainly shows, in its different parts, greater structural and mineralogical variations that are usually expected in one and the same mass.

It may be mentioned incidentally that Mr. Lazard Cahn writes me he has three individuals of a chondritic stone, weighing altogether about 15 pounds, from the Plainview locality, and which doubtless belong to the same fall. This being the case, the total weight given in my previous paper must be increased to "about" 31 kilograms.



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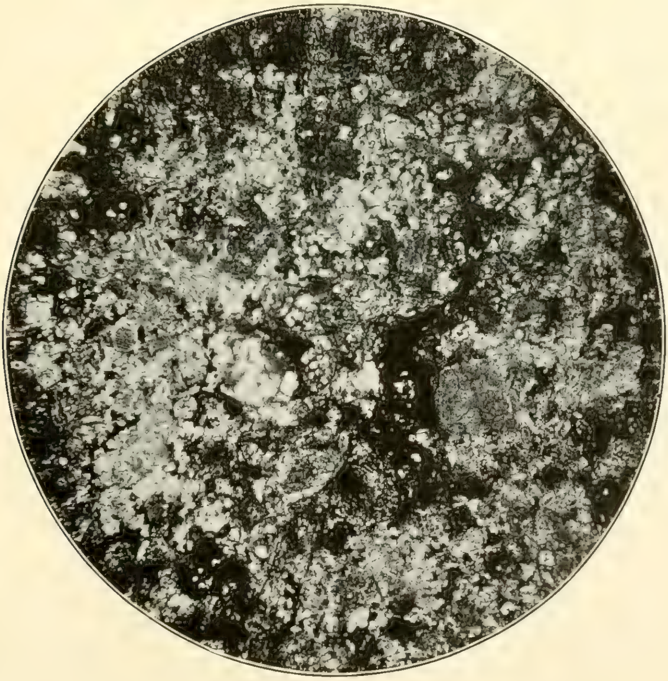
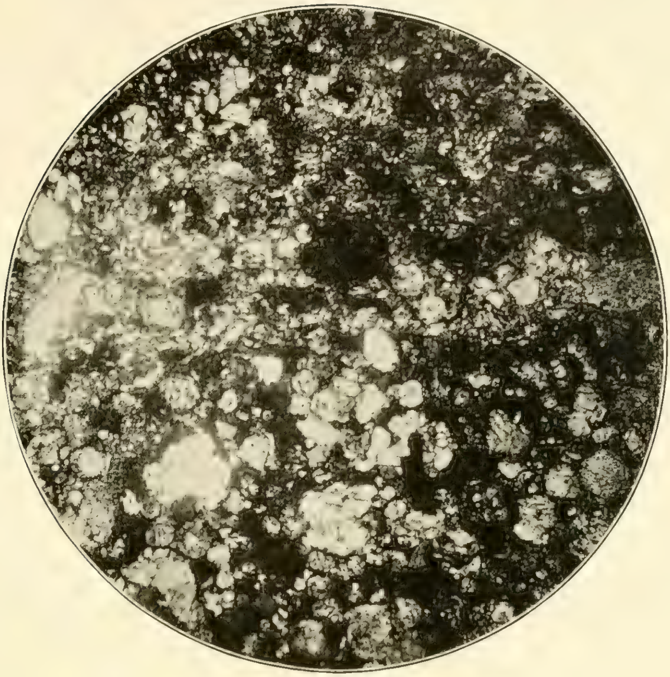


2

MICRO-STRUCTURE OF THE PLAINVIEW, TEXAS, METEORITE

FOR EXPLANATION OF PLATE SEE PAGE 504



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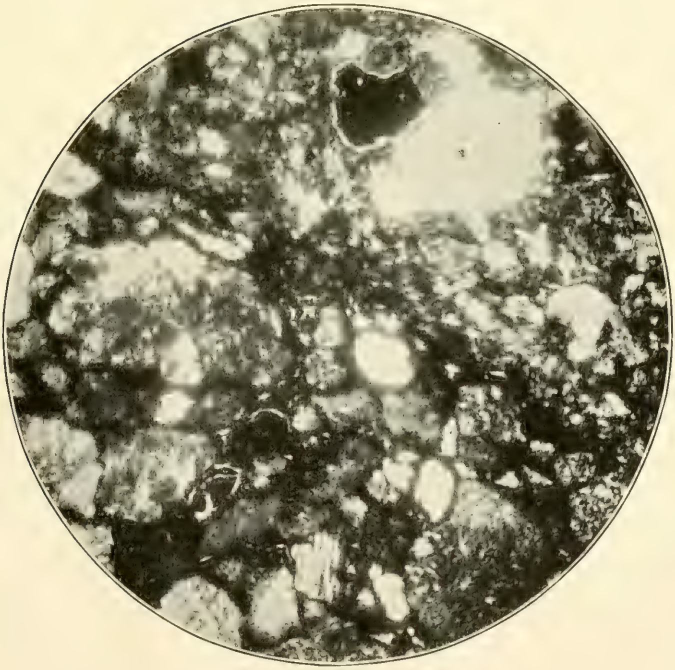

2

MICRO-STRUCTURE OF THE PLAINVIEW, TEXAS, METEORITE

FOR EXPLANATION OF PLATE SEE PAGE 504

MAMMALS AND REPTILES COLLECTED BY THEODOOR DE BOOY IN THE VIRGIN ISLANDS.

By Gerrit S. Miller, Jr.,

Curator, Division of Mammals, United States National Museum.

INTRODUCTION.

During the winter of 1916–17 Mr. Theodoor de Booy excavated two Indian sites in the Virgin Islands—one at Magen's Bay, St. Thomas, the other at Salt River, St. Croix. This work was done for the Museum of the American Indian, Heye Foundation, New York City. The remains of mammals and reptiles found in the deposits were submitted to me for identification, and a representative series of the bones has been given to the United States National Museum by Mr. George G. Heye. A wild-killed agouti from St. Thomas was presented by Mr. de Booy.

As regards the localities, Mr. de Booy writes as follows under date of March 15, 1917:

The bones from St. Thomas were found in a kitchen midden at Magen's Bay on the north coast of the island. This bay abounds in shell food and in fish of all kinds. It must have offered an ideal dwelling place for the pre-Columbian inhabitants of St. Thomas. The midden was fairly large in extent and from 4 to 7 feet deep. From this depth must be deducted the covering of diluvium, which was from 1 to 2 feet thick according to the slope. The animal bones were found below the diluvial deposit in a semi-indurated mass of clay-like soil plentifully mixed with shells, charcoal, sherds, and other artifacts. As I dug up the entire midden, the bones that were found can fairly be regarded as representing the entire range of animals represented in the deposit. The St. Croix site was near the mouth of Salt River on the western bank. Conditions did not differ materially from those found in St. Thomas. Evidence was discovered in the deposits that the inhabitants of St. Thomas led an adventurous and roving existence. Several artifacts were procured of Porto Rican and Santo Domingan origin, unmistakably so, as they differed totally from the normal culture found in the midden. Further proof of this roving disposition was found when I excavated in the same midden four shells of *Helix* [*Pleurodonte*] *bornii*, which is not found in St. Thomas but has its nearest habitat in Porto Rico. The lips of these shells were perforated as if to facilitate carrying them.

MAMMALS.

ISOLOBODON PORTORICENSIS Allen.

St. Thomas: 92 specimens (representing probably about 30 individuals): palates 3; frontals 2 pairs and 1 odd; parietals 2 pairs;

occipital 1; auditory bulla 1; mandibles (right) 10, (left) 5; scapula 1; humerus (right) 2, (left) 3; innominate (right) 2, (left) 4; femur (right) 22, (left) 13; tibia (right) 9, (left) 11.

St. Croix: 56 specimens (representing probably about 15 individuals): mandibles (right) 6, (left) 4; scapula 1; humerus (right) 3, left 2; radius (right) 5; ulna (left) 1; innominate (right) 3, (left) 1; femur (right) 7; (left) 9; tibia (right) 4, (left) 10.

The numerous remains of *Isolobodon* from St. Thomas and St. Croix show no characters that suggest the existence of any tendency toward local differentiation. The same fact is equally true when they are compared with material from Porto Rico and Santo Domingo.[1] It seems highly improbable that any mammal could retain so remarkable a degree of uniformity over such a range as this if its distribution had been due to natural causes. It is equally difficult to believe that local forms did in fact exist on the different islands, but that no clue to their peculiarities should be given by the many jaws, teeth, and leg bones which have been collected. Dispersal by pre-Columbian man suggests itself as the most probable means by which such a distribution could have been effected. While this explanation can not yet be taken as final, it is distinctly pointed to by the facts: (*a*) that the bones of *Isolobodon* have thus far been found chiefly if not exclusively in kitchen middens, (*b*) that the abundance of the remains shows that the flesh was an important article of food, and (*c*) that the pre-Columbian inhabitants of St. Thomas had intercourse with a territory which exactly coincides with the animal's known range.

DASYPROCTA AGUTI (Linnaeus).

An old male of the golden-rumped Brazilian agouti was collected on St. Thomas. It is a perfect specimen (Cat. No. 217950, U.S.N.M.), preserved in alcohol, and of its identification there can be no doubt. As the animal was seen on several occasions running about and evidently wild there is no likelihood that it had been recently imported.[2] The capture of this specimen is of special interest, as it demonstrates the fact that the Brazilian agouti has been introduced on St. Thomas. The species was recorded as long ago as 1852 by Knox,[3] but it has hitherto seemed possible that there was an error

[1] Smiths. Misc. Coll., vol. 66, No. 12, pp. 4–5, December 7, 1916.

[2] The animal was "wild-killed," although not by me. I had seen this same agouti twice, but had no gun with me, as I was on my way to my own work on those two occasions. Then I went after it for two Sundays with a gun, and of course did not see it. So I finally offered a reward to my workmen for it and one of them got it with a dog. From the reports I received I am sure that there are some more on the island and that these are of the same variety and not the dark-rumped ones. So you can eliminate the theory that this was an escaped pet or was given to me by a well-meaning friend. (de Booy, letter of March 5, 1917.)

[3] A historical account of St. Thomas, W. I., p. 221.

of determination, because material from St. Thomas in the British Museum was afterward identified by Alston[1] as *Dasyprocta cristata.* Mr. Oldfield Thomas writes me under date of March 6, 1917, that he has examined the specimens mentioned by Alston and that they are obviously referable to some member of the *cristata* group. There is now little doubt that introductions of agoutis have been made from both Brazil and the Lesser Antilles. That the genus *Dasyprocta* was probably not represented in the Virgin Islands during pre-Columbian times is indicated by the absence from the kitchen middens of bones referable to any of its species.

Measurements of No. 217950: Head and body, 540; tail, 15; hind foot, 125 (110); ear from meatus, 40; ear from crown, 25; condylobasal length of skull, 101.2; palatal length, 54.6; zygomatic breadth, 59; least interorbital breadth, 32; mastoid breadth, 34.4; occipital depth, 27; least depth of rostrum behind incisors, 24; frontal depth at level of anterior zygomatic root, 29.4; mandible, 64.5; mandibular toothrow (alveoli), 29.

TRICHECHUS MANATUS Linnaeus.

The atlas and axis of one individual, and three fragments of ribs probably not from the same animal as the vertebrae, were dug from the midden on St. Croix.

REPTILES.

CYCLURA MATTEA, new species.

Type.—Left humerus (Cat. No. 59358, U.S.N.M.). Collected in kitchen midden at Magen's Bay, St. Thomas, Virgin Islands, by Theodoor de Booy. Presented by George G. Heye.

Characters.—Humerus resembling that of *Cyclura cornuta* from Santo Domingo and *C. stejnegeri* from Mona Island in general form, but with extremities broader in proportion to total length of the bone, and capitellum broader in proportion to its height. The radial fossa is deeper and better defined than in C. *stejnegeri.* Pelvis much more robust than in *C. cornuta* (that of *C. stejnegeri* not seen).

Measurements.—Humerus (type and Cat. No. 59359, U.S.N.M.): total length 80.3 (76.4); greatest width of proximal extremity, — (30.7); greatest width of distal extremity, 29.5 (—); least width of shaft, 7. [illegible] 7.5); capitellum, 13.1 by 8.1 (12.3 by 8.0). Pelvis (No. 59734); ilium 6 mm. in front of acetabulum, 14.4 by 7 (10.4 by 5.2)[2]; ischium at level of small foramen, 13.8 by 5.6 (10.6 by 4.2) pubis at narrowest region, 11.0 by 5.9 (7.3 by 4.0); acetabulum 21.8 by 18.0 (16.2 by 14.0).

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[1] Proc. Zool. Soc. London, 1876, p. 348.

[2] Measurements in parentheses are those of a fully adult *C. cornuta* (No. 28625).

Specimens examined.—Two left humeri and an imperfect left innominate.

Remarks.—So far as can be judged from the structure of the humerus *Cyclura mattea* is much more nearly related to *Cyclura cornuta* and *C. stejnegeri* than it is to the *C. pinguis* of Anegada. Doctor Barbour has kindly had the left humerus removed from the type-specimen of *C. pinguis* and sent to me for comparison. It is here figured on plate 81 (fig. 3). Though from an animal much older than either of the specimens of *C. mattea* (figs. 4, 5), it is by comparison decidedly small: total length, 61.5; greatest breadth of proximal extremity, 23.7; greatest breadth of distal extremity, 21.5; least width of shaft, 7; capitellum, 9.4 by 5.2. It agrees with the humeri of *C. mattea*, *C. cornuta*, and *C. stejnegeri* in the general characters by which the humerus of *Cyclura* differs from that of *Iguana*, principal among which are the great breadth of the extremities as compared with the total length of the bone, and the presence of a well-defined radial fossa. But it is immediately distinguishable by several details of form, notably by the shorter, broader general outline of the expanded portion at each extremity. The length of the sharply defined, ridge-like outer border of the bone in the region of the capitellum and radial fossa is equal to half the width of the distal expansion, while in both *C. mattea*, *C. cornuta*, and *C. stejnegeri* it is conspicuously greater than half this width. As to the peculiarities of *Cyclura mattea* as compared with *C. cornuta* and *C. stejnegeri:* the remains appear to represent a much larger animal; the ratio of greatest width of proximal expansion of humerus to the length of the bone is 40 in *C. mattea* (paratype), 34.4 in *C. stejnegeri* (No. 29366), and 33.4 in *C. cornuta* (No. 28625); the same ratios for the distal expansion are 36.7 (type), 31.9, and 33.4.

The question naturally arises as to whether *Cyclura mattea* may not have been brought to St. Thomas by man, as has undoubtedly been the case with the species of *Iguana* now or recently living on the island. There is, however, no such evidence for artificial introduction as that presented by the rodent *Isolobodon.* The animal is distinct from that of both Mona Island and Santo Domingo; the humerus of the extinct Porto Rican member of the genus is not yet known.[1]

CHELONIA MYDAS (Linnaeus).

Shells and limbs of sea turtles of various ages and sizes are represented by about 40 fragments from St. Thomas and two dozen from St. Croix. All the more complete bones appear to be referable to *Chelonia mydas*, though members of other marine genera may be

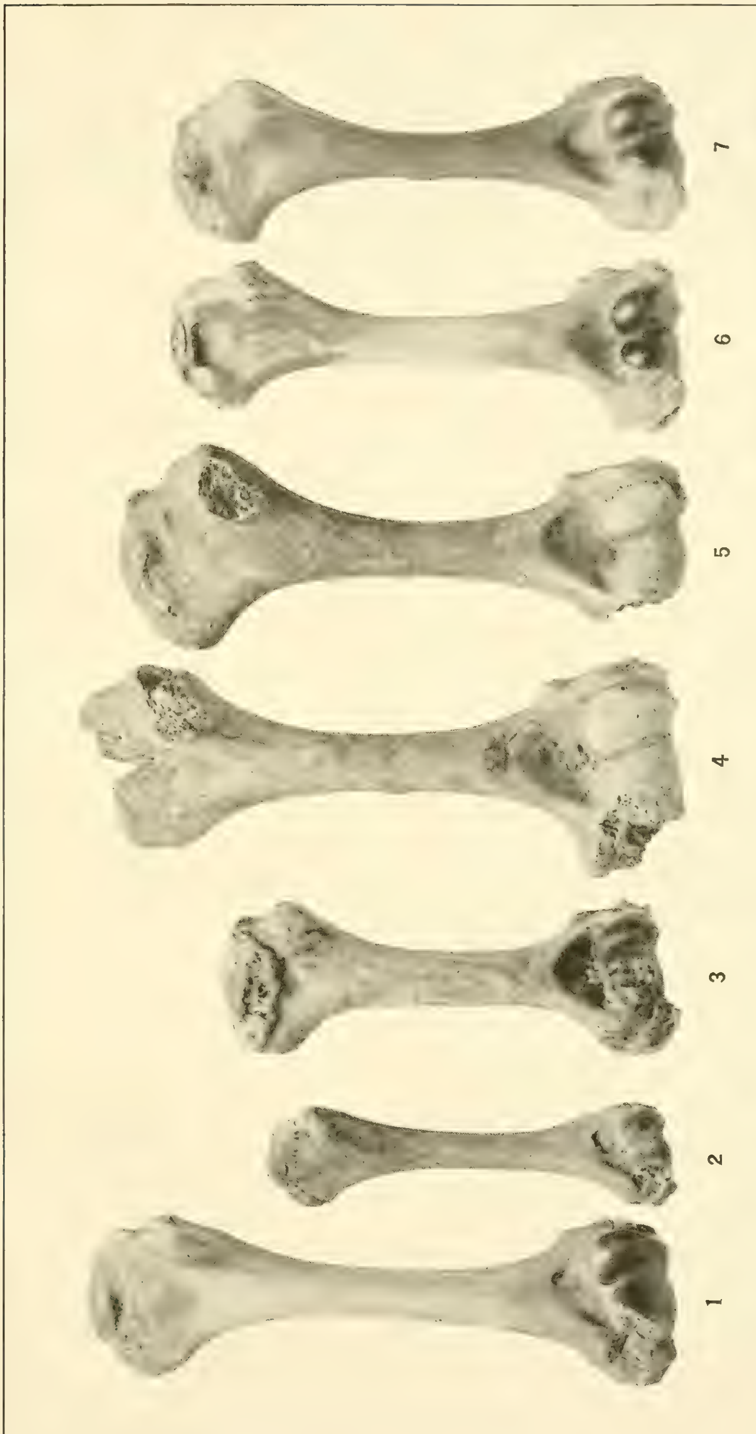
[1] Barbour, Proc. Biol. Soc. Washington, vol. 30, p. 98, May 23, 1917.

represented among the less characteristic smaller pieces. Of the freshwater *Pseudemys palustris*, whose remains occur freely in the Indian deposits of Cuba and Santo Domingo, there is no trace.

EXPLANATION OF PLATE 81.

Left humerus, natural size.

Fig. 1. *Iguana rhinolopha.* Cat. No. 35633, U.S.N.M. No history.
2. *Iguana rhinolopha.* Cat. No. 22814, U.S.N.M. No history.
3. *Cyclura pinguis.* Type. Cat. No. 12082, Mus. Comp. Zool. Anegada.
4. *Cyclura mattea.* Type. Cat. No. 59358, U.S.N.M. St. Thomas.
5. *Cyclura mattea.* Paratype. Cat. No. 59359, U.S.N.M. St. Thomas.
6. *Cyclura cornuta.* Cat. No. 28625, U.S.N.M. No history.
7. *Cyclura stejnegeri.* Cat. 29366, U.S.N.M. Mona Island.



HUMERI OF IGUANA (1-2) AND CYCLURA (3-7)

FOR EXPLANATION OF PLATE SEE PAGE 511

BONES OF BIRDS COLLECTED BY THEODOOR DE BOOY FROM KITCHEN MIDDEN DEPOSITS IN THE ISLANDS OF ST. THOMAS AND ST. CROIX.

By Alexander Wetmore.

Of the Biological Survey, United States Department of Agriculture.

INTRODUCTION.

The presence of avian remains in the ancient refuse heaps that mark aboriginal camp or village sites is always of interest to ornithologists. Such fragments may represent species still extant, or, more seldom, may reveal forms less fortunate in the struggle for existence, that have been exterminated, leaving these parts of skeletons, disarticulated or broken, as the only indications of their former existence.

Recently the writer has had the privilege of examining a collection of bird bones secured by Mr. Theodoor de Booy for the Museum of the American Indian, Heye Foundation, from kitchen middens on St. Thomas and St. Croix in the Virgin Islands. The remains from St. Thomas consist of fifty-one bones or parts of bones taken from a midden at Magen's Bay on the north coast of the island during December, 1916. These fragments were found below a diluvial surface deposit that was from 1 to 2 feet thick. The material examined from the island of St. Croix, 22 fragments in all, was taken during January, 1917, from a midden on the north coast of the island on the western bank of Salt River near its mouth. For a more complete account of the sites where this material was collected, and the conditions under which it was secured, the reader is referred to the preceding paper in this volume by Mr. Gerrit S. Miller, jr.[1]

Mr. De Booy believes that there is certain evidence that the natives of the Virgin Islands had communication with Porto Rico and Santo Domingo, so that it is possible that bones found in these middens may in part have originated elsewhere. In spite of this element of uncertainty concerning the origin of these specimens, notes on this material are of value, as it may be considered doubtful that individuals of the native species represented have been transported for any great distance. Thirteen species of birds, including one described here as

[1] Proc. U. S. Nat. Mus., vol. 54, 1918, p. 507.

new, have been identified in the remains from both islands. A series of these specimens, including the type of the new rail described below, has been presented to the United States National Museum by Mr. George G. Heye, at whose direction the work of excavating these middens was carried out.

A detailed description of the collection follows.

LIST OF SPECIMENS FROM ST. THOMAS.

PUFFINUS LHERMINIERI Lesson.

A right ulna and a left humerus, both more or less chipped and broken about the ends, are referred to this species. These bones are somewhat heavier than those in the single modern skeleton available for comparison, but are within the limit of individual variation. In this genus, individuals of the same species often show great differences in the diameter and length of the wing bones—a fact that is well shown in a good series of skeletons of *Puffinus kuhlii borealis* in the collections of the United States National Museum. There are no other published records of the occurence of *P. lherminieri* on the island of St. Thomas.

AESTRELATA, species.

A left tibio-tarsus from St. Thomas belongs to a petrel of this genus. In *AEstrelata* the cnemial process of the tibio-tarsus is short and rounded while in *Puffinus* it is long and broad.[1] The condyles of the specimen in hand agree in size with those in skins of *AE. hasitata.* It seems probable that it may represent either *AE. hastitata* (Lafresnaye) or *AE. diabolica* (Lafresnaye).[2] Skeletons of these forms are not at present available so that definite comparisons can not be made. No species of petrel has been recorded previously from the island.

SULA LEUCOGASTRA (Boddaert).

The following bones of this booby are present in the collection: A right humerus nearly entire, the shaft of a left humerus, a nearly complete right coracoid, a left femur that lacks the inner condyle, and a left tibio-tarsus with the proximal end missing. These bones in *Sula leucogastra* may be readily distinguished from those in *Sula piscator* upon careful comparison, and in some instances the differences between the two species are striking. This is true especially in the case of the head of the femur. In *S. leucogastra* the femoral head is globular with an irregularly grooved area marking the attachment of the *ligamentum teres.* In *S. piscator* the head of the femur is distinctly flattened with a large rounded pit or depression formed to receive the distal end of the ligament. The tibio-tarsus

[1] See Shufeldt, R. W., Ibis, 1916, p. 634.

[2] See Noble, G. K., Bull. Mus. Comp. Zool., vol. 60, 1916, pp. 370–374.

is larger and the coracoid more slender in *leucogastra* than in *piscator*.

Though modern accounts do not include St. Thomas in the range of the common Booby, the species is known from other islands near by. Boodies are reported from some islets between Culebrita and Cayo Norte, about 12 miles west of St. Thomas,[1] and may occur elsewhere in the vicinity.

FREGATA MAGNIFICENS Mathews.

The distal end of a right humerus and a left coracoid nearly complete are from the skeleton of the Man-o'-War Bird. There is marked difference in size in skeletons of males and females of this species, the female having the bones longer and heavier throughout than the male. The fragments from St. Thomas seem to have come from a male as they are small and slender.

The Man-o'-War Bird is common around the islands of the Virgin group at the present day. Published lists of the birds of St. Thomas do not include it, but the writer has observed the species in the passage east of Culebra and Culebrita.

NYCTANASSA VIOLACEA (Linnaeus).

The Yellow-crowned Night Heron is represented by two right and two left humeri, more or less complete, the distal portion of a left tarso-metatarsus and parts of two right tibio-tarsi. These fragments agree in all their characters with modern skeletons of *Nyctanassa violacea*, but are above the average in size. This heron differs from other herons examined from the West Indies and from North America north of Mexico in having the fibula ankylosed at its lower end to the shaft of the tibia. In *Botaurus lentiginosus*, *Ixobrychus exilis*, *Ardea herodias*, *Herodias egretta*, *Egretta t. thula*, *Dichromanassa rufescens*, *Hydranassa tricolor ruficollis*, *Butorides v. virescens*, and *Nycticorax n. naevius*, the distal end of the fibula remains free.[2] That *Nycticorax* should differ from *Nyctanassa* and resemble other herons in this respect seems strange.

It is interesting to note that the present-day natives of the Virgin Islands consider the flesh of the Yaboa (as they call the Yellow-crowned Night Heron) a delicacy, and this species is in favor as a game bird. The fragments recorded here seem to show a similar preference on the part of the aboriginal inhabitants.

GALLUS GALLUS (Linnaeus).

Among the fragments from the island of St. Thomas occur the following remains of the domestic fowl: Nine cervical vertebrae, including those from the sixth to the fifteenth inclusive, save the ninth;

[1] Wetmore, A., Birds of Porto Rico, U. S. Dept. Agr. Bull. 326, 1916, p. 19.
[2] Skeletons of *Ardea occidentalis* are not available for examination.

two humeri from right and left sides, respectively, broken but nearly complete; a right and a left ulna; one right metacarpus; the anterior part of a sternum including the spina sterni and the lower portion of the grooved anterior end of the keel; a broken sacrum; the distal end of a right femur; the proximal end of a right tibia and the proximal part of a left metatarsus. Apparently these bones all belonged to one individual. All seem rather small so that they may have come from a female bird. They agree in all details of structure with more modern skeletons of the domestic fowl.

Concerning these specimens Mr. de Booy wrote to Mr. Miller under date of December 25, 1916: "I am sending you herewith the fourth and last shipment from St. Thomas. Amongst other things it contains two skulls of large animals [fish] and also a set of vertebrae and some ribs, etc., of the Isolobodon (?). I found the latter inside a large cooking vessel in the Magen's Bay kitchen middens." In a letter to me, dated July 6, 1917, he adds: "* * * the vessel was quite deep down, and numerous other specimens were on top of it." Unfortunately the bones found in the bowl were not specially designated in the package in which they were sent to Washington. But the vertebrae of *Gallus*, listed above, were the only vertebrae in the entire collection from the island of St. Thomas, save for isolated segments of the backbones of fishes. Hence it would seem beyond doubt that part if not all, of the fowl remains must have been contained in this cooking vessel.

NESOTROCHIS, new genus.

Plate 82, figs. 1–5.

Type.—*Nesotrochis debooyi*, new species (Family Rallidae).

Characters.—Femur and tibia (no other parts of skeleton seen) much stronger and heavier in proportion to length than in other North and South American Rallidae examined; Femur equal in length to that of *Aramides cayanea* but much broader and heavier, with highest point of ridge of trochanter maxima opposite a line passing through the articular head; shaft more strongly curved; tibio-tarsus slightly longer than that of *Aramides cayanea* and much heavier especially toward distal end; proximal head larger and stronger, with inner facet more deeply excavated and the ridge external to this concavity with a rounded tubercle on its outer margin; a slight ridge on the posterior articular surface of the condyles; all crests and tubercles more strongly developed.

NESOTROCHIS DEBOOYI, new species.[1]

Description.—Type. Cat. No. 225845 U.S.N.M., right femur, from a kitchen midden at Magen's Bay, St. Thomas, Virgin Islands, collected December, 1916, by Theodoor de Booy.

[1] This species is named in honor of the collector, Mr. Theodoor de Booy.

Femur with head large, anterior margin produced strongly as a ridge. Depression for attachment of *ligamentum teres* deep and elongate, with two slightly indicated excavations at bottom. Neck, when viewed from above, as broad as head with a very slightly indicated constriction separating it from head. Trochanter maxima raised in a broad, strongly marked ridge, with the upper margin evenly rounded when viewed from the outer side. The highest median point in the ridge is opposite the center of the head and not anterior to this point as in other rails examined. Outer surface of upper end of bone broadly expanded, this expansion being equal on the two sides. A wide shallow depression on the anterior face below the trochanteric ridge. The shaft is more strongly curved than in other rails examined. Its anterior and inner surfaces are lightly rugose save for a narrow space at either end of the bone. These rugosities are very lightly impressed and are in a general way transverse. The medullary opening is equidistant from either end of the bone. The condyles are imperfect, being worn or eaten away distally. The rotular channel is deeply impressed. There is a shallow popliteal depression bounded distally by a high ridge passing from inner to outer condyle. At the lower end of the popliteal depression is a slightly raised ridge making a shallow distal pit. There are no pneumatic foramina. A strongly marked *linea aspera* arises on the inner side half way between the proximal end of the bone and the medullary opening. This line swings in a gradual curve to the posterior surface and then passes down to the angular base of the inner condyle. The tuberosities marking the attachments for the ilio-femoral and ischio-femoral muscles are strong and well defined. The shaft is plano-convex, being flattened on the outer portion of the posterior side. It is somewhat compressed on the antero-internal face. At the medullary opening the shaft is bent strongly backward.

Tibio-tarsus with proximal head large and strong. Inner facet deeply excavated (deeper than in *Aramides cayanea*, nearly as deep as in *Gallirallus australis*). The ridge external to this concavity has a strongly rounded tubercle on its outer anterior margin. This the writer has not seen in other rails. Anterior crest rather deeply impressed for the attachment of the strong tendon of the *muscle femoro-tibialis*. That part of the groove excavated immediately above the inner anterior crest is at right angles to the longitudinal axis of the bone and has its inner margin raised and complete. The outer anterior crest (perfect in one fragment) is broad and strong with a nearly straight margin below and a well curved outline above. The inner anterior crest is broken away, but the margins indicate that it was broad and as heavy as in other rails. The peroneal ridge is long and strong. It is higher distally, where it terminates in a blunt, slightly projecting spine. The nutrient foramen enters the shaft immediately below and behind the peroneal ridge, 3 millimeters distant from its base. The fibula is lost, but was ankylosed by a slender attachment at its distal end to the shaft of the tibia. The lower portion of the tibio-tarsal shaft is broad and flattened on its anterior surface with the usual osseous bridge under which ran the tendon of the muscle *extensor digitorum communis.* The distal condyles are large and heavy, with a broad sulcus between them anteriorly. On the articular surface is a slight median ridge.

Measurements.—Femur, Cat. No. 225845, U.S.N.M. (type) : Length, 76.5 mm.; transverse diameter through center of head, 17 mm.; transverse diameter through medullary foramen, 7.5 mm.; intercondylar diameter,[1] 16.6 mm.

Tibio-tarsus, Cat. No. 225845, U.S.N.M.: Length, 110 mm.; breadth through lower end of peroneal ridge, 9 mm.; greatest breadth through condyles, 12.5 mm.; length of articular face of peroneal ridge, 17 mm.

Remarks.—This bird is represented by portions of eight bones, all from the posterior limb—namely: Two nearly complete right femora, the proximal portion of a left femur from a smaller individual, a nearly complete right tibio-tarsus, the distal end of two others and portions of two left tibio-tarsi, one of which lacks the anterior end, while in the other the condyles are missing.

The relationships of this remarkable rail must remain for the present somewhat obscure. It might be supposed that it would resemble *Aramides* closely, but this is not the case. The bones at hand are equal in length to the same bones in *Aramides cayanea* but are much more robust. There is no skeleton of the large *A. ypecaha* available, but there are several skins in the collections of the United States National Museum in which the knee joint has been disarticulated so that the tibio-tarsus is complete. In these the tibio-tarsus is from 20 to 25 mm. longer than in *Nesotrochis debooyi*, while the intercondylar breadth at the distal end is slightly less, though this region is covered by skin. From this it is seen that the proportions of the two birds are entirely different.

In other rails available that part of the femoro-tibial depression above the inner anterior crest of the tibio-tarsus slopes inward and downward, and has no defined inner margin; there is also a terminal decurved hook on the outer anterior crest that is not present in *Nesotrochis*, though this may have been slightly developed as specimens available show some wear here. The distal ridge found on the posterior articular surface of the tibio-tarsal condyles in *Nesotrochis* is absent in other rails. The slight lateral rugae on the femoral shaft are well developed in *Aramides* and are lightly indicated in a specimen of *Tribonyx mortieri.*

[1] Not exact, as lower ends of condyles are missing

The limb bones that represent this new form bear a striking resemblance to those of *Gallirallus* in their strong, robust development. In length, bones from the hind-limb in the two genera are practically the same. *Nesotrochis* has the femur heavier and more strongly curved while the tibio-tarsus is very similar save that the condyles are broader and stronger than in *Gallirallus*. The discovery of other parts of the skeleton of *Nesotrochis* will be awaited with interest as it may be supposed that they will show marked differences from the type found in other New World rails. It is possible that this species possessed feeble powers of flight or even that it was flightless, facts that might account for its extermination when its haunts were invaded by man.

ANOÜS STOLIDUS (Linnaeus) (?).

A partly complete left humerus agrees with the large wing bone of the Noddy fairly well, but the identification is not certain. The skeletal material available at present in the Sterninae is small and several important species are lacking, so certain identification in the case of this one bone is made difficult. The Noddy is not known at present from St. Thomas, but occurs on other islands not far distant.

STERNA, species.

The shaft of a right humerus belongs in this genus. It is possible that the species represented in *Sterna anaetheta* (Scopoli), but skeletons of this species are not available for comparison.

LIST OF SPECIMENS FROM ST. CROIX.

PUFFINUS, species.

The proximal end of a right humerus in the material from St. Croix belongs to a shearwater, but with the material available it can not at present be identified. The bone in question represents a species larger than *P. lherminieri* and smaller than *P. gravis* so that by a process of elimination it may be supposed that it is *P. puffinus*, as that species is intermediate in size between the other two. Some weight is given this supposition when it is remembered that a shearwater of this group has recently been described from Bermuda as *Puffinus p. bermudae* by Nichols and Mowbray.[1] No skeletons of this species are at hand for comparison so that the matter of the determination of this fragmentary humerus is left in abeyance. The bone in question is of the type that has the shaft well rounded below the head. No species of shearwater has been recorded previously from the island of St. Croix.

SULA PISCATOR (Linnaeus).

This species is represented by the shaft of a right humerus from which both condyles and head are gone. The humeral shafts in *S.*

[1] Auk, 1916, p. 195.

piscator and *S. leucogastra* are practically identical in curvature and size, but in *S. piscator* the ridge marking the insertion of the muscle *latissimus dorsi* is placed farther from the upper margin of the humerus than in *S. leucogastra*. When the humerus is viewed directly from above (with the bone oriented in its natural position in life), this ridge, in *piscator*, is located near the inner marginal line, while in *leucogastra* it is median or slightly external to the center of the space. The fragment of bone from St. Croix agrees with *S. piscator* in the position of this ridge, and is identified as that species. *Sula cyanops* has the humerus much larger than in either of the two described above. *Sula piscator* has not been known previously from the island of St. Croix.

NYCTANASSA VIOLACEA (Linnaeus).

The anterior half of a right coracoid comes from the skeleton of this heron.

GALLINULA CHLOROPUS (Linnaeus).

The distal end of a tibio-tarsus belongs to this species without question, while a femur nearly complete is assigned here with some hesitation. Careful comparison of femora of *Fulica americana* and *Gallinula chloropus* has shown that the two are very similar, save that this bone in *Gallinula* is more slender, and in the specimens examined the trochanteric ridge is continued ventrally to the posterior margin of the articular surface as a sharp projection. In *Fulica* the femur is more robust, and the trochanteric ridge lowers as it passes back until it merges smoothly into the bone at a point median to the posterior margin. The fulicine femur in the collection from St. Croix is somewhat more slender than that in available specimens of *G. chloropus* from the United States and from the Seychelle Islands, but has the trochanteric ridge slightly intermediate in its structure between *Fulica americana* and *Gallinula*. Skeletons of *Fulica caribaea* Ridgway are not available at present, so that the characters of the femur in this species are not known. Because of its slenderness the femur from St. Croix is provisionally referred to *G. chloropus*. This species is said to be common on the island at the present time.

NESOTROCHIS DEBOOYI Wetmore.

Nine of the 22 bones examined from the island of St. Croix belong to this remarkable rail. All are fragments of the tibio-tarsus more or less complete according to the specimen. Two of these are nearly entire, three fragments come from the head of the bone, three have the shaft and condyles nearly complete, while the remaining bone is a badly crumbled bit from the condylar region. These fragments are identical in form with those examined from St. Thomas, but on the whole average stronger and heavier. Three of the bones from

St. Croix are much larger and heavier than the others and illustrate what may have been sexual differences as an equivalent difference is found between males and females of *Gallirallus australis* (the males in *Gallirallus* being larger). The average difference in size between the series of tibio-tarsi from St. Thomas and St. Croix is so apparent that the birds from the two islands seem distinct when it is supposed that the variation among individual bones from the same locality is due to sex. This point, however, is uncertain, while it is a fact that the largest bones from St. Thomas are equal to the smallest ones from St. Croix. For this reason it is thought inadvisable at the present time to separate the bird from St. Croix as a distinct form. There is at best considerable uncertainty as to the exact place of origin of bone remains from kitchen midden deposits, but it may be supposed that where so many bones representing one species are found, that these came from the island on which the midden was located. There is no proof, however, that they belong to a truly indigenous species, nor is it known that they were not brought as needed from somewhere else. The comparative abundance of the remains of this rail in these deposits when compared with other species of birds indicate that it possessed flesh that was held in high esteem as a source of food. This being the case, there is no evidence to show that these rails may not have been kept as captives and transported from island to island by their owners. We may suppose, however, that this was not true to any great extent for rails in general feed largely upon animal food and are not readily kept in captivity for any length of time.

CORVUS LEUCOGNAPHALUS Daudin.

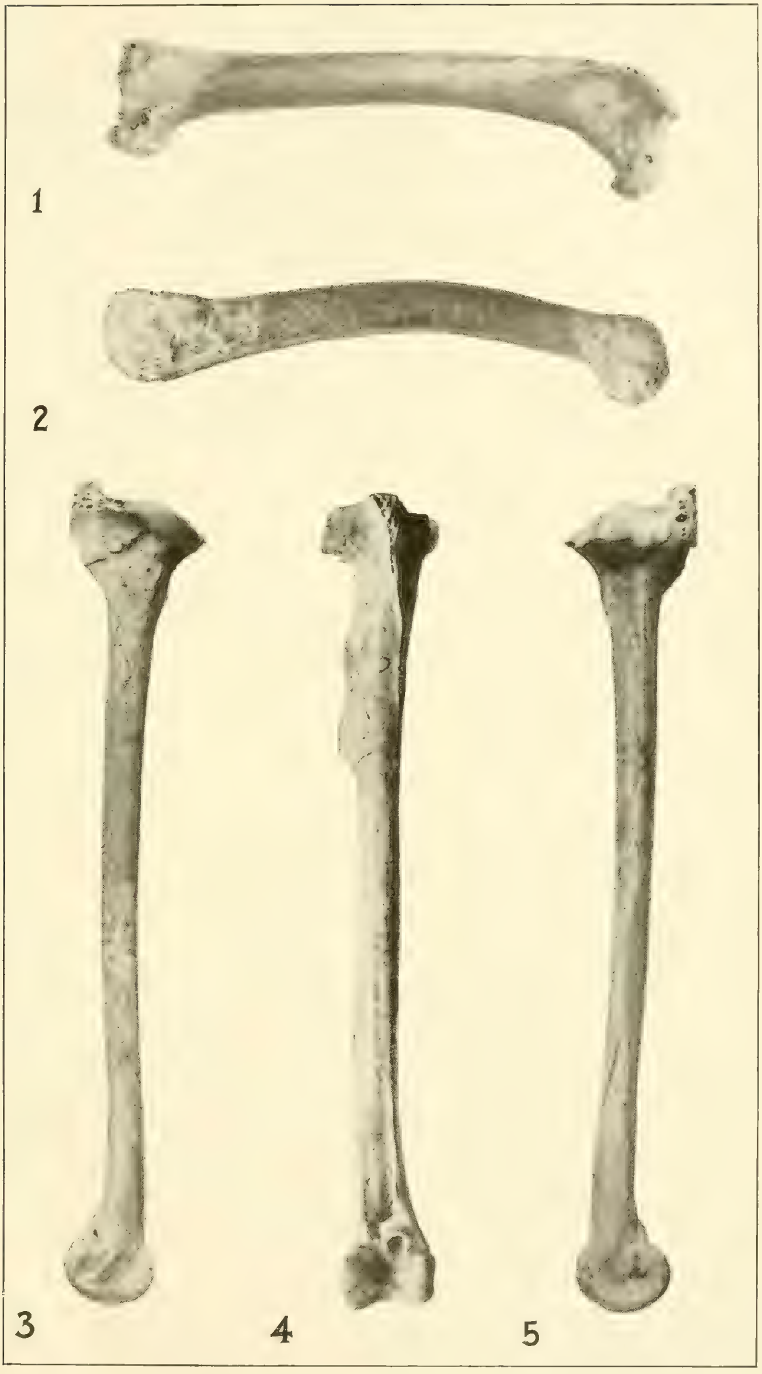
The discovery of bones of *Corvus* in these kitchen midden deposits is of great interest, as no species of this genus has been recorded farther east in the West Indies than Porto Rico. The crow is represented in the present collection by a femur, one nearly entire humerus, and the proximal end of a second one. These bones are identical in configuration with the form found in Porto Rico save that the entire humerus has the shaft more slender. Humeri of male birds only are available for comparison so that this difference may be considered sexual as males and females of *Corvus brachyrhynchos* Brehm from the United States differ in the same way.

The presence of these bones in kitchen midden deposits is of course not certain proof of the former presence of a crow native to St. Croix, but may be taken as representing a possibility. Crows may have been kept captive in cages and transported from island to island or may have been killed and eaten on Porto Rico and their bones brought in some way to St. Croix. That there might have been an indigenous bird of this genus in St. Croix is made somewhat probable by the fact that the island when first discovered was covered by dense forests such as crows inhabit in Porto Rico at the present time. The French who founded a colony on St. Croix some time after 1650 (the island was first settled about 1625) found their settlement very unhealthy. After severe losses from fevers and other diseases fostered, as they thought, by the dense, damp tree growth they finally set fire to the forest and burned off the densely wooded covering of the entire island. To this great conflagration may be ascribed the present-day paucity of species that make up the existing island fauna as there can be no question but that many indigenous forms were destroyed either by the fire or by the sudden change in ecological conditions that followed it. Elsewhere in the West Indies species of the genus *Corvus* have retreated before the clearing of forested areas. This is especially true in Porto Rico where Gundlach found *Corvus leucognaphalus* common in 1875, while at the present time the few known survivors of this bird are restricted to the Luquillo Forest above Mameyes, the only wooded area of any extent remaining on the island. Complete destruction of the forests of St. Croix might therefore have led to the extermination of the crow had it been resident there in pre-Columbian times.

EXPLANATION OF PLATE 82.

(All figures about natural size.)

FIGS. 1–2. Right femur of *Nesotrochis debooyi* type, Cat. No. 225845,U.S.N.M.
3–5. Right tibio-tarsus of *Nesotrochis debooyi*, Cat. No. 225845, U.S.N.M.



FEMUR (1-2) AND TIBIO-TARSUS (3-5) OF NESOTROCHIS DEBOOYI

FOR EXPLANATION OF PLATE SEE PAGE 522

TWO NEW LAND SHELLS OF THE EPIPHRAGMOPHORA TRASKII GROUP.

By Paul Bartsch,

Curator, Division of Marine Invertebrates, United States National Museum.

My short paper on the Californian land shells of the *Epiphragmophora traskii* group [1] resulted in having a lot of land shells sent to me by west American collectors for classification.

Among these are two lots which represent races not heretofore described. They were collected by Mr. Herbert N. Lowe, of Long Beach, California, in mountains from which no material was available at the time the paper mentioned above was prepared. It is quite possible that careful collecting in the higher altitudes of other isolated peaks in Southern California and adjacent Mexican territory will bring additional forms to our attention.

Mr. Lowe has kindly donated both types to the United States National Museum, and I take great pleasure in bestowing the name *Epiphragmophora cuyamacensis lowei* on the new form from Palomar Mountain.

EPIPHRAGMOPHORA CUYAMACENSIS LOWEI, new subspecies.

Plate 83, figs. 1, 2, 3.

Shell very large, depressed, helicoid, broadly, openly umbilicated, horn colored, with a chestnut band at the periphery which is flanked on each side by a narrow zone, a little lighter than the general color of the shell. Nuclear whorls one and a half, moderately rounded, marked by retractively curved, incremental lines and scattered papillae. Postnuclear whorls marked by somewhat irregularly spaced and irregularly developed, retractively slanting, depressed lirations, which give to the surface a somewhat roughened aspect, and rather strongly developed, elongated papillae which are arranged in series that form curves, slanting in just the opposite direction from the incremental lines. These papillae are rather regularly developed and quite evenly distributed on the upper surface; on the lower surface they are shorter and inclined to be hemispherical.

[1] Proc. U. S. Nat. Mus., vol. 51, pp. 609–619, pls. 114–117, 1916.

Here, too, they are quite regularly distributed, but a little more densely spaced immediately behind the aperture than on the rest of the shell. Aperture large; outer lip very slightly reflected; inner lip expanded at the base and slightly reflected over the umbilicus; parietal wall covered by a thin callus.

The type (Cat. No. 216906, U.S.N.M.) has six whorls and measures—altitude, 15.9 mm.; greater diameter, 26.7 mm.; lesser diameter, 21.2 mm. It comes from Palomar Mountain, which Mr. Lowe informs me is sometimes called Smith Mountain. He states further that this is a detached mountain midway between the San Jacintos on the north and the Cuyamacas on the south. He says that it is about 5,700 feet at the highest peak, and that the shell was obtained at an altitude of 5,000 feet.

EPIPHRAGMOPHORA TRASKII ISIDROENSIS, new subspecies.

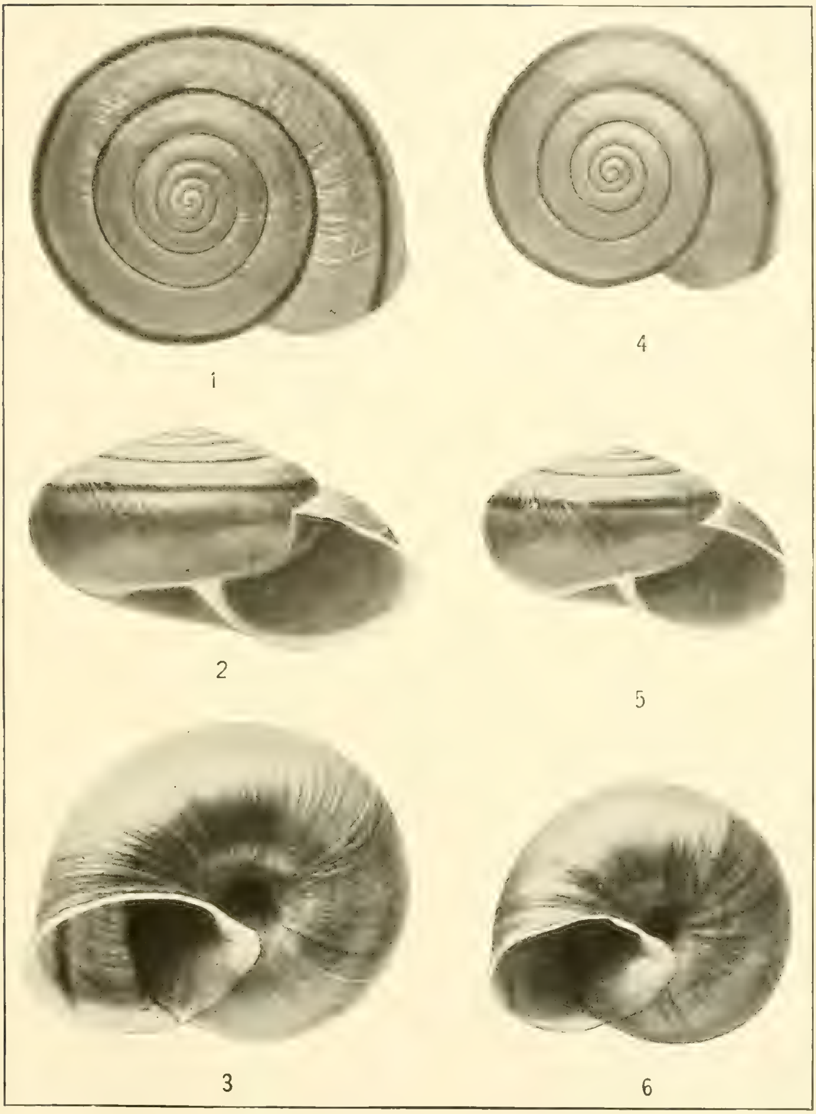
Plate 83, figs. 4, 5, 6.

Shell depressed, helicoid, horn-colored, with a broad chestnut band at the periphery, that is edged on either side by a somewhat lighter zone than the general tint of the shell, which is almost as wide as the brown band. Nuclear whorls one and three-quarters, moderately rounded, densely covered with small papillae, which gives the entire surface a granulose appearance. The succeeding whorls are marked by decidedly, obliquely curved, retractive lines of growth and rows of well rounded, small papillae which form lines practically at right angles to the lines of growth. In addition to this sculpture the last two whorls are marked by rather distantly spaced, somewhat interrupted, feebly incised spiral lines. Base well rounded, with a moderately broad umbilicus, which is almost half covered by the reflected inner lip, marked by strong incremental lines and the weakly incised spiral striations which equal those on the upper surface. The general papillation is absent on the lower surface excepting immediately behind the aperture where there is a dense massing of very fine granules, which is also the case on the upper surface. Aperture large, subcircular; outer lip very slightly reflected; inner lip broadly expanded at the base and reflected to half cover the umbilicus.

The type and another specimen were collected by Mr. H. N. Lowe on Campo San Isidro Mountain on the Mexican border. The type (Cat. No. 216907, U.S.N.M.) has 5.5 whorls and measures—altitude, 13.5 mm.; greater diameter, 21.3 mm.; lesser diameter, 17.6 mm. The other specimen, which is in Mr. Lowe's collection, is not quite mature.

EXPLANATION OF PLATE 83.

FIGS. 1, 2, and 3. *Epiphragmophora cuyamacensis lowei.*
4, 5, and 6. *Epiphragmophora traskii isidroensis.*



NEW LAND SHELLS FROM CALIFORNIA

FOR EXPLANATION OF PLATE SEE PAGE 524

REPORT ON THE CALCAREOUS SPONGES COLLECTED DURING 1906 BY THE UNITED STATES FISHERIES STEAMER ALBATROSS IN THE NORTHWESTERN PACIFIC.

By Sanji Hōzawa,

Of the Science College, Tokyo Imperial University.

INTRODUCTION.

A number of calcareous sponges were set aside by Prof. I. Ijima from among the Hexactinellid material collected by the United States Fisheries steamer *Albatross* during her cruise in the northwest Pacific in 1906, and now being worked over by him for report. The Calcarea specimens were kindly placed in my hand for examination. Small as the collection is, it proved to be a highly interesting one, in that it was found to comprise in all 13 species, of which 11 seem to be new to science.

The following is the list of the species:

Family HOMOCOELIDAE Dendy.

1. *Leucosolenia albatrossi*, new species.
2. *Leucosolenia canariensis* (Michlucho-Maclay).

Family SYCETTIDAE Dendy.

3. *Sycon simushirensis*, new species.

Family HETEROPIIDAE Dendy.

4. *Heteropia medioarticulata*, new species.

Family GRANTIIDAE Dendy (emend).

5. *Grantia nipponica*, new species.
6. *Grantia beringiana*, new species.
7. *Achramorpha diomediae*, new species.
8. *Leucandra tuba*, new species.
9. *Leucandra poculiformis*, new species.
10. *Leucandra foliata*, new species.
11. *Leucandra kurilensis*, new species.
12. *Leucandra splendens*, new species.
13. *Leucopsila stylifera* (O. Schmidt).

Next follows a list of the stations, showing their position, depth, and the species obtained at each:

Station 4777. 52° 11′ N.; 179° 49′ E.; about 12 miles north of Semisopochnoi Island, Aleutian Islands; 52 fathoms____*Leucandra poculiformis*, new species.

Station 4788. 54° 50′ 24″ N.; 167° 13′ E.; 8.8 miles southwest of north point of Copper Island, Comandorski Islands; 57 fathoms — *Leucosolenia albatrossi*, new species. *Grantia beringiana*, new species.

Station 4789. 54° 49′ 45″ N.; 167° 12′ 30″ E.; 9.1 miles southwest of north point of Copper Island, Comandorski Islands; 56 fathoms — *Leucosolenia albatrossi*, new species. *Leucosolenia canariensis*.

Station 4790. 54° 38′ 45″ N.; 167° 11′ 45″ E.; 15 miles northwest of Cape Monati, Bering Island, Comandorski Islands; 64 fathoms — *Leucandra splendens*, new species. *Leucopsila stylifera*.

Station 4792. 54° 36′ 15″ N.; 166° 57′ 15″ E.; 8.2 miles southeast of Cape Monati, Bering Island, Comandorski Islands; 72 fathoms — *Leucandra splendens*, new species. *Leucopsila stylifera*.

Station 4803. 46° 42′ N.; 151° 45′ E.; 9 miles southeast of Cape Rollin, Simushir Island, Kurile Islands; 229 fathoms — *Sycon simushirensis*, new species. *Grantia nipponica*, new species. *Achramorpha diomediae*, new species. *Leucandra kurilensis*, new species. *Leucopsila stylifera*.

Station 4822. 37° 8′ 10″ N.; 137° 8′ E.; 4.5 miles northeast of Nosaki, Notojima, Noto; 130 fathoms — *Grantia nipponica*, new species.

Station 4877. 34° 20′ 30″ N.; 130° 11′ E.; 6.3 miles northeast of Okinoshima, Chikuzen, Kiushu; 59 fathoms — *Leucandra tuba*, new species.

Station 4894. 32° 33′ N.; 128° 32′ 10″ E.; 5 miles southwest of Osesaki, Hizen, Kiushu; 95 fathoms — *Leucandra foliata*, new species.

Station 5017. 46° 43′ 30″ N.; 143° 45′ E.; 12.5 miles southeast of Cape Tonin, Saghalin; 64 fathoms — *Heteropia medioarticulata*, new species.

Station 5024. 48° 43′ 10″ N.; 144° 59′ 30″ E.; northeast of Cape Patience, Saghalin; 67 fathoms — *Heteropia medioarticulata*, new species.

DESCRIPTION OF THE SPECIES.

1. LEUCOSOLENIA ALBATROSSI, new species.

Plate 84, fig. 1.

This new species is represented in the collection by two specimens obtained at two closely situated stations off Copper Island. Both are nearly alike in appearance and structure, only differing in size. I have selected the smaller specimen from Station 4788 as the type (Cat. No. 9182 U.S.N.M.), of which a portion (about one-third of the whole) is shown in natural size in plate 84, figure 1.

Structure.—The type-specimen forms an irregularly shaped colony consisting of numerous proliferous lobes of varying size and shape. The lobes are somewhat lamellar, irregularly ascending, and folded. They are hollow, the pseudogaster extending into them in the form of slitlike spaces. The pseudoscula, found in a few number on the upper surface of the sponge, measure up to about 7 mm. in diameter. They are each provided with an irregularly undulating membrane. The wall of the pseudogaster, ½–1 mm. thick, is made up of a close reticulation of ascon tubes. It appears on the outer surface closely and minutely punctate from the presence of very numerous pseudopores, which lead into the interspaces between the ascon tubes. The pseudopores are, as usual, circular, with a diameter of 150–500μ. The ascon tubes are 150–450μ wide. The inner surface of the wall is perforated by numerous small oscula of 100–700μ diameter, each leading into a single or more gastral cavities of the ascon tubes. The prosopyles are circular appertures of about 20μ diameter.

The color of the sponge in alcohol is white, with a slight yellowish tint. Under the microscope there are visible in the wall numerous spherical granules of a yellowish color and with a diameter of 4–12μ. The sponge readily falls into pieces, being of a very delicate texture.

The skeleton consists of triradiates, quadriradiates, and oxea. The main part of the ascon wall is composed of triradiates and quadriradiates, both of which are arranged promiscuously in a single layer. the apical rays of the latter projecting into the gastral cavity, but

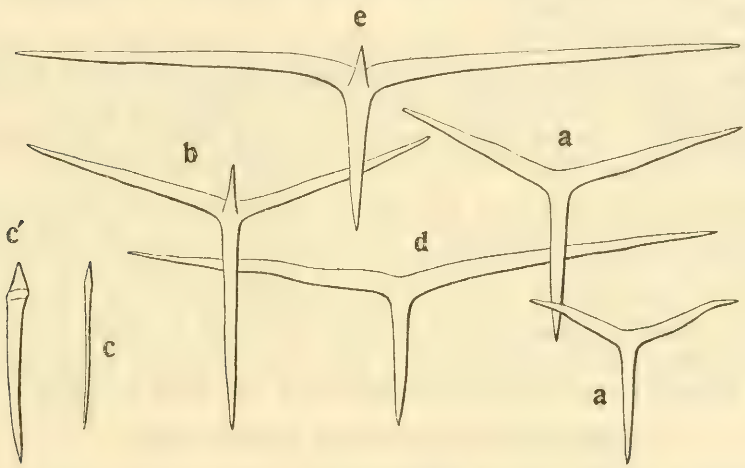


FIG. 1.—LEUCOSOLENIA ALBATROSSI. *a*, TRIRADIATES OF ASCON-TUBE. *b*, QUADRIRADIATE OF ASCON-TUBE. *c*, OXEA OF ASCON-TUBE. *c′*, SAME SEEN FROM SIDE. *d*, TRIRADIATE OF THE LINING LAYER OF PSEUDOGASTER. *e*, QUADRIRADIATE OF THE LINING LAYER OF PSEUDOGASTER. All $\times 300$.

otherwise without any definiteness in the orientation of the rays of both. The skeletal layer lining the pseudogaster, and having a thickness of nearly 40μ, is made up of a somewhat different kind of triradiates and quadriradiates, both of which are fairly closely arranged in a few layers, the apical rays of the latter projecting into the pseudogaster. The oxea occur in a few number only in the outer parts of ascon tubes, running parallel to the tube surface, but showing no rule as to the direction they take.

Spicules (fig. 1).—Triradiates of ascon tubes (*a*) slightly sagittal, with paired rays slightly longer than basal ray. All rays are of equal thickness. Paired rays very slightly curved, often somewhat crooked, sharply pointed, 80–100μ long and 8μ thick at base. Basal ray straight, tapering gradually to sharp point, 70–90μ long and 8μ thick at base.

Quadriradiates of ascon tubes (*b*) nearly similar to the above triradiates except in the presence of apical ray. This is much shorter and slightly thinner than facial rays, gradually tapering and sharply pointed, slightly curved upwards, 40–60μ long and 6μ thick at base.

Oxea of ascon tubes (*c*) with distinct sharply pointed lance head, more or less curved, broadest at the lance head, 70–90μ long and 8μ broad at head.

Triradiates of the lining layer of pseudogaster (*d*) strongly sagittal, with paired rays much longer than basal ray and standing nearly at right angles to the latter. Basal ray straight, sometimes slightly thinner than paired rays, 60–90μ long and 8μ thick at base. Paired rays nearly straight except for the slight curvature at base, rarely crooked, gradually tapering to sharp point, 130–240μ long and 8–12μ thick at base.

Quadriradiates of the lining layer of pseudogaster (*e*) nearly similar to the triradiates just mentioned, but with a short slender curved apical ray of 40–60μ length and 6–8μ thickness at base.

Localities.—Off the north point of Copper Island, Comandorski Islands (Station 4788, 57 fathoms; Station 4789, 56 fathoms).

Remarks.—This species can not be identified with any species already known of the genus. The canal system of the reticulate type D[1] and the sagittal triradiates and quadriradiates in the lining layer of pseudogaster appear to be characteristic to it. The oxea closely resemble those of *Leucosolenia variabilis* Haeckel, *L. botryoides* (Ellis and Solander), etc. The other specimen from station 4789 alluded to above is entered under Cat. No. 9180, U.S.N.M.

2. LEUCOSOLENIA CANARIENSIS (Michlucho-Maclay).

Plate 84, fig. 2.

Nardoa canariensis Michlucho-Maclay, Jenaische Zeitschr., vol. 4, 1868, p. 230.
Nardoa sulphurea Michlucho-Maclay, Jenaische Zeitschr., vol. 4, 1868, p. 230.
Nardoa rubra Michlucho-Maclay, Jenaische Zeitschr., vol. 4, 1868, p. 230.
Tarroma canariense Haeckel, Prodromus, 1870, p. 244.
Tarroma rubrum Haeckel, Prodromus, 1870, p. 245.
Ascaltis canariensis Haeckel, Kalkschwämme, 1872, p. 52, pl. 9, figs. 1–3; pl. 10, figs. 1, *a–c*.
Ascaltis compacta Schuffner, Jenaische Zeitschr., vol. 11, 1877, p. 404, pl. 25, fig. 9.
Leucosolenia nanseni Breitfuss, Zoologische Anzeiger, vol. 19, 1896, p. 427; Zoologische Jahrb. Syst., Abt. 10, 1898, p. 106, pl. 12, figs. 1–9.
Leucosolenia canariensis Lakschewitsch, Zoologische Jahrb., vol. 1, 1886, p. 300, pl. 7, fig. 1.—Thacker, Proc. Zool. Soc. London, 1908, p. 762, pl. 40, fig. 3, text-figs. 157–160.—Dendy and Row, Proc. Zool. Soc. London, 1913, p. 724.

The collection contains a single specimen of this species (Cat. No. 9181, U.S.N.M.). The sponge (pl. 84, fig. 2) consists of a massive

[1] Dendy, A. A Monograph of the Victorian Sponges, Pt. I. The Organization and Classification of the Calcarea Homocoela, with descriptions of the Victorian Species. Trans. Roy. Soc. Victoria, vol. 3, No. 1, 1891, pp. 30–32.

assemblage of recticulating ascon tubes. It is of a flattened oval shape, broadest at the upper end and narrowed toward the lower end, which forms a short stalk for attachment. It is apparently devoid of either an osculum or a pseudosculum. Total length about 15 mm.; greatest breadth about 10 mm. The thickness is about 5 mm. as measured in the thickest part. The entire outer surface of the sponge seems to be covered with a finely folded continuous membrane. The recticulation of ascon tubes is rather loose. Grayish white in alcohol. Soft and delicate in texture.

Structure.—The bad state of preservation of the specimen made it difficult to ascertain the fine internal structure. However, it is probable that the ascon tubes have no papillae on the inner surface.

The skeleton is composed of triradiates and quadriradiates, arranged in a single layer in the wall of ascon tubes. Some of the former are provided with a small knob representing the rudimentary apical ray. The latter occur relatively sparsely and mixed together with the triradiates; their apical rays project into the gastral cavity. There is no conspicuous difference in size between the dermal and the more deeply situated spicules.

Spicules.—Triradiates regular, with rays straight, usually somewhat bluntly and sometimes sharply pointed, rather slender, 50–140μ long and 6–12μ thick at base.

Quadriradiates of the same shape and size as the triradiates, but with a short, slender, straight, and sharply pointed apical ray. In an example of the spicule, the apical ray measured 30μ long and 2μ thick at base.

Localities.—Canary Islands (Michlucho-Maclay, Haeckel); Cape Verde Islands (Thacker); Mauritius (Schuffner); Minorca (Lakschewitsch); Spitzbergen, Arctic Ocean (Breitfuss); off the north point of Copper Island, Comandorski Islands (Station 4789, 56 fathoms).

3. SYCON SIMUSHIRENSIS, new species.

Plate 84, fig. 6.

This new species is based on a single specimen in the collection (Cat. No. 9170 U.S.N.M.). It is a small solitary individual (pl. 84, fig. 6) of a slightly laterally compressed tubular shape, narrowed at base, which is torn off. The osculum at the upper end is in a collapsed state. Length about 9 mm.; the greatest breadth about 2 mm.; thickness of wall not over 0.4 mm. To the naked eye both dermal and gastral surfaces appear nearly smooth. Color grayish white in alcohol. Texture moderately firm.

Structure.—The canal system is of the syconoid type. The flagellate chambers are arranged radially around the rather wide gastral cavity; they are more or less united at places where they come into contact with one another.

The articulate tubar skeleton is composed of triradiates, its proximal joints being formed by the basal rays of subgastral triradiates. Those tuber triradiates which form the distal joints have the basal rays grouped into tufts together with a number of oxea. The gastral skeleton is made up of triradiates, quadriradiates, and the paired rays of subgastral triradiates. The two former are fairly regularly arranged around gastral apertures with basal rays directed downward and with apical rays projecting into the gastral cavity. The quadriradiates are much less numerous than the triradiates. The oscular margin is very thin, but richly supplied with spicules; externally

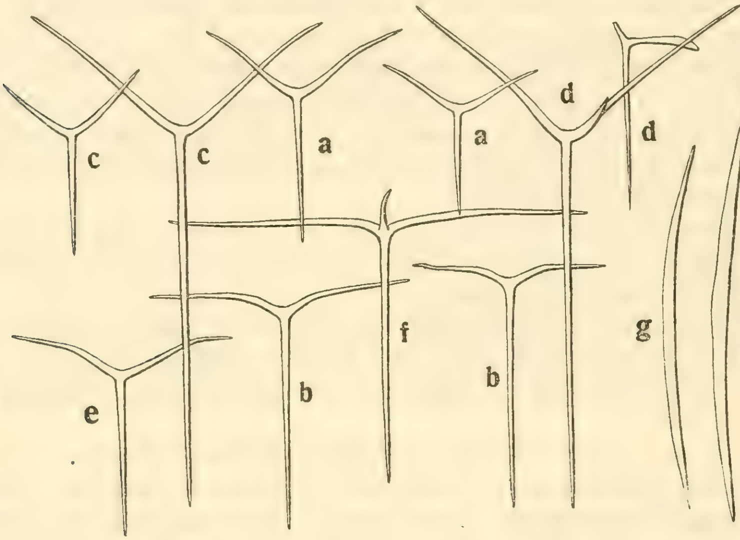


FIG. 2.—SYCON SIMUSHIRENSIS. *a*, TUBAR TRIRADIATES. *b*, SUBGASTRAL TRIRADIATES. *c*, GASTRAL TRIRADIATES. *d*, GASTRAL QUADRIRADIATES. *e*, TRIRADIATE OF OSCULAR MARGIN. *f*, QUADRIRADIATE OF OSCULAR MARGIN. *g*, OXEA OF OSCULAR MARGIN. All ×150.

there are found triradiates, large oxea, and linear spicules, all which form a thin fringe, and internally there exist quadriradiates in a layer. Both the tri- and the quadriradiates lie tangentially with downwardly directed basal rays.

Spicules.—Tubar triradiates (*a*) slightly sagittal with slender rays. Basal ray longer and slightly thinner than paired rays, tapering from base to sharp point, straight, 100–140μ long and 6μ thick at base. Paired rays slightly doubly curved forewards in basal parts and backwards in the remaining parts; 90–100μ long and 8μ thick at base. Subgastral triradiates (*b*) sagittal. All rays slender, tapering from base to sharp point, not lying in the same plane. Basal ray distinctly longer than paired rays, straight, about 200μ long and 6–8μ thick at base. Paired rays strongly diverging, distinctly curved at a point a short distance from base, 80–120μ long and 6–8μ thick at base.

Gastral triradiates (*c*) sagittal. All rays slender, equally thick, tapering to sharp point. Basal ray straight, much longer than paired rays, 110–330μ long and about 8μ thick at base. Paired rays nearly equal, slightly doubly curved, first forewards and then backwards; 70–180μ long and about 8μ thick at base.

Gastral quadriradiates (*d*) similar to gastral triradiates, except in the presence of apical ray. Apical ray much shorter than facial rays, slightly curved and gradualy tapering to sharp point, 40–80μ long.

Oxea at distal end of flagellate chambers generally slightly curved, sharply pointed at both ends, about 80μ long and 4μ thick.

Triradiates of oscular margin (*e*) sagittal. All rays nearly equally thick, tapering from base to sharp point. Basal ray straight, slightly longer than paired rays. Paired rays rather strongly divergent, distinctly bent at the middle of their length. In an example of the spicule the basal ray measured 140μ long and 6μ thick at base, and the paired rays 110μ long and 6μ thick at base.

Quadriradiates of oscular margin (*f*) very strongly sagittal. Basal ray straight, sharply pointed, slightly longer than paired rays. Paired rays sightly curved at base, otherwise nearly straight, standing nearly at right angles to basal ray. Apical ray short, tapering to sharp point. In a large example of the spicule the basal ray measured 250μ long and 6μ thick, and the paired rays 190μ long and 8μ thick at base.

Oxea of oscular margin (*g*) spindle-shaped, slightly curved, generally thickest nearer inner than outer end, about 370μ long and 12μ thick.

Linear spicules of oscular margin straight or slightly curved, sharply pointed at both ends, 240μ or more long and 2–4μ thick.

Locality.—Off Cape Rollin, Simushir Island, Kuriles (Station 4803, 229 fathoms).

4. HETEROPIA MEDIOARTICULATA, new species.

Plate 84, fig. 7.

Four specimens of this new species exist in the collection. They are all of a closely similar appearance, being of a more or less bent and laterally compressed tubular shape, attached by the narrowed stalk-like base and showing at the somewhat contracted upper end an osculum, which is surrounded by a trace of a collar.

The largest specimen (pl. 84, fig. 7), which I make the type of the species (Cat. No. 9186 U.S.N.M.), is nearly 40 mm. long and 10 mm. broad in the broadest part, where the wall is about 2 mm. thick. The oval osculum measures 3 mm. by 2 mm. across. The dermal surface is nearly smooth though not quite even. The gastral surface appears slightly hispid, due to the projecting apical rays of gastral quadriradiates. The color in alcohol is grayish white. The texture is pretty firm.

Structure.—The canal system is typically syconoid. The dermal cortex is rather thin, the gastral cortex thicker. Flagellate chambers are radially arranged around the gastral cavity. They are cylindrical, almost straight, slightly narrowed distally and scarcely branching. Each flagellate chamber communicates with the gastral cavity by means of a very short exhalant canal. The meshes of the lacework formed by the gastral spicules constitute the openings of exhalant canals into the gastral cavity. They are angularly circular or oval with a diameter of about $\frac{1}{3}$ mm.

The dermal skeleton is made up of oxea and of the paired rays of subdermal pseudosagittal triradiates. The oxea run somewhat longitudinally in a few layers, parallel to the surface. There may occur very slender hair-like oxea grouped into small sparsely distributed tufts, which project on the dermal surface. The tubar skeleton is composed of the centripetal basal rays of subdermal pseudosagittal triradiates, of the centrifugal basal rays of subgastral sagittal triradiates, and of tubar triradiates which are placed in several layers between the spicules just mentioned. The gastral skeleton consists of the paired rays of subgastral sagittal triradiates, of gastral triradiates arranged in several layers, and of a small number of gastral quadriradiates, the apical rays of which project into the gastral cavity pointing upwards. The basal rays of gastral tri- and quadriradiates are directed towards the sponge base and are grouped into bundles. The skeleton of the oscular margin is a close-meshed reticulum formed by fine longitudinally disposed linear spicules and by triradiates with strongly divergent paired rays.

Spicules.—Subdermal triradiates (*a*) pseudosagittal, irregular. All rays nearly equally thick, gradually tapering to sharp point, not lying in the same plane. Basal ray longer than paired rays, usually nearly straight except for a slight curvature at base, sometimes crooked, 140–240μ long and 12μ thick at base. Paired rays unequally long and differently shaped. The longer ray nearly twice as long as the shorter, doubly flexed, curving first backwards and then slightly forewards, sometimes crooked, 100–160μ long and 12μ thick at base. The shorter ray not straight, being distinctly curved in the middle parts, 60–80μ long and 12μ thick at base.

Tubar triradiates (*b*) sagittal, more or less varying in size and shape. Rays nearly equally thick, gradually tapering to sharply pointed end, not lying in the same plane. Basal ray distinctly or sometimes only slightly longer than paired rays, straight, 170–290μ long and 12μ thick at base. Paired rays slightly curved, rather irregular in outline, 100–190μ long and 12μ thick at base.

Subgastral triradiates (*c*) sagittal, with wide oral angle. All rays equally thick, lying nearly in the same plane and gradually tapering to sharp point. Basal ray slightly longer than paired

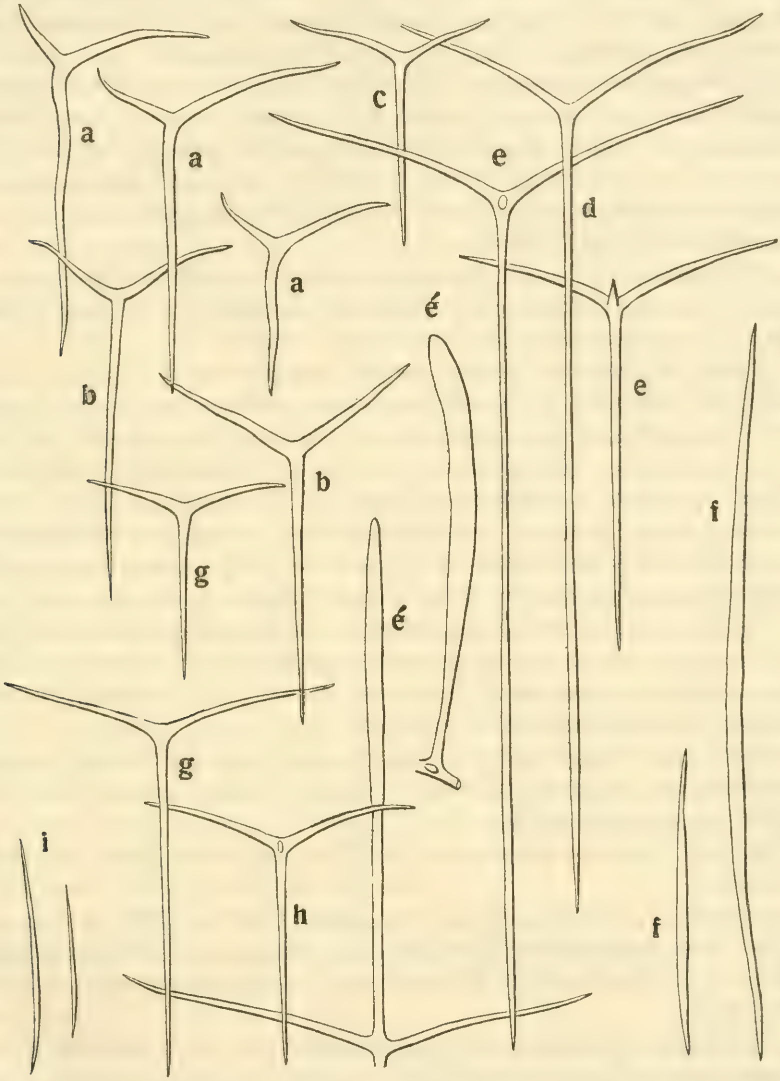


FIG. 3.—HETEROPIA MEDIOARTICULATA. *a*, SUBDERMAL TRIRADIATES. *b*, TUBAR TRIRADIATES. *c*, SUBGASTRAL TRIRADIATE. *d*, GASTRAL TRIRADIATE. *e*, GASTRAL QUADRIRADIATES. *e'*, APICAL RAYS OF GASTRAL QUADRIRADIATES. *f*, DERMAL OXEA. *g*, TRIRADIATES OF OSCULAR MARGIN. *h*, QUADRIRADIATE OF OSCULAR MARGIN. *i*, OXEA OF OSCULAR MARGIN. All ×150.

rays, straight, 170–200µ long and 10–12µ thick at base. Paired rays nearly equal, curving first backwards, and then very slightly forwards, 90–140µ long and 10–12µ thick at base.

Gastral triradiates (*d*) strongly sagittal, slender-rayed. Basal ray much longer than paired rays, straight, perceptibly narrowed in the middle parts, ending in sharp point, 560–730μ long and 8–12μ thick at base. Paired rays equal or but slightly differentiated in length, gradually tapering, showing more or less distinct double curvature, 180–240μ long and 8–12μ thick at base.

Gastral quadriradiates (*e*) similar to gastral triradiates, differing only in the presence of apical ray. Apical ray (*e′*) very strong, variable in length, slightly curved upwards, strongly laterally compressed, irregular in outline, narrow at base and broadening distally to terminate with obtuse end, 260–470μ in length, 16μ in breadth, and up to 25μ in thickness.

Dermal oxea (*f*) elongate spindle-shaped, usually slightly curved, rather irregular in outline, more or less sharply pointed at ends, 470–700μ long and 12–16μ thick in the middle.

Linear spicules of dermal cortex very slender, hair-like, straight, sharply pointed at both ends, may measure 240μ long and 1μ thick.

Triradiates of oscular margin (*g*) strongly sagittal. All rays nearly equally thick, gradually tapering. Basal ray straight, very finely pointed, 150–300μ long and 10–12μ thick at base. Paired rays strongly diverging, sharply pointed, slightly curved backwards in basal parts and either straight or slightly curved forewards in the remaining parts, 100–150μ long and 10–12μ thick at base.

Quadriradiates of oscular margin (*h*) like the triradiates of oscular margin except in the presence of apical ray. Apical ray much shorter than either basal or paired rays, slightly curved and very sharply pointed, directed upwards.

Oxea of oscular margin (*i*) slender, slightly curved, broadest nearer one end than the other, sharply pointed at both ends, 150–230μ long and 4μ thick.

Linear spicules of oscular margin similar to those of dermal cortex.

Localities.—Off Cape Tonin, Saghalin (Station 5017, 64 fathoms), Cat. No. 9186, U.S.N.M., type and paratype; off Cape Patience, Saghalin (Station 5024, 67 fathoms), two specimens, Cat. No. 9087, U.S.N.M.

Remarks.—This species is remarkable for the presence of some intermediate layers of triradiates, indicative of the articulate tubar skeleton, between the centripetally and centrifugally directed basal rays of subdermal and subgastral triradiates.

5. GRANTIA NIPPONICA, new species.

Plate 84, fig. 8.

This new species is represented in the collection by three specimens. The sponge represents a solitary person of a slightly laterally compressed tubular form, gradually narrowed toward the base and showing at the upper truncate end an oval osculum provided with a weakly developed collar. The dermal surface is nearly smooth or slightly hispid. The gastral surface is distinctly echinated by the projecting apical rays of gastral quadriradiates.

The largest specimen (pl. 84, fig. 8), which I have selected as the type (Cat. No. 9188 U.S.N.M.), is 52 mm. long, 7 mm. broad in the middle and 4 mm. broad at base. The sponge wall is about 1 mm. thick. The osculum is 4 mm. long and 2 mm. wide. The color in alcohol is grayish white; the texture pretty firm.

Structure.—Dermal and gastral cortices are pretty well developed, containing some quantity of mesogloea. The former is slightly thicker than the latter. The canal system is of the syconoid type. The flagellate chambers are arranged radially around the gastral cavity. They are straight, circular in cross-section, nearly equally wide in all parts, unbranched or very slightly branched, and open either separately or several together through an exhalant canal into the gastral cavity. Further details concerning the soft parts could not be ascertained owing to the bad state of preservation.

The dermal skeleton is composed of triradiates which are either tangentially or more or less confusedly arranged in several layers. Oxea in sparse distribution project to a slight degree and nearly vertically from the dermal surface. The tubar skeleton is of the many-jointed articulate type. The gastral skeleton is made up of (1) the paired rays of subgastral triradiates, (2) gastral triradiates occuring generally in groups and with downwardly pointed basal rays, (3) gastral quadriradiates with their prolonged apical rays projecting into the gastral cavity, and (4) the small quadriradiates which surround the exhalant canals. The skeleton of oscular collar consists of oxea in two kinds and of triradiates and quadriradiates, all being closely set together. The last named two kinds of spicules have basal rays directed downwards.

Spicules.—Dermal triradiates (*a*) slightly sagittal or subregular. Rays equally thick, straight and gradually tapering to sharp point, not lying in the same plane but directed slightly inwards, 80–160μ long and 12–16μ thick at base.

Tubar triradiates (*b*) sagittal. Rays straight, sharply pointed, nearly equally thick, not lying all in one plane. Basal ray about one and half as long as paired ray, 130–160 μ long and 12 μ thick at base. Paired rays nearly equal, 70–90 μ long and 12 μ thick at base.

Subgastral triradiates (*c*) differing from the tubar triradiates only in having more widely open oral angle. In a typical example, basal ray 180 μ long, paired rays 100 μ long, all 12 μ thick at base.

Gastral triradiates (*d*) sagittal, rather slender-rayed. Basal ray straight, much longer and slightly thinner than paired ray, nearly uniformly thick throughout, except at the thickened basal parts and the tapering and sharply pointed end, sometimes slightly narrowed in the middle parts, 350–500 μ long and 12 μ thick at base. Paired rays slightly irregular in outline, curving first backwards and then slightly forewards, about 190 μ long and 16 μ thick at base.

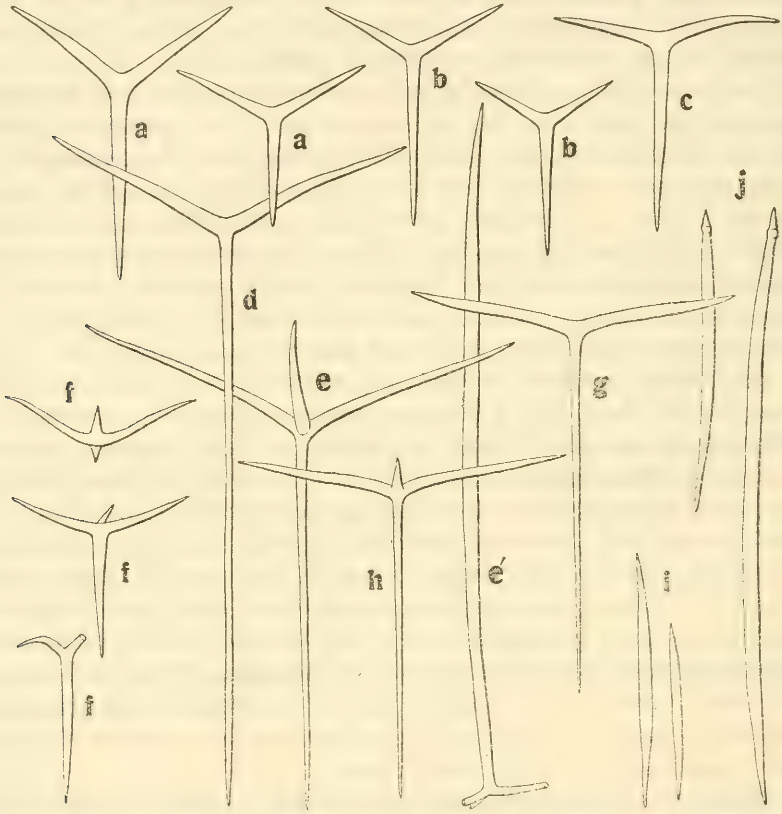


FIG. 4.—GRANTIA NIPPONICA. *a*, DERMAL TRIRADIATES. *b*, TUBAR TRIRADIATES. *c*, SUBGASTRAL TRIRADIATE. *d*, GASTRAL TRIRADIATE. *e*, GASTRAL QUADRIRADIATE. *e′*, APICAL RAY OF GASTRAL QUADRIRADIATE. *f*, QUADRIRADIATES OF EXHALANT CANALS. *f′*, SAME SEEN FROM LATERAL SIDE. *g*, TRIRADIATE OF OSCULAR COLLAR. *h*, QUADRIRADIATE OF OSCULAR COLLAR. *i*, OXEA PROJECTING FROM DERMAL SURFACE. *j*, OXEA OF OSCULAR COLLAR. All ×150.

Gastral quadriradiates (*e*) similar to the gastral triradiates, differing only in the presence of apical ray. Apical ray (*e′*) varying considerably in length, slightly curved upwards and occasionally at the same time crooked, nearly uniformly thick in the greater part of its length, but narrowed in the basal parts and at the pointed end, 330–700 μ long and 16 μ thick in the middle parts.

Quadriradiates of exhalant canals (*f*) small. Basal ray nearly straight, gradually tapering to sharp point, about 110 μ long and 10 μ thick at base. Paired rays nearly as long as but slightly narrower than basal ray; curved in accommodation to the curvature of exhalant canal, about 80 μ long and 6 μ thick at base. Apical ray (f') slender, sharply pointed, angularly curved in the middle, 30 μ long and 4 μ thick at base.

Triradiates of oscular collar (g) strongly sagittal. Basal ray much longer and thinner than paired rays, straight, finely pointed, 310 μ long and 10 μ thick at base. Paired rays very strongly diverging. standing nearly at right angles to basal ray, obsoletely showing double curvature, 160 μ long and 14 μ thick at base.

Quadriradiates of oscular collar (h) like the triradiates of same, except in the presence of apical ray. Apical ray much shorter than facial rays, never attaining so great a length as in gastral quadriradiates.

Oxea (i) slightly curved or nearly straight, sharply pointed at both ends, 130–300 μ long and 12 μ thick in the thickest parts.

Oxea of oscular collar (j) slightly curved and more or less irregular in outline, nearly uniformly thick for the most part of their length but tapering toward the pointed ends. Close to one end, provided with a feebly developed nodiform ring. They are 240–550μ long and 12–16μ thick in the middle.

Linear spicules of oscular collar slender, hair-like, straight, sharply pointed at both ends, the thickest part lying nearer one end than the other, 160–280μ long and 3μ thick.

Localities.—Off Nosaki, Notojima, Province Noto on the western coast of Japan (Station 4822, 130 fathoms); off Cape Rollin, Simushir Island, Kuriles (Station 4803, 229 fathoms).

Remarks.—The specimen from Station 4803 (Cat. No. 9172, U.S.N.M.) measures only about 11 mm. in total length and 2½ mm. in maximum breadth, the wall being nearly 0.4 mm. thick. It differs from the type-specimen in the smaller size of its spicules, in the less number of the layers of tubar triradiates, and in the presence of hair-like oxea projecting from the dermal surface. The most remarkable feature of the present species consists in the excessive prodongation of apical rays in gastral quadriradiates.

6. GRANTIA BERINGIANA, new species.

Plate 85, fig. 9.

A single specimen in the collection has served as the type of this new species (Cat. No. 9183, U.S.N.M.), Sponge (pl. 85, fig. 9), a solitary individual, cylindrical, slightly latellay compressed, broadened, and somewhat bent in the basal parts. The osculum at the upper end has a thin margin. The dermal surface is fairly hispid, due to projecting oxea. The gastral surface appears nearly smooth to the naked eye, in spite of numerous fine apical rays of gastral quadriradiates protruding through it. Total length of body 28 mm., greatest breadth about 10 mm., wall about 1 mm. thick, osculum about 5 mm. in major diameter. The color in alcohol is whitish. The texture is fairly firm and elastic.

Structure.—The dermal cortex is fairly thick. It is about 0.4 mm. thick. The gastral cortex is also well developed, but is distinctly thinner than the dermal, measuring about 0.25 mm. in thickness. The canal system is of the syconoid type. The flagellate chambers are rather short, cylindrical, straight, not unfrequently slightly branched; each passes at the apopyle into a long exhalant canal, a diaphragm occurring at the boundary. The dermal skeleton consists of few layers of triradiates, which are tangentially but otherwise rather irregularly disposed. Large oxea, grouped into small bundles and placed perpendicularly or somewhat obliquely to the dermal surface, project far beyond the surface, their proximal parts being deeply imbedded in the chamber layer. The tubar skeleton is made up of triradiates in two or three irregular layers, as well as of the basal rays of subgastral triradiates and quadriradiates. The gastral skeleton forms a thin layer, consisting mainly of gastral quadriradiates, of which the basal ray generally points toward the base and apical ray projects into the gastral cavity in oblique inclination toward the osculum. In addition to the quadriradiates there occur in the layer the paired rays of subgastral triradiates as well as the facial rays of subgastral quadriradiates. The skeleton of oscular margin consists of interlacing oxea, triradiates, and quadriradiates. The oxea are arranged longitudinally; the basal rays of tri- and quadriradiates are directed regularly downward.

Spicules.—Dermal triradiates (*a*) slightly sagittal. All rays slightly irregular in outline, nearly equally thick, lying in one plane. Basal rays nearly straight, usually slightly shorter than paired rays, 90–260μ long and 20μ thick at base. Paired rays subequal, nearly straight, excepting a slight curvature near base, 180–260μ long and 20μ thick at base.

Tubar triradiates (*b*) sagittal. Rays slightly irregular in outline, lying not in one plane. Basal ray much longer and slightly thicker than paired rays, nearly straight, 290–370μ long and 24–28μ thick at base. Paired rays slightly curved at base and nearly straight or weakly crooked in the remaining parts, 160–220μ long and 20–24μ thick at base.

Subgastral triradiates (*c*) strongly sagittal. Rays sharply pointed, nearly equally thick, lying not in one plane. Basal ray straight, much longer than paired rays, 150–240μ long and 12–16μ thick at base. Paired rays strongly diverging, curved rather angularly in the middle parts, 130–170μ long and 16–20μ thick at base.

Subgastrial quadriradiates (*d*) nearly similar to subgastral triradiates except in the presence of well-developed apical ray. Paired rays sometimes unequal. Apical ray very slender, slightly curved, sharply pointed, about 50μ long and 8μ thick at base.

Gastral quadriradiates (*e*) more or less sagittal. Rays nearly equally thick, gradually tapering to sharp point. Basal ray straight, longer than paired rays, 150-240μ long and 12–16μ thick at base. Paired rays usually slightly curved and irregular in outline, 110–170μ

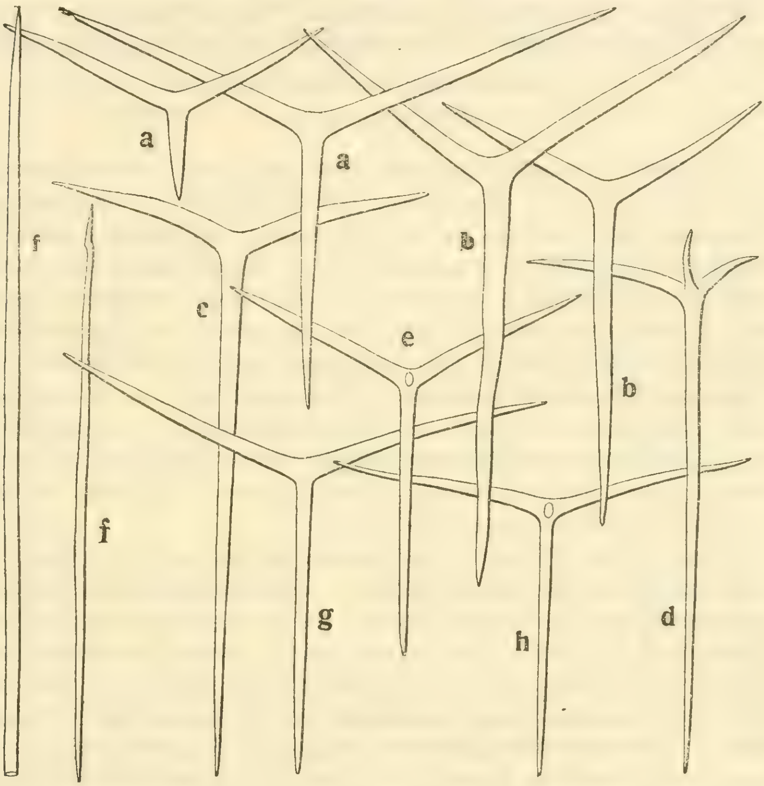


FIG. 5.—GRANTIA BERINGIANA. *a*, DERMAL TRIRADIATES. *b*, TUBAR TRIRADIATES. *c*, SUBGASTRAL TRIRADIATE. *d*, SUBGASTRAL QUADRIRADIATE. *e*, GASTRAL QUADRIRADIATE. *f*, OXEA. *g*, TRIRADIATE OF OSCULAR MARGIN. *h*, QUADRIRADIATE OF OSCULAR MARGIN. All $\times$150.

long and 16μ thick at base. Apical ray fairly well developed, slightly curved in distal parts, 100–210μ long and 12–16μ thick at base.

Large oxea (*f*) straight, nearly uniformly thick throughout entire length excepting the sharply pointed ends. A small example of the spicule measured 500μ long and 8μ thick; a large one over 1μ long by 12μ thickness.

Triradiates of oscular margin (*g*) strongly sagittal. Basal ray straight, slightly thinner than paired rays, finely pointed, 120–260μ long and 12–16μ thick at base. Paired rays strongly diverging, sharply pointed, 130–240μ long and 16–20μ thick at base.

Quadriradiates of oscular margin (*h*) strongly sagittal. Basal ray straight, finely pointed, 200–260μ long and 12μ thick at base. Paired rays strongly diverging, distinctly thicker than basal ray, obscurely showing double curvature, 160–200μ long and 16μ thick at base.

Large oxea of oscular margin similar to those which project from the dermal surface.

Locality.—Off the north point of Copper Island, Comandorski Islands (Station 4788, 57 fathoms).

Remarks.—This species resembles *Grantia comoxensis*[1], but shows some differences, chiefly in the external form and in the spiculation.

7. ACHRAMORPHA DIOMEDIAE, new species.

Plate 85, fig. 10.

The collection contains a single specimen of this new species (Cat. No. 9171, U.S.N.M.). The sponge (pl. 85, fig. 10) is in the form of a thin-walled and slightly curved cylindrical tube about 8 mm. long, inferiorly narrowed and swollen in the upper parts, the swelling beginning a little below the osculum. Maximum breadth of body 1½ mm. The terminal osculum leads into the gastral cavity of a habitus corresponding to that of the entire specimen. A feebly developed fringe exists around the osculum. The sponge wall is less than ½ mm. thick. The dermal surface is slightly hispid due to projecting oxas. The gastral surface is also more or less rough on account of the projecting apical rays of gastral quadriradiates. The color is nearly white in alcohol; the texture delicate.

Structure.—Both dermal and gastral cortices are very thin. The canal system is of the syconoid type. The flagellate chambers are of an elongate sac-like shape, circular or oval in cross-section with a diameter of 50–150μ. They extend nearly across the entire thickness of wall. Internally they communicate with exhalant canals which run through the gastral cortex before opening into the gastral cavity. The very wide inhalant canals start from beneath the dermal cortex and penetrate deeply into the interspaces between flagellate chambers.

The dermal skeleton is made up of tangential sagittal triradiates which are loosely distributed in a very thin layer with basal rays pointed downward. The larger oxea are grouped into tufts, with their proximal ends deeply stuck in the chamber layer and the distal ends projecting from the dermal surface. The tubar skeleton consists of the basal rays of subgastral triradiates and of the large oxea just mentioned. The gastral skeleton is composed of loosely arranged quadriradiates, lying parallel to the gastral surface in a single or two layers; their basal rays are directed toward the sponge base,

[1] *Grantia comoxensis* Lambe, Sponges from the Pacific Coast of Canada. Proc. and Trans. Roy. Soc. Canada, 1893, sec. 4, art. 3, pp. 39, 40, figs. 3, *a–c*.

while the apical rays project into the gastral cavity. The skeleton of the oscular margin is formed of two kinds of oxea forming a fringe and of very closely set triradiates and quadriradiates, both of which have very strongly diverging paired rays, the basal ray being directed downward in a regular manner.

Spicules.—Dermal triradiates (*a*) slightly sagittal, slender rayed. All rays nearly equally thick, tapering gradually to sharp point. Basal ray straight, slightly longer than paired rays, 140–240 μ long and 8–10 μ thick at base. Paired rays nearly equal, straight or slightly curved backward, 110–200 μ long and 8–10 μ thick at base.

Subgastral triradiates (*b*) strongly sagittal. All rays nearly equally thick, lying in one plane. Basal ray straight, tapering to

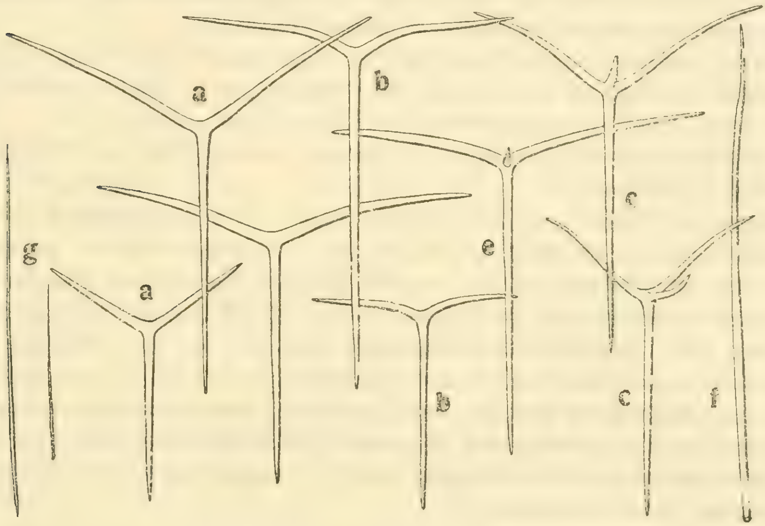


FIG. 6.—ACHRAMORPHA DIOMEDIAE. *a*, DERMAL TRIRADIATES. *b*, SUBGASTRAL TRIRADIATES. *c*, GASTRAL QUADRIRADIATES. *d*, TRIRADIATE OF OSCULAR MARGIN. *e*, QUADRIRADIATE OF OSCULAR MARGIN. *f*, OXEA PROJECTING FROM DERMAL SURFACE. *g*, OXEA OF OSCULAR MARGIN. All ×150.

fine point, 200–310 μ long and 8–10 μ thick at base. Paired rays strongly diverging, equal, nearly half as long as basal ray, curved backward at a point nearer the base than the sharply pointed end, 100–150 μ long and 8–10 μ thick at base.

Gastral quadriradiates (*c*) sagittal. Basal ray straight, much longer and slightly thicker than paired rays, 200–250 μ long and 10–12 μ thick at base. Paired rays equal, doubly curved, ending in sharp point, 110–150 μ long and 8–10 μ thick at base. Apical ray curved forward, tapering from base to very sharp point, about 100 μ long and 8 μ thick.

Triradiates of oscular margin (*d*) strongly sagittal. Basal ray straight, sharply pointed, slightly longer and distinctly thinner than paired rays, about 250 μ long and 12 μ thick at base. Paired rays strongly diverging, slightly curved backward, somewhat bluntly pointed, about 200 μ long and 16 μ thick at base.

Quadradiates of oscular margin (*e*) nearly similar to the triradiates of oscular margin, except in the presence of short apical ray, which is slightly curved upward and tapering from base to sharply pointed end. In a large example of the spicule the basal ray measured 26 μ long by 8 μ thick at base, and the paired rays 16 μ long by 12 μ thick at base.

Oxea projecting from dermal surface (*f*) not very stout, rather slender, straight or slightly curved, and nearly uniformly thick in the greater part of their length, though tapering at ends, which are finely pointed. The majority of these spicules are found broken. A large fragment measured about 600 μ in length and 8 μ in thickness. The same spicules occur also in the oscular margin.

Oxea proper to oscular margin (*g*) very slender, hair-like, nearly straight or slightly curved, thickest nearer inner than outer end; both ends finely pointed; 280–600 μ long and 2–4 μ thick.

Locality.—Off Cape Rollin, Simushir Island, Kuriles (Station 4803, 229 fathoms).

Remarks.—This new species may easily be distinguished from Jenkin's species *Achramorpha glacialis*,[1] *A. nivalis*[2] and *A. grandinis*,[3] by the presence of the gastral skeleton containing tangential quadriradiates as well as by the absence of microxea. The species differs from Topsent's *Achramorpha truncata*[4] by the presence of tangential quadriradiates in the gastral skeleton and by the different share and size of the oxea which project from the dermal surface; and finally from Breitfuss's *Achramorpha schulzei*[5] by the absence of microxea and by the different shape of subgastral triradiates and of gastral quadriradiates.

8. LEUCANDRA TUBA, new species.

Plate 84, fig. 3.

This species is based on a single specimen found in the collection. (Cat. No. 9184, U.S.N.M.) It consists of a mass of complexly anastomosing tubes (pl. 84, fig. 3), partly blind and partly provided with an osculum at the free end. The tubes are cylindrical or more or less laterally compressed, and may be 5–10 mm. wide at their base, where the wall is about 2 mm. thick. The osculum is naked and circular in outline with a diameter of 1½–2½ mm. Both dermal and gastral

[1] Jenkins, The Calcarea of the National Antarctic Expedition. Natural History Reports, vol. 4, 1908, pp. 31, 32, pl. 34, figs. 98–102.

[2] Idem, pp. 33–35, pl. 27, figs. 7, 8; pls. 35, 36, figs. 105–112.

[3] Idem, pp. 32, 33, pl. 27, fig. 4; pls. 34, 35, figs. 103, 104.

[4] *Grantia truncatu* Topsent, Éponges calcaires recueillis par le Français dans l'Antarctique. Bull. Mus. His. Nat., Paris, 1907, pp. 540, 541.

[5] *Ebnerella schulzei* Breitfuss, Kalkschwämme der Bremer Expedition nach Ost-Spitzbergen im Jahre 1889, Zool. Anzeiger, 1896, vol. 19, pp. 492, 430; Zool. Jahrb. Syst. Abt., 1898, vol. 11, pp. 113–115, pl. 13, figs. 39–52.

surfaces are smooth. The color in alcohol is white with a somewhat grayish tint. The texture is very compact and rather hard.
lation of small tangential triradiates, to which there may be added a small number of specially large tangential triradiates and some microxea in scattered distribution. The skeleton of oscular margin is a close interlacement of small triradiates and quadriradiates, both which have strongly divergent paired rays and downwardly directed basal ray. There may be found in addition some triradiates of an unusually large size.

Structure.—The canal system is leuconoid. The wide inhalant canals, starting from beneath the dermal surface, run centripetally into the chamber layer, becoming narrower as they divide into branches. The exhalant canals are also wide and branching. The gastral apertures, by which the exhalant canals open into the gastral cavity, are circular or oval measuring up to $\frac{1}{2}$ mm. across. The flagellate chambers, closely packed in the chamber layer, are oval or nearly spherical with diameter of 30–60 μ.

The dermal skeleton is made up of large and small triradiates placed tangentially in several confused layers. On the dermal surface are found microxea in thinly scattered distribution. The skeleton of the chamber layer likewise consists of large and small triradiates in dense and irregular disposition. Along the larger exhalant canals there occur a different sort of triradiates in addition to some quadriradiates with apical rays projecting into the canal. The gastral skeleton is fairly well developed; it is composed of a dense reticu-

Spicules.—The larger dermal triradiates (*a*) regular or subregular. Rays nearly straight, gradually tapering toward the pointed end, very variable in dimensions, 200–800μ long and 20–90μ thick at base. The smaller dermal triradiates (*b*) slightly sagital; the rays nearly uniformly thick, not lying all in one plane. Basal ray slightly longer than paired rays, straight, usually 200–300μ long and 16–28μ thick at base. Paired rays slightly curved, 150–270μ long.

Triradiates of chamber layer (*c*) regular, very variable in size. Rays straight, 350–800μ long and 40–90μ thick at base.

Quadriradiates of the larger exhalant canals (*d*) have gradually tapering and sharply pointed rays of nearly equal thickness, the facial rays not lying in one plane. Basal ray straight, about 200μ long and 16μ thick at base. Paired rays more or less curved around the exhalant canals, about 200μ long and 16μ thick at base. Apical ray much shorter and thinner than facial rays, slightly curved and very finely pointed, about 50μ long and 8μ thick at base.

Triradiates of the larger exhalant canals (*e*) nearly similar to the above quadriradiates, only differing in the absence of apical ray.

Gastral triradiates (*f*) strongly sagittal. Basal ray straight, sharply pointed, thinner and shorter than paired rays, 80–150μ

long and 16μ thick at base. Paired rays slightly curved and strongly divergent, often unequal in length and obtuse at end, 200–400μ long and 20–24μ thick.

Regular gastral triradiates large. Similar to large dermal triradiates.

Triradiates of oscular margin (*g*) strongly sagittal. Basal ray straight, nearly uniformly thick for the greater part of its length, sharply pointed, about 300μ long and 16μ thick at base. Paired rays

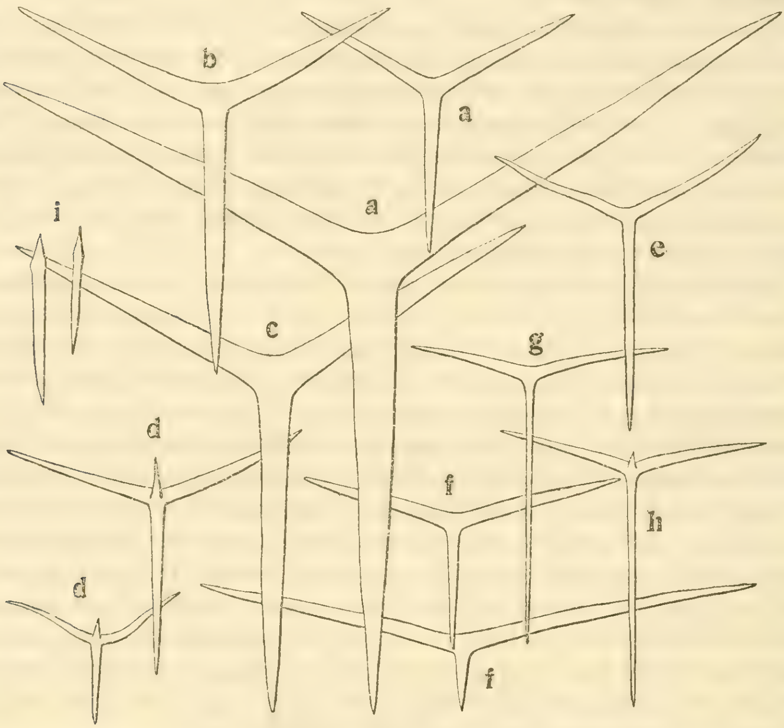


FIG. 7.—LEUCANDRA TUBA. *a*, REGULAR DERMAL TRIRADIATES. *b*, SAGITTAL DERMAL TRIRADIATE. *c*, TRIRADIATE OF CHAMBER LAYER. *d*, QUADRIRADIATES OF THE LARGER EXHALANT CANAL. *e*, TRIRADIATE OF THE LARGER EXHALANT CANAL. *f*, GASTRAL TRIRADIATES. *g*, TRIRADIATE OF OSCULAR MARGIN. *h*, QUADRIRADIATE OF OSCULAR MARGIN. *i*, GASTRAL MICROXEA. *a–h*, ×100; *i*, ×400.

much shorter and thicker than basal ray; slightly curved, very strongly diverging, about 160μ long and 20μ thick at base.

Quadriradiates of oscular margin (*h*) strongly sagittal, exactly similar to triradiates of oscular margin except in having slender apical ray.

Microxea (*i*) nearly straight, forming lance-head at one end, 40–56μ long and 2–4μ thick at head.

Locality.—Near Okinoshima, Prov. Chikuzen in Kiushu (Station 4877, 59 fathoms).

9. LEUCANDRA POCULIFORMIS, new species.

Plate 84, fig. 4.

Only a single specimen of this new species is represented in the collection (Cat. No. 9189, U.S.N.M.). It has the form of a thick-walled cup with a very irregular-shaped laterally compressed osculum at the upper end. The sponge was probably attached by the inferior, somewhat narrowed, and broken-off end. It is nearly 38 mm. high and 28 mm. broad in the broadest part. The gastral cavity is about 25 mm. deep The sponge wall is thickest in the lower parts, where it measures 13 mm. in thickness. This diminishes gradually toward the sharp-edged oscular margin. To the naked eye the outer surface appears nearly smooth. The gastral surface is perforated by numerous small exhalant apertures of 2 mm. and under in diameter. The color in alcohol is in part whitish and in part more or less brownish. The texture is not very compact, but rather soft and brittle.

Structure.—The canal system is leuconoid. The flagellate chambers are ovoid or nearly spherical, measuring about 70–120μ in their longest diameter. They are thickly and irregularly set between the branches of inhalant and exhalant canals, which are surrounded by a fairly thick layer of mesogloea.

The dermal skeleton is composed of several layers of variously sized tangential triradiates. Microxea cover the external surface all over, disposed at varying angles to it. The skeleton of the chamber layer consists in the main of triradiates, which are of very variable sizes and are thickly set together without any definite order. The wall of the larger exhalant canals is provided with a different sort of triradiates besides having quadriradiates with apical ray projecting into the lumen. There exists a gastral skeleton which is fairly well demarked from the chamber layer. It is composed of a thin layer of tangential triradiates and of microxea, which occur moderately densely together all over the gastral surface. The same kinds of spicules as those of the larger exhalant canals are also found in the gastral skeleton. Further, there occur in it some small and strongly sagittal tri- as well as quadriradiated, both of which are, however. not numerous. The oscular margin shows no special spicules.

Spicules.—Dermal triradiates (*a*) regular or subregular. Rays nearly equally thick, gradually tapering from base to sharp point, very variable in size, 130–680μ long and 20–60μ thick at base.

Triradiates of chamber layer (*b*) regular or subregular, similar to those of dermal skeleton, 280–640μ long and 40–60μ thick at base. Much smaller triradiates occur in a small number.

Triradiates of the larger exhalant canals (*c*) are sagittal. Rays nearly equally thick, now lying all in one plane. Basal ray nearly straight, gradually tapering, sharply pointed, 130–260μ long and 12–32μ thick at base. Paired rays longer than basal ray, gently curved forwards and gradually tapering to sharp point, 170–370μ long and 16–32μ thick at base.

Quadriradiates of the larger exhalant canals (*d*) similar to the above triradiates, except in the presence of short and slightly curved apical ray. Basal ray 140–270μ long and 20–30μ thick at base. Paired rays 230–330μ long and 20–32μ thick. Apical ray about 60μ long and 16–20μ thick at base.

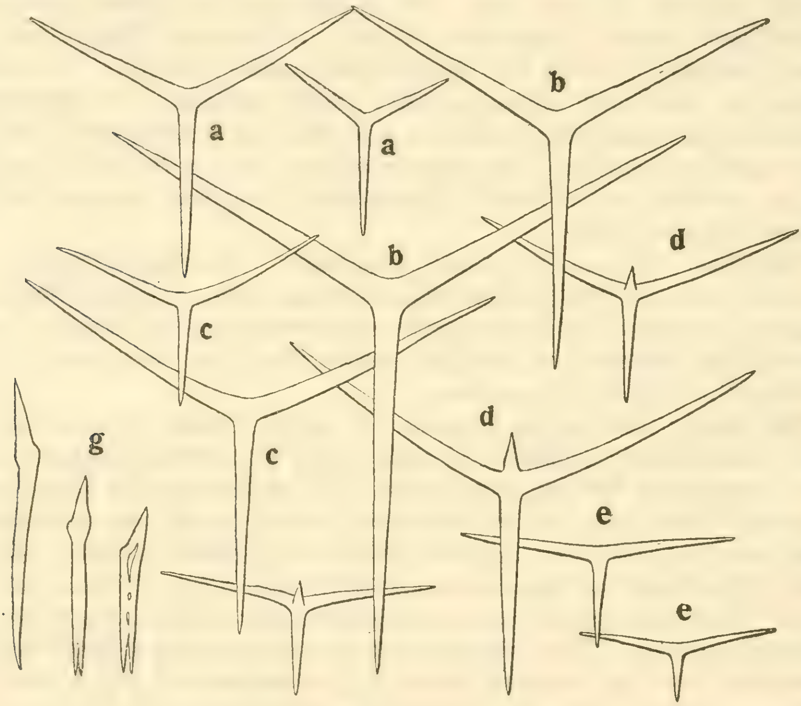


FIG. 8.—LEUCANDRA POCULIFORMIS. *a*, DERMAL TRIRADIATES. *b*, TRIRADIATES OF CHAMBER LAYER. *c*, TRIRADIATES OF THE LARGER EXHALANT CANAL. *d*, QUADRIRADIATES OF THE LARGER EXHALANT CANAL. *e*, GASTRAL TRIRADIATES. *f*, GASTRAL QUADRIRADIATE. *g*, DERMAL MICROXEA. *a–f*, ×100; *g*, ×400.

The larger gastral triradiates regular or subregular, nearly similar to those of dermal skeleton and of chamber layer.

The smaller gastral triradiates (*e*) strongly sagittal. All rays equally thick, sharply pointed. Basal ray nearly straight, distinctly shorter than paired rays, 80–120μ long and 16–20μ thick at base, lying slightly out of the plane of paired rays. These are nearly straight or slightly curved, very strongly divergent, 120–200μ long and 16–20μ thick at base.

Gastral quadriradiates (*f*) exactly similar to gastral triradiates, but with a short apical ray. Basal ray 90–110μ long and about 20μ

thick at base. Paired rays, 130–180μ long and about 20μ thick at base.

Microxea of dermal skeleton (*g*) slightly curved, proximally tapering to sharp point, distally terminating with a lance-head which is slightly bent and provided with sharp or obtuse apex, 60–90μ long and 4–6μ thick at head.

Microxea of gastral skeleton exactly similar to those of dermal skeleton.

Locality.—Off Semisopochnoi Island, Aleutian Islands (Station 4777, 52 fathoms).

Remarks.—This species differs from *Leucandra tuba*, new species, chiefly in the peculiar external form, in spiculation and in the absence of a skeleton proper to oscular margin. In external form it closely resembles the members of the genus *Pericharax* Poléjaeff.

10. LEUCANDRA FOLIATA, new species.

Plate 84, fig. 5.

This new species is founded on the strength of a single specimen in the collection (Cat. No. 9185, U.S.N.M.). The sponge (pl. 84, fig. 5) is foliate, consisting of a single continuous lamella, which is irregularly folded or convoluted. It is attached in the middle of its lower surface by means of several nipple-shaped basal processes. The lamella is about 55 mm. broad and about 4 mm. thick in the middle parts where it is thickest. The thickness decreases peripherally toward the very thin oscular margin. The inner surface of the lamella appears smooth to the naked eye; it is minutely punctuate, due to the apertures of exhalant canals, which are more distinct in the middle parts than in the periphery. The outer surface is likewise smooth, but without the punctate appearance of the inner surface. The color in alcohol is greyish white. The texture is fairly compact, rigid and brittle.

Structure.—Very wide inhalant canals arise just beneath the dermal surface and penetrate deep into the chamber layer, giving off numerous branches on the way. Small exhalant canals combine into a number of larger ones which open on the gastral surface by the apertures above alluded to. Between the inhalant and exhalant canal systems the flagellate chambers are quite irregularly scattered. They are oviid or spherical, with a diameter of 50–100μ.

The dermal skeleton is very thin and is composed of chiefly small and occasionally very large tangential triradiates, with basal ray pointing away from oscular margin. The skeleton of the chamber layer consists of large triradiates of a slightly variable size, which are densely set together without definite order. The larger exhalant canals are lined with quadriradiates, the apical ray of which projects into the canalar lumen. There exists a gastral skeleton made up of triradiates in two sorts and of quadriradiates, all which spicules are disposed parallel to the gastral surface. The gastral surface is covered with microxea occurring irregularly, but moderately densely together.

Spicules.—Dermal triradiates in part (*a*) regular or subregular, very large though variable in size; rays nearly straight, tapering from base to sharp point, 190–900μ long and 28–100μ thick at base. Other dermal triradiates (*b*) sagittal, slender; rays nearly equally thick, not lying in one plane. Basal ray straight, usually slightly longer than paired rays, 110–250μ long and 8–20μ thick at base. Paired rays gently curved forewards, 80–210μ long and 8–20μ thick at base.

Triradiates of chamber layer regular or subregular, variable in size; similar to those of dermal skeleton.

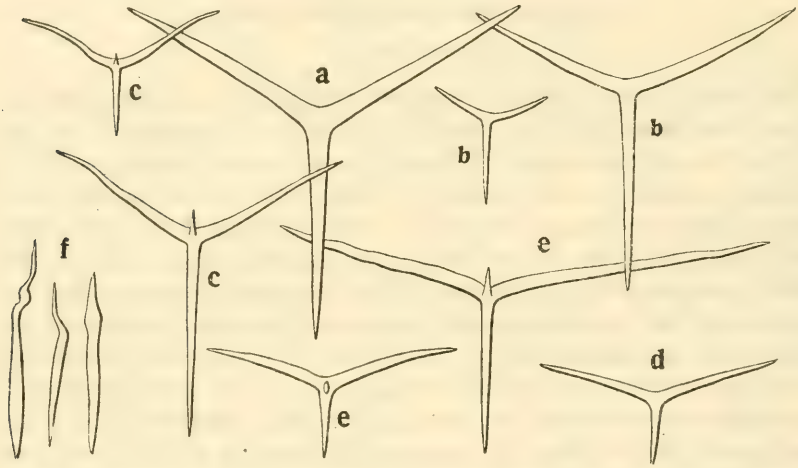


Fig. 9.—Leucandra foliata. *a*, regular dermal triradiate. *b*, sagittal dermal triradiates. *c*, quadriradiates of the larger exhalant canal. *d*, gastral triradiate. *e*, gastral quadriradiates. *f*, microxea. *a–e*, ×100; *f*, ×400.

Quadriradiates of the larger exhalant canals (*c*) sagittal, slender. Basal ray straight, usually longer, but sometimes shorter than paired rays, not lying in the plane of paired rays. Paired rays curved, sometimes more or less crooked, usually slightly broader than basal ray, 150–200μ long and 12–16μ thick at base. Apical ray very slender, more or less curved, finely pointed, measuring up to 100μ long and 12μ thick at base.

Gastral triradiates regular or subregular, large; similar to those of dermal skeleton and of chamber layer.

The smaller gastral tiradiates (*d*) strongly sagittal, exactly like gastral quadriradiates except in the absence of apical ray.

Gastral quadriradiates (*e*) strongly sagittal, with basal ray straight, much shorter and slightly thinner than paired rays, 80–210μ long and 12–16μ thick at base. Paired rays doubly slightly curved, first backwards and then forwards; irregular in outline, 170–330μ long and 20μ thick at base. Apical ray very short, tapering to sharp point, up to 70μ long.

Microxea (*f*) obtusely or sharply pointed at the inner end, more or less hastate and sharply pointed at the outer end. They are of a more or less irregular outline, being usually thickest nearest the inner end than the outer.

Locality.—Off Osesaki, Province Hizen in Kiushu (Station 4894, 95 fathoms).

Remarks.—This species is distinguished from *Leucandra tuba*, new species, by its remarkable external form, by having no proper oscular skeleton, by the presence of gastral quadriradiates, and by some other points of detail in the spiculation. It differs from *Leucandra poculiformis*, new species, by its external form, by the dimensions and characters of spiculation, etc.

11. LEUCANDRA KURILENSIS, new species.

Plate 85, fig. 11.

This species is represented by a single specimen in the collection (Cat. No. 9173, U.S.N.M.). The sponge (pl. 85, fig. 11) represents a solitary individual of a strongly laterally compressed oval shape attached by its one side to a foreign body. A circular osculum of about 1½ mm. and surrounded by a fringe of oxea opens near one end of the body. Total length, including the oscular fringe, about 12 mm.; greatest breadth, about 8mm.; thickness of wall, about 1 mm. The dermal surface is slightly rough from the projecting ends of oxea; the gastral surface is smooth, but is perforated by uniformly distributed circular exhalant apertures 0.4–0.5 mm. wide. The color in alcohol is grayish white. The texture is fairly firm.

Structure.—Unfortunately it is difficult to exactly determine the state of the canal system, owing to the bad state of preservation, but it seems to be of the sylleibid type, intermediate between the syconoid and the leuconoid. The flagellate chambers are more or less elongate and are arranged radially around the wide exhalant canals.

The dermal skeleton is well developed, attaining a thickness of about one-third that of the sponge wall or even somewhat thicker. It is made up of tangential triradiates in many confused layers. Large oxea and finer linear spicules project from the dermal surface, their proximal parts being imbedded in the chamber layer. The tubar skeleton consists in the main of irregularly distributed triradiates, but shows an indication of the articulate character in the presence of subgastral sagittal triradiates in a small number. The gastral skeleton is thin, consisting of triradiates closely set and disposed parallel to the gastral surface in several layers. The oscular margin contains large oxea and finer linear spicules which form a dense fringe, as well as regularly and closely set triradiates, which have basal ray directed downward and paired rays standing out nearly at right angles from it.

Spicules.—Dermal triradiates (a) sagittal. All rays nearly equally thick, slightly irregular in outline. Basal ray straight, generally

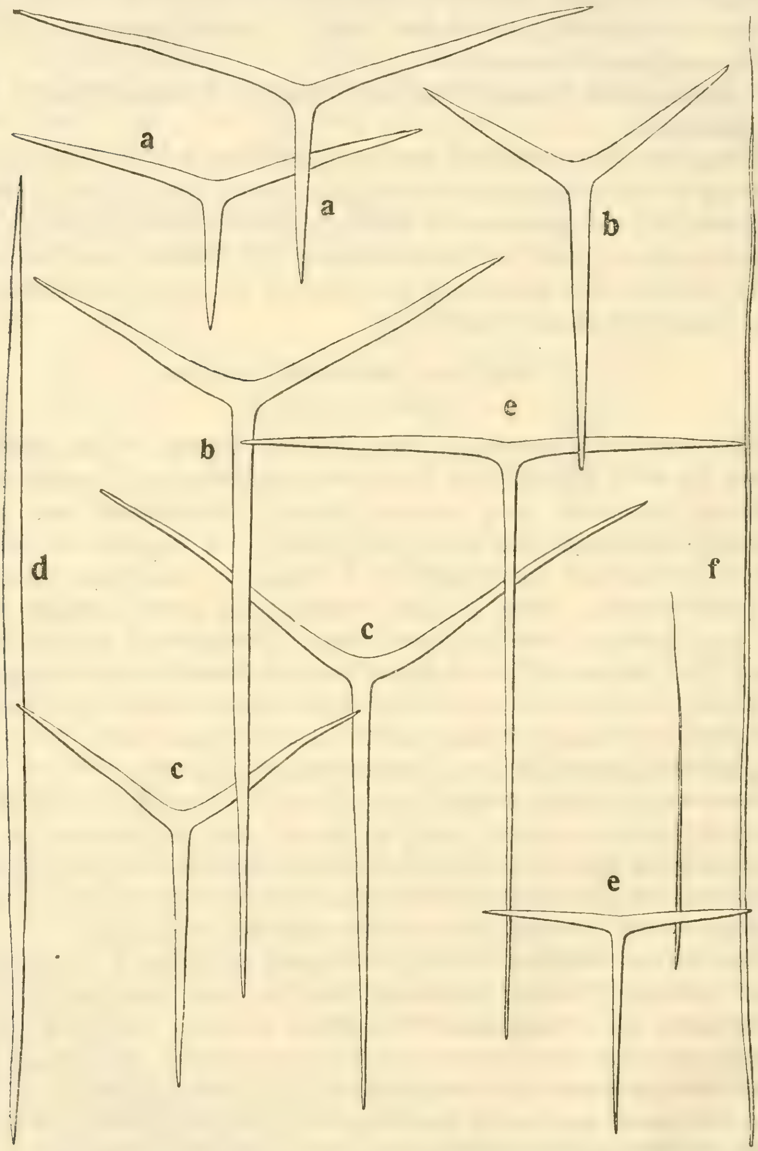


FIG. 10.—LEUCANDRA KURILENSIS. *a*, DERMAL TRIRADIATES. *b*, TUBAR TRIRADIATES. *c*, GASTRAL TRIRADIATES. *d*, OXEA. *e*, TRIRADIATES OF OSCULAR MARGIN. *f*, LINEAR SPICULES OF OSCULAR MARGIN. All ×150.

shorter than paired rays, 120–170μ long and 20μ thick at base. Paired rays usually equal, widely diverging, nearly straight or slightly curved backwards, 190–290μ long and 20μ thick at base.

Tubar triradiates (*b*) sagittal. Rays equally thick, moderately variable in size and shape. Basal ray nearly straight, tapering to sharp point. Paired rays nearly equal, simply slightly curved forward or doubly curved, first forward and then backward, ending in sharp point. Those tubar triradiates which lie directly beneath the gastral cortex have more widely diverging paired rays than the others. Basal ray 270–520μ and paired rays 170–230μ long; both 20–24μ thick at base.

Gastral triradiates (*c*) sagittal, with slender rays lying all in the same plane. Basal ray longer than paired rays, straight, 240–400μ long and 20μ thick at base. Paired rays sharply pointed, showing more or less distinct double curvature, being curved forward at basal parts and backward in the remaining parts, 190–300μ long and 20μ thick at base.

Triradiates of oscular margin (*e*) strongly sagittal. Basal ray usually much longer and thinner than paired rays, straight, sharply pointed at end, 180–570μ long and 12μ thick at base. Paired rays equal, more or less sharply pointed, very strongly diverging, standing out almost at right angles from basal ray, 110–220μ long and 16μ thick at base.

Large oxea of body surface and oscular margin (*d*) straight or slightly curved, sharply pointed at both ends, attaining a length of over 1 mm. and a thickness of 20–40μ in the middle.

Linear spicules very slender, straight, sharply pointed at both ends. Those of general body surface 370μ to 1 mm. long and 5–10μ thick; same of oscular margin (*f*) 1.4 mm. or more long and 4–20μ thick.

Locality.—Off Cape Rollin, Simushir Island, Kuriles (Station 4803, 229 fathoms).

Remarks.—This species seems to be nearly related to both *Leucandra anguinea* (Ridley[1]) and *L. pulvinar* (Haeckel[2]), but is readily distinguished from either by its external form and by the dimensions and other details of most of the spicules.

12. LEUCANDRA SPLENDENS, new species.

Plate 85, figs. 12–14.

Three specimens of this new species exist in the collection. One of them (pl. 85, fig. 12), which came from Station 4790, was selected as the type of the species (Cat. No. 9178, U.S.N.M.). It is of an ovoid shape, measuring 22 mm. in length and 11 mm. in greatest breadth. The outer surface is strongly hispid, owing to the presence of large oxea projecting from it. The osculum at the upper end is circular, provided with a well developed fringe of about 3½ mm.

[1] *Leucortis anguinea* Ridley, Spongida. Reports on the Zoological Collections made in the Indo-Pacific Ocean during the Voyage of H. M. S. *Alert*, 1881–1882, pp. 629, 630, pl. 53, fig. L; pl. 54, figs. *d, d'*.

[2] *Leucortis pluvinar* Haeckel, Kalkschwämme, 1872, pp. 162–166, pl. 29.

height; it leads into a wide gastral cavity. The sponge wall is about 2 mm. thick in the middle parts of the body. The color in alcohol is grayish-white and the texture moderately firm.

Structure.—The canal system is of the leuconoid type. The dermal pores, thickly distributed all over the surface, lead into narrow canals which soon join together to form very wide inhalent canals running deep into the wall. The exhalant canals are also very wide and originate from deep parts of the wall. The apertures by which they open into the gastral cavity measure up to 2 mm. across. The flagellate chambers are densely and irregularly arranged between inhalant and exhalant canals. They are more or less spherical, measuring 100–150μ in diameter.

The skeleton of the dermal cortex is composed of tangential triradiates arranged in a few layers. Their basal ray is in most cases pointed toward the sponge base. The large oxea which occur thickly in vertical disposition in the sponge wall project out on the dermal surface. Microxea are found in two kinds on the dermal surface; the smaller kind is thinly scattered all over the surface in tangential disposition, while the larger kind is grouped into small tufts which project externally in association with large oxea. The skeleton of the chamber layer consists of quadriradiates of various sizes. Though seemingly irregularly scattered, the majority of them have basal rays directed centrifugally, thus presenting a trace of the articulate character. The gastral skeleton is very thin, being made up of quadriradiates, the apical ray of which projects into exhalant canals or into the gastral cavity. The skeleton of the oscular margin is composed of large oxea, microxea, triradiates and quadriradiates. The large oxea are longitudinally placed, paralled with the basal rays of tri- and quadriradiates. The microxea are thinly scattered on the outer surface. The tri- and quadriradiates have very strongly divergent paired rays which stand nearly at right angles to the basal ray.

Spicules.—Dermal triradiates (*a*) slightly sagittal, with rays sharply pointed and lying in the same plane. Basal ray nearly straight, usually slightly shorter and broader than paired rays, 250–400μ long and 20–24μ thick at base. Paired rays equal or slightly differentiated in length, slightly curved forewards at base and nearly straight or slightly curved in the remaining parts, 270–440μ long and 16–20μ thick at base.

Quadriradiates of chamber layer (*b*) slightly sagittal. All rays nearly equally thick and sharply pointed. Basal ray straight, 300–450μ long and 32μ thick at base. Paired rays slightly curved forewards at base and nearly straight or slightly curved backwards in the remaining parts, more or less irregular in outline, 300–450μ long and 32μ thick at base. Apical ray much shorter than facial rays, slightly curved.

Gastral quadriradiates (*c*) slightly sagittal, with slender, straight, and sharply pointed rays. Basal ray slightly shorter but not thinner than paired rays, 170–330μ long and 24–28μ thick at base. Paired rays widely divergent, 210–440μ long and 20–24μ thick at base. Apical ray thinner and shorter than facial rays, 150–170μ long and 16μ thick at base.

Triradiates of oscular margin (*d*) very strongly sagittal. Rays nearly equally thick. Basal ray longer than paired rays, 330–500μ

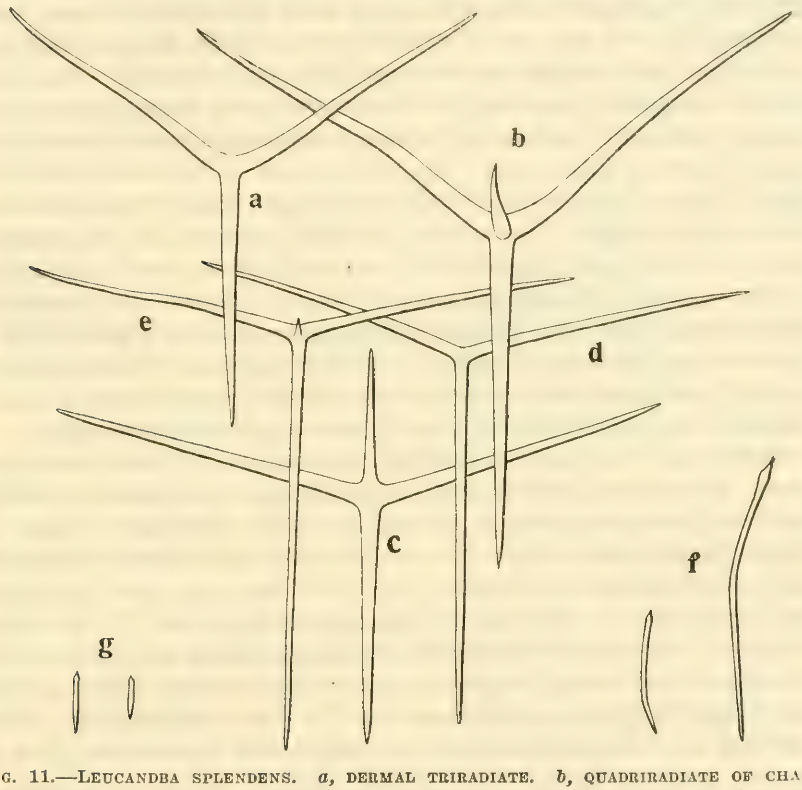


FIG. 11.—LEUCANDRA SPLENDENS. *a*, DERMAL TRIRADIATE. *b*, QUADRIRADIATE OF CHAMBER LAYER. *c*, GASTRAL QUADRIRADIATE. *d*, TRIRADIATE OF OSCULAR MARGIN. *f*, LARGER MICROXEA. *g*, SMALLER MICROXEA. All ×100.

long and 20–24μ thick at base. Paired rays strongly diverging, slightly curved backwards or nearly straight, 270–400μ long.

Quadriradiates of oscular margin (*e*) very strongly sagittal, slender-rayed. Basal ray straight, sharply pointed, 190–570μ long and 16–24μ thick at base. Paired rays nearly as thick as basal ray but slightly shorter, slightly curved, strongly diverging, 160–400μ long and 12–16μ thick at base. Apical ray very short, slightly curved, and finely pointed.

Large oxea of body surface slender, nearly straight, nearly uniformly thick in the middle greater parts and sharply pointed at both ends, up to 8 mm. or more long and 20–40μ thick in the middle.

The larger microxea (*f*) slender, more or less angularly curved, sharply pointed at proximal end, and provided with lance-head at distal end, 180–400μ long and 6–8μ thick in the middle.

The smaller microxea (*g*) very short, straight, or slightly curved, provided with lance-head, 60–80μ long and 6–8μ thick in the middle.

Locality.—Off Cape Monati, Bering Island, Comandorski Islands (Station 4790, 64 fathoms; Station 4792, 72 fathoms).

Remarks.—The other two specimens (Cat. Nos. 9176 and 9177, U.S.N.M.) on hand are much larger than the type-specimen. One of them (pl. 85, fig. 13) is of an elongate ovoid shape, measuring about 60 mm. in length and 35 mm. in greatest breadth. The osculum is irregularly circular, with a diameter of about 8 mm. The dermal surface is uneven and moreover strongly hispid, due to projecting tufts of large oxea. The sponge wall is thickest in the basal parts (about 10 mm. thick) and becomes gradually thinner toward the oscular margin. The gastral surface is perforated by numerous circular or oval apertures of exhalant canals, up to 3 mm. in diameter.

The second specimen agrees well with the first in both external and internal features. Plate 85, figure 14, represents a portion of it, as seen from the gastral surface. In this specimen, the hispidity of dermal surface as well as the oscular fringe are very weakly represented. The wall measures about 8 mm. in greatest thickness.

With regard to the microscopical structure of the above two specimens, there is an essential agreement with the type-specimen, though not without some points of deviation in their spiculation which require special mentioning. In both of them, the dermal triradiates, the quadriradiates of chamber layer, and the large oxea are found in dimensions on the whole somewhat larger than in the type-specimen. In addition to the quadriradiates, there may occur in the chamber layer a small number of similar triradiates. The microxea are found in greater abundance than in the type-specimen. They can not be distinguished into the larger and the smaller form so readily as in the latter.

13. LEUCOPSILA STYLIFERA (O. Schmidt).

Plate 85, figs. 15, 16.

Leuconia stilifera O. SCHMIDT, Atlant. Spong., 1870, p. 73, pl. 2, fig. 24.

Leuconia stilifera HAECKEL, Prodromus., 1870, p. 247.

Leucandra stilifera HAECKEL, Kalkschwämme, 1872, p. 225, pl. 33, figs. 4*a*–4*f*; pl. 40, fig. 11.

Leucopsila stylifera DENDY and ROW, Proc. Zool. Soc. London, 1913, p. 776.

There exist five specimens of the species in the collection (Cat. Nos. 9169, 9174, 9175, 9179, U.S.N.M.). They are either tubular solitary individuals or irregular colonies consisting of a few persons broadly connected together and indicated by the several oscula present. The largest specimen (pl. 85, fig. 15), upon which I base the further description, was obtained off Cape Monati, Bering Island (station 4792). It is a solitary person of an irregularly bent and strongly laterally compressed tubular shape. The osculum at the upper end is surrounded by a thin undulating oscular margin. The narrowed inferior parts of the body are provided with a number of irregularly shaped processes for attachment. Total length of body about 140 mm., greatest breadth about 30 mm., and the wall about 3 mm. thick. The dermal surface is nearly quite smooth. The gastral surface is also smooth, though not even, being perforated by exhalent apertures of varying size (50μ–303 mm. wide). The dermal surface appears white, and the chamber layer also the gastral surface grayish. The dermal cortex is rigid and elastic, and may easily be sparated from the chamber layer, which is very soft.

Structure.—The canal system is of the leuconoid type. The chamber layer is strongly lacunar, being traversed by well-developed inhalent and exhalent canals. Between these canals are thickly packed together the ovoid or spherical flagellate chambers of 60–100μ diameter. The exhalant canals unite into tolerably wide trunks which open into the gastral cavity. The latter is rather narrow.

The dermal skeleton is well developed, composed as it is of tangential triradiates and microxea. The triradiates are arranged in several layers with basal rays directed downward. The microxea are very closely set all over the dermal surface but leaving meshlike pores of inhalent canals measuring 50–100μ across. The skeleton of the chamber layer is made up of a confused mass of microxea and of very large quadriradiates irregularly scattered among the former. The gastral skeleton is formed solely of microxia disposed in a dense layer; only occasionally the quadriradiates of the chamber layer join the gastral skeleton with their apical rays which project into the gastral cavity. The oscular fringe is supported by irregularly and closely set microxea and triradiates, with an admixture of oxea occasionally occurring in longitudinal disposition.

Spicules.—Dermal triradiates sagittal. Rays nearly equally thick, straight, sharply pointed, lying in the same plane. Basal ray distinctly shorter than paired rays which are strongly divergent. Basal ray 450–950μ long and 50–70μ thick at base.

Quadriradiates of chamber layer sagittal, very large, variable in size, with rays of nearly equal thickness and slightly irregular outline. Basal ray straight, shorter than paired rays, 0.8–1.27 mm. long and 100–150μ thick at base. Paired rays usually equal, sometimes unequal, either curved simply forewards or showing double curvature, in the latter case curved distinctly forewards in the proximal parts and slightly backwards in the distal parts, 0.9–2 mm. long and 100–150μ thick at base. Apical ray shorter than basal ray, straight or slightly curved, 350–850μ long and 100–150μ thick at base.

Microxea slightly curved in an S-like manner. Its thinner end sharply pointed, the broader end forming a more or less sharply pointed head marked off by a nodiform ring.

Oxea of oscular margin slender, nearly straight. A small example of the spicule measured $\frac{1}{2}$ mm. or over in length and 4μ in thickness.

Localities.—Greenland (O. Schmidt, Haeckel); off Cape Monati, Bering Island, Comandorski Islands (Station 4790, 64 fathoms; Station 4792, 72 fathoms); off Cape Rollin, Simushir Island, Kuriles (Station 4803, 229 fathoms).

Remarks.—Of the remaining specimens on hand of the species, I may call attention to the one from Station 4790, which is shown in plate 85, figure 16. In it the oscular oxea are more numerously present than in the type. They are broadest near the inner end, which is simply sharply pointed; the outer end forms a lance-head similar to that of microxea. They are 0.6–3 mm. or more long and 15–20μ thick.

EXPLANATION OF PLATES.

Plate 84.

Fig. 1. *Leucosolenia albatrossi*, new species. A portion of the type-specimen, natural size. Station 4788.

2. *Leucosolenia canariensis* (Michlucho-Maclay). Station 4789. Natural size.

3. *Leucandra tuba*, new species. The type-specimen, natural size. Station 4877.

4. *Leucandra poculiformis*, new species. The type-specimen, natural size. Station 4777.

5. *Leucandra foliata*, new species. The type-specimen, natural size. Station 4894.

6. *Sycon simushirensis*, new species. The type-specimen. ×2. Station 4803.

7. *Heteropia medioarticulata*, new species. The type-specimen, natural size. Station 5017.

8. *Grantia nipponica*, new species. The type-specimen, natural size. Station 4822.

Plate 85.

9. *Grantia beringiana*, new species. The type-specimen, natural size. Station 4788.

10. *Achramorpha diomediae*, new species. The type-specimen. ×2. Station 4803.

11. *Leucandra kurilensis*, new species. The type-specimen, natural size. Station 4803.

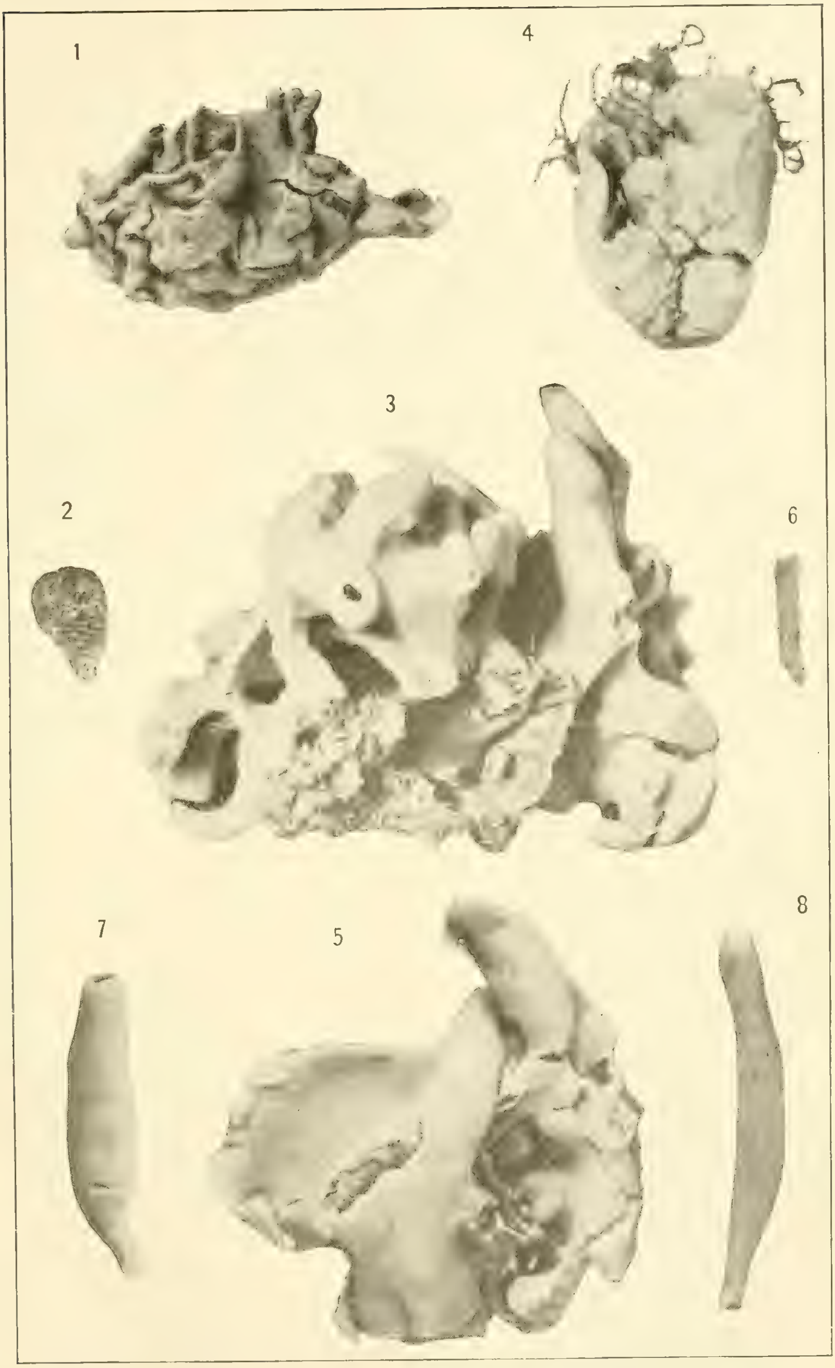
12. *Leucandra splendens*, new species. The type-specimen, natural size. Station 4790.

13. *Leucandra splendens*, new species. One of the specimens from Station 4792, natural size.

14. *Leucandra splendens*, new species. A portion of another specimen from Station 4792, natural size, to show the gastral surface.

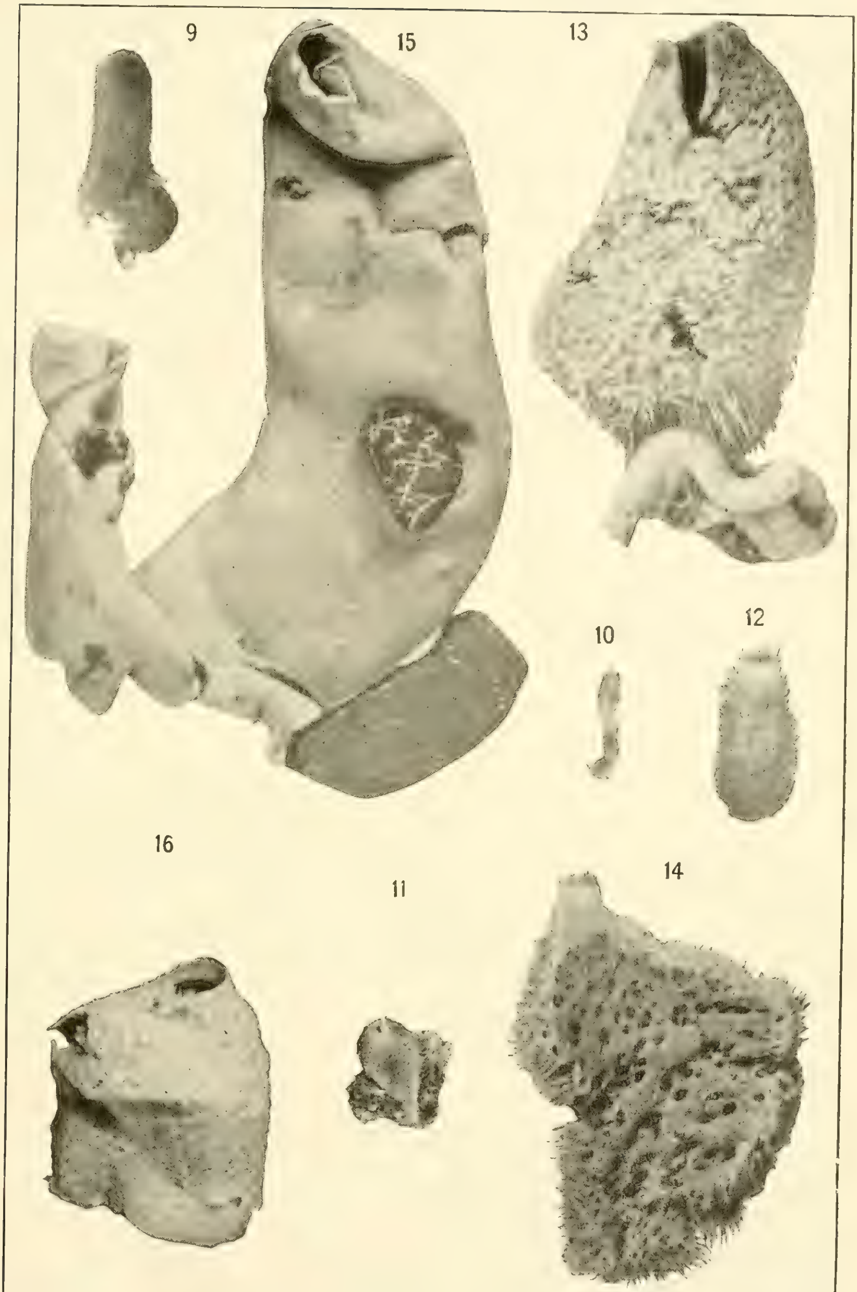
15. *Leucopsila stylifera* (O. Schmidt). A specimen from Station 4792, natural size.

16. *Leucopsila stylifera* (O. Schmidt). A specimen from Station 4790, natural size.



NEW NORTH PACIFIC CALCAREOUS SPONGES

FOR EXPLANATION OF PLATE SEE PAGE 556



NEW NORTH PACIFIC CALCAREOUS SPONGES

FOR EXPLANATION OF PLATE SEE PAGE 556

ON THE FAYETTE COUNTY, TEXAS, METEORITE FINDS OF 1878 AND 1900 AND THE PROBABILITY OF THEIR REPRESENTING TWO DISTINCT FALLS.

By George P. Merrill,
Head Curator, Department of Geology, United States National Museum.

Under date of February 10, 1900, Prof. O. C. Charlton, then of Baylor University, Waco, Texas, sent me two chips of a stony meteorite, concerning the exact nature of which he was in doubt, but which were brought to him by a Mr. C. L. Melcher, of Swiss Alp, Fayette County, in that State. Subsequent correspondence developed the fact that three stones had been found by Mr. Melcher, weighing, respectively, 16 pounds 9¾ ounces, 12 pounds 3½ ounces, and 2 pounds 12 ounces. The meteoric nature of the material was easily established, and from the locality where found, color, general texture, and other features of the stones, which were badly oxidized exteriorly, it was assumed by me, as well as by others, that they were a part of the Fayette County (Bluff) stone found in 1878 and described by Whitfield and Merrill in the American Journal of Science for August, 1888. The largest, nearly complete individual of this (1900) find passed immediately into the hands of H. A. Ward and is the 8,619-gram mass figured on plate 64 of Farrington's catalogue of 1916. A 3,136-gram piece, approximately one-half of the 12-pound individual, is in the collection of the United States National Museum, and the remainder is or was in the cabinet of the university at Waco.

As stated above, the identity of the find of 1900 with that of 1878 was unquestioned at the time, and has apparently remained so until the present day. I, at least, had no occasion to doubt until a short time ago when examining a number of thin sections in connection with the occurrence of the problematic phosphate, concerning which I have prepared sundry papers.[1] That the two finds are not identical but must be regarded as two distinct falls will, I think, be apparent from the descriptions below.

[1] See On the Calcium Phosphate in Meteoric Stones, Amer. Journ. Sci., vol. 43, 1917, pp. 322–324.

Concerning the stone of 1878, little more need be added to what is given in the paper referred to above. A broken surface shows a dense, dark-brown stone, very indistinctly chondritic and with none of the mineral constituents determinable by the unaided eye. A freshly polished surface is of a greenish-gray cast and shows abundant flecks of metal, but the chondritic structure still remains obscure (see fig. 1, pl. 86). On going over the sections a second time I find the colorless interstitial mineral full of gas cavities, referred to in my paper of 1888, and concerning the nature of which I was then in doubt, to be a calcium phosphate occurring in the characteristic, irregular forms (see text-fig. 1). It differs somewhat from other occurrences which I have described in that it shows a somewhat higher relief in the section and is rendered actually clouded by the abundance of empty, irregular cavities. Its phosphatic nature has been determined beyond doubt by microchemical tests.

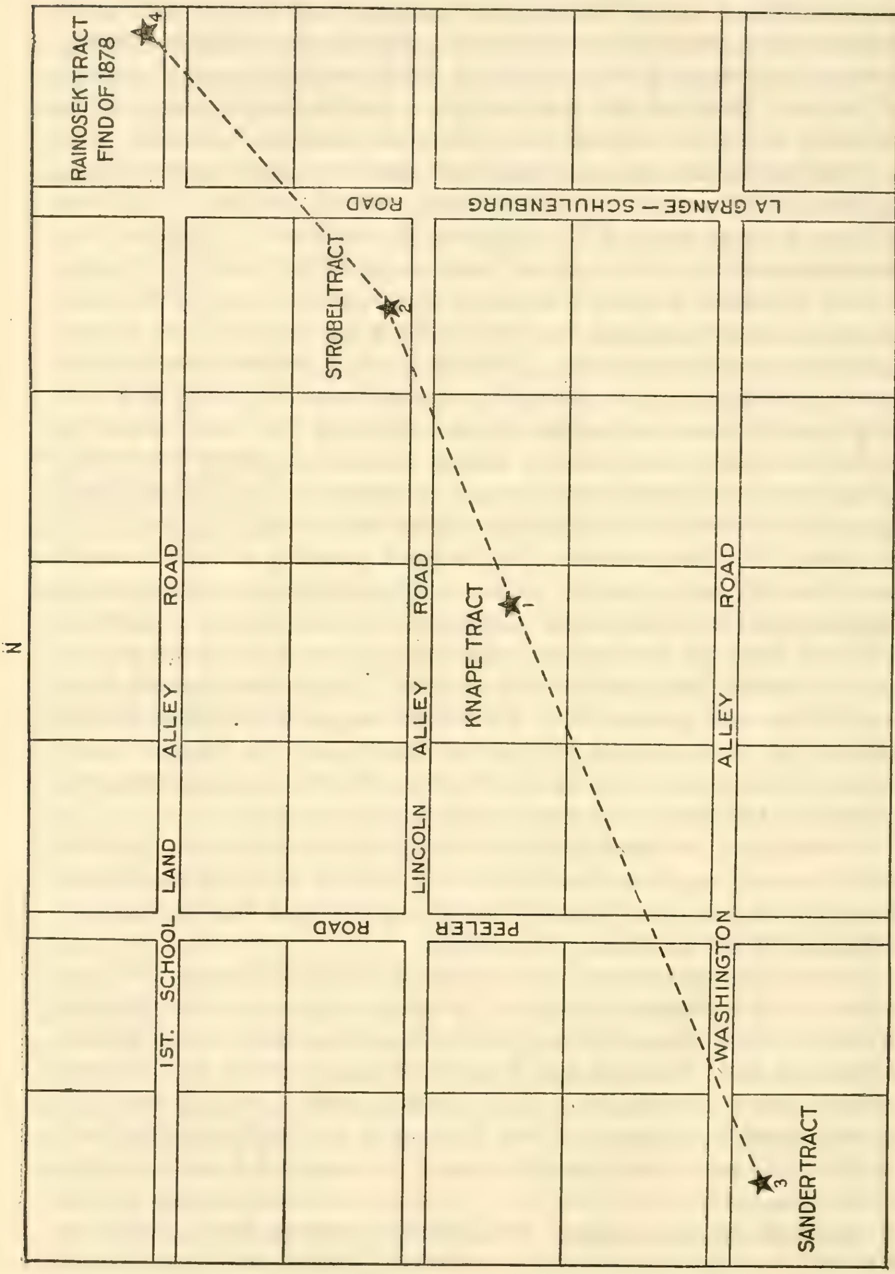
FIG. 1.—CHARACTERISTIC FORM OF PHOSPHATIC MINERAL IN BLUFF, FAYETTE COUNTY, METEORITE. ACTUAL SIZE ABOUT 1.5 MM. IN GREATEST DIAMETER.

The first chips forwarded of the stone found in 1900 differed but little in macroscopic appearance from the above, being dark brownish in color with no distinctive structural features, though in thin section the chondritic structure is much more pronounced (see fig. 2, pl. 86). The most striking difference lies in the physical condition of the two prevailing silicates, the olivine and enstatite. In the stone of 1878 they are so filled with dust-like particles as to be dull and cloudy, while in that of 1900 they are clear and pellucid. The difference may be compared with that so frequently found between the feldspars of some of our older granites and those of the more recent effusive rocks. Further, the ground of the stone of 1900 is doubtfully crystalline. Indeed, I am disposed to consider it fragmental, and to class the stone, following Brezina, as a veined spherulitic chondrite (Cca). An equally distinctive feature, however, lies in the fact that in the slides of the 1900 stone I find numerous chondrules composed wholly of the polysynthetically twinned pyroxene, none of which appear in any of the slides examined of the 1878 find. The calcium phosphate occurs here also, but in clear, limpid forms lacking the cavities so conspicuous in the other. Both stones are veined, though in the find of 1900 the vein filling seems less dense and the included silicate fragments more angular and otherwise less altered.

An interesting feature brought out by a cross section and shown in plate 87 is the peculiarly pitted character of the interior of the mass in contrast with the more compact exterior portion and that bordering on the fracture lines or veinlets which traverse it in various directions. All around the margin, for a width varying from 1 to 2 centimeters, is a zone of oxidation projecting irregularly inward, and within which the stone is firm and compact, acquiring a smooth, lustrous surface, and with abundant small, metallic points, mainly of troilite. Each of the veinlets has a similar border varying in width up to 10 millimeters. The areas between the boundary zone and the emargined veins are relatively poor in metallic constituents, and filled with numerous very irregular, minute cavities. The cause of these pittings can not be satisfactorily explained. They are too numerous and too large to have been occupied by metal, in which, in fact, the stone is poor, and indeed it would seem impossible that the metal could have been removed without the sulphide also suffering to a greater or less extent. Neither can they be due to the partial removal of the sulphide, since this mineral remains fresh and unaltered in the outer zones and those bordering the veins, where it would most likely be attacked. Except on the immediate weathered surface this constituent remains quite untouched. The thought suggests itself that the cavities may have been filled originally by lawrencite, but the presence of so large a quantity of this mineral must certainly have resulted in the complete destruction of the stone when exposed to a terrestrial atmosphere. The veinlets, it may be said, are filled by disconnected stringers of metal, sulphide, carbonaceous matter, and secondary iron oxide. In the slice figured there is relatively a large amount of troilite as compared with nickel iron, while in the Bluff stone of 1878 the reverse is true. In a section from a chip of the mass in the Field Museum, which Doctor Farrington has kindly furnished, this does not hold true, however.

It remains to be noted that the 3,136-gram individual of the 1900 stone is more deeply oxidized than that of 1878, which may perhaps mean that it has been longer exposed to terrestrial weathering and inferentially belong to an earlier fall.

The relative positions of the various finds of 1878 and 1900 are shown in the accompanying chart (p. 560) prepared by Mr. Melcher in 1900, but which reached my hands from Professor Charlton only a few days ago. Nos. 1, 2, and 3 on the Knape, Strobel, and Sanders tract represent the localities of the finds of 1900. No. 4 is the 1878 stone brought by Hensolt to New York, sold to Ward, and described by Whitfield and myself in 1888 under the name of Fayette (afterwards changed to Bluff) County. It will be noted it is somewhat out of line with the other three. The distance between Nos. 1 and 3 on Mr. Melcher's drawings is given as about 2½ miles, and 1 mile from 2 to 4.



MAP OF FAYETTE CO. SCHOOL LANDS

The differences between the finds of 1878 and 1900, as I have pointed them out, are in my opinion amply sufficient to warrant their being considered distinct falls. The question of what this 1900 find shall be called is a troublesome one. The name La Grange would be appropriate, but that it has been given to an iron from Oldham County, Kentucky. That of Swiss Alp, Mr. Melcher's post-office address, is unfortunately geographically misleading. It is suggested, therefore, that the stone of 1900 be known as the Cedar, Fayette County stone, Cedar being the name of a small village a little to the southwest of Bluff.

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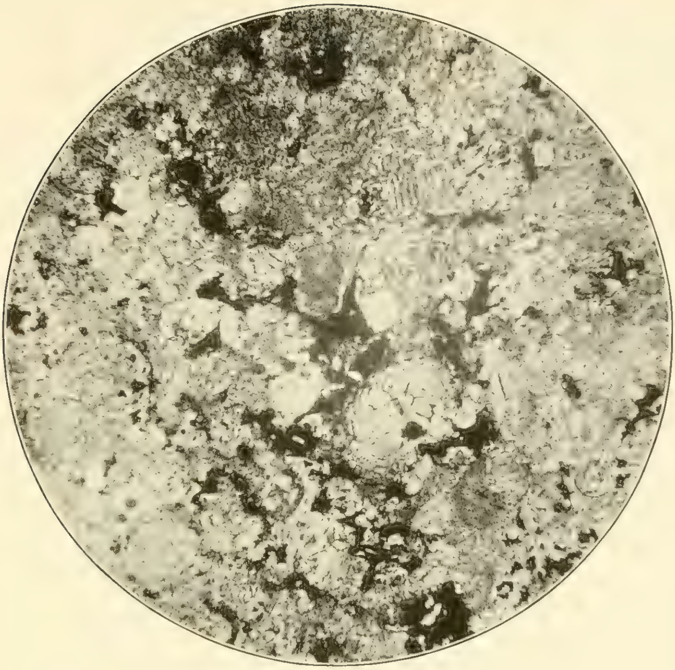

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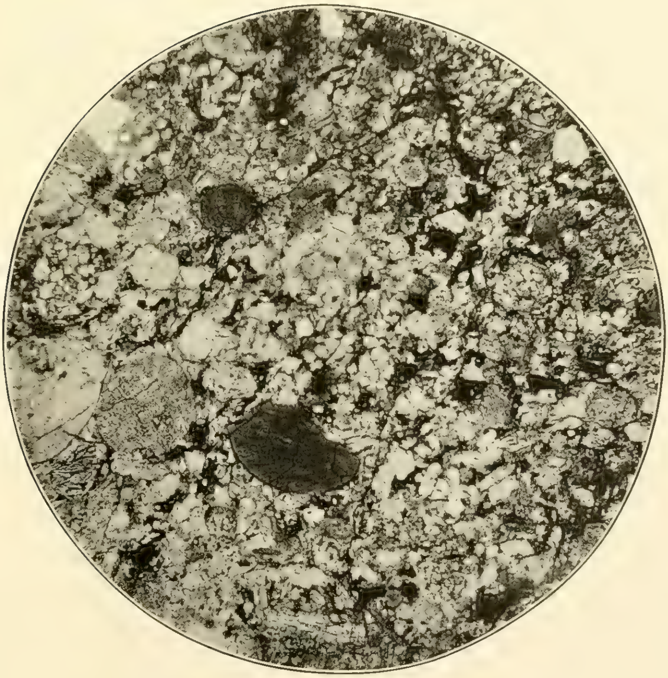
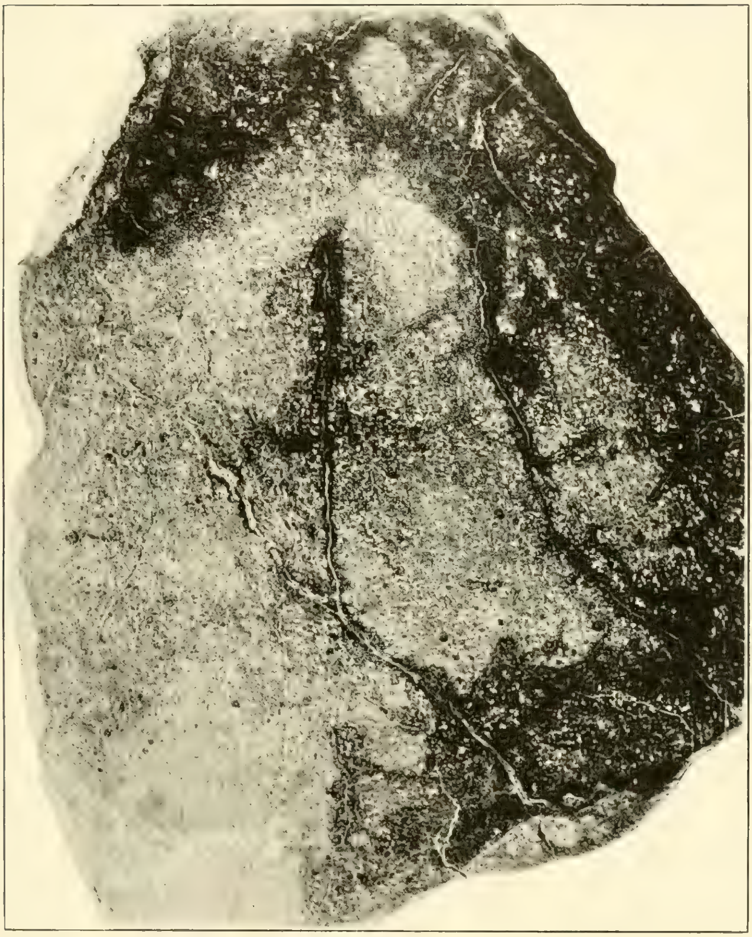


2

THE FAYETTE COUNTY, TEXAS, METEORITE

FOR DESCRIPTION OF PLATE SEE PAGE 558



POLISHED SLICE OF THE CEDAR, FAYETTE COUNTY, TEXAS, METEORIC STONE, ABOUT TWO-THIRDS NATURAL SIZE

The polished surface shows a dark, compact margin thickly studded with particles of troilite and some nickel iron (white in the figure). The veins, or properly the cracks, cutting across the surface are emargined by like narrow, compact borders carrying the same constituents. The intermediate gray portions are full of pits or cavities, also showing in white, which at first sight seemingly result from the removal of the metal and metallic sulphide. (See p. 558.)

FOR EXPLANATION OF PLATE SEE PAGE 558

DESCRIPTIONS AND NOTES ON SOME ICHNEUMON-FLIES FROM JAVA.

By S. A. Rohwer,

Of the Bureau of Entomology, United States Department of Agriculture.

This paper, which is a contribution from the Branch of Forest Insects, Bureau of Entomology, contains the descriptions of 10 new species of Ichneumon-flies submitted for determination by Dr. K. W. Dammerman. All of the species have been reared. The types of all of them are in the United States National Museum.

In the descriptions the term "reclivous nervellus" is used in place of "nervellus postfurcal," as understood by Thomson and others.

Genus ERIPTERNIMORPHA Viereck.

The three species described below seem to belong to *Eripternimorpha* Viereck. This is especially true of the first species, which is closely allied to the genotype of Viereck's genus. They resemble each other in being black and in having the metathorax and legs (mostly) red, but they may be separated by the following key:

Wings unicolorous; the third and apical half of the second tergite rufous *scirpophagae.*
Wings with a cloud below the stigma; second and third tergites black, the second with the posterior margin white ---------- 1.
1. First tergite rufous ---------- *javensis.*
First tergite black ---------- *dammermani.*

ERIPTERNIMORPHA SCIRPOPHAGAE, new species.

Closely allied to *Eripternimorpha schoenobii* Viereck, but the intermediate coxae are red instead of black, the postpetiole is broader and has a median longituinal depression and the second tergite is much wider posteriorly than long (not with the length and apical width subequal).

Female.—Length, 9 mm. Body opaque, closely, finely granular; clypeus not separated from the face by a distinct suture, the apical margin truncate; the area between the eyes distinctly longer than wide; antennae filiform without an annulus, the third and fourth joints subequal; notauli well defined, practically complete; scutellum flat, not margined, shining, sparsely punctured; propodeum long with a transverse carina before the middle and an irregular carina defining the petiolar area; propodeal spiracles slitlike; nervellus reclivous; nervulus interstitial; second intercubitus nearly obliterated; the areolet trapezoidal; recurrent somewhat before the first intercubitus; first tergite with the dorsal carina extending nearly to the middle, the lateral carinae complete but poorly defined basally; the first tergite shining, with irregular, scattered punctures along the posterior margin, twice as wide posteriorly as anteriorly; the second tergite gradually widening posteriorly so it is twice as wide on the posterior margin as on the anterior margin; legs robust; ovipositor a little less than one-half as long as abdomen. Black; propodeum, metapleurae, the posterior part of mesepisternum, the first tergite, apical half of the second and entire third tergite rufous; the apical half of the seventh tergite white; legs rufous; trochanters, anterior and intermediate tarsi black; posterior legs wanting beyond coxae; face and mesosternum with dense white hair; thorax above with sparser white hair; wings uniformly subhyaline, venation dark brown.

Type-locality.—Cheribon, Java.

Described from one female which was reared from a pupa of *Scirpophaga sericea*, February, 1913, by K. W. Dammerman.

Type.—Cat. No. 21494, U.S.N.M.

ERIPTERNIMORPHA JAVENSIS, new species.

Female.—Length, 9 mm. Body subopaque, finely, closely granular; apical margin of clypeus truncate; clypeus sharply defined laterally by elongate supraclypeal foveae, not defined in the dorsal middle; face with close, well-defined punctures; antennal foveae deeply depressed, not carinate above, shining, transversely striate; area between the eyes much longer than wide; frons shining, with well-defined but close punctures; the posterior part of the propodeum striato-punctate; notauli well defined by feebly foveolate furrows; mesonotum shining, sparsely punctured; scutellum flat, not margined laterally; propodeum long with a transverse carina near the base and with only a feebly indicated carina defining the petiolar area; the area before the first transverse carina shining, propodeal spiracle short oval; first tergite shining sparsely punctured, lateral carinae complete, the dorsal carinae extending to the spiracle; second tergite distinctly longer than the posterior width, widening to the middle and then becoming parallel-sided; its posterior width twice as great as anterior width; ovipositor a little more than half as long as abdomen; nervulus slightly post-furcal; areolet large, pentagonal; second recurrent slightly beyond the middle; nervellus strongly reclivous, broken above the middle. Black; antennae with a broad white dorsal semiannulus; thorax posterior to a line drawn tangent to the anterior margin of the scutellum, the propodeum and the first tergite rufous; legs rufous; apical margin of the second, sixth, and seventh tergites white; the trochanters, four anterior femora above, four anterior tibiae beneath, posterior tibiae entirely and all of the tarsi brown; wings hyaline, a large brownish spot below the stigma; venation dark brown.

Type-locality.—Pasoerocan, Java.

Described from one female reared from the pupa of *Sciropophaga intacta* Snellen by J. van der Goot.

Type.—Cat. No. 21495, U.S.N.M.

ERIPTERNIMORPHA DAMMERMANI, new species.

Female.—Length, 10 mm. Anterior margin of the clypeus truncate sharply separated laterally by the supraclypeal foveae, but not separated on the dorsal middle, its surface shining, with distinct punctures basally but impunctate apically; face with close, well-defined punctures; frons sparsely punctured; area between the eyes longer than wide; antennal foveae deep, carinate above, shining, with the surface transversely striate; mesoscutum shining, with close punctures; notauli well defined, complete; posterior and lateral part of the pronotum irregularly striato-reticulate; upper part of mesepisternum sparsely coriaceous; scutellum flat, shining, almost without punctures, not margined laterally; propodeum long, basal carina poorly defined and with no carina defining the petiolar area; the area in the basal middle shining; spiracles short oval; first tergite shining, impunctate, lateral carina complete, the dorsal carinae extending half way beyond the spiracles; second tergite closely punctured on a dull surface, somewhat longer than the posterior width, oblique, anteriorly, parallel-sided beyond the middle, the posterior width a little more than half the basal width; ovipositor about half the length of the abdomen; nervellus reclivous, broken well above the middle; nervulus interstitial, areolet pentagonal; recurrent at about the middle. Black; antennae with a narrow, white, semiannulus beneath; the thorax beyond a line drawn tangent to the anterior margin of the scutellum and the propodeum rufous; abdomen black; the apical margin of the first, second, and seventh tergites and a lateral spot on the apical margin of the third white; legs rufous; the anterior pair mostly brownish; the intermediate trochanters, tibiae, and tarsi brown; posterior trochanters, tibiae, and tarsi black; calcaria white; wings hyaline, with a large brown cloud below the stigma; venation dark brown.

Type-locality.—Cheribon, Java.

Described from one female reared from the pupa of *Scirpophaga sericea*, July, 1912, by K. W. Dammerman, for whom this species is named.

Type.—Cat. No. 21496, U.S.N.M.

ECHTHROMORPHA NOTULATORIA (Fabricius).

One male from Poerwakarta, J. . Reared in May, 1911, from the pupa of *Ocinara signifera* by K. W. Dammerman.

Morley (Fauna Brit. India Hym., vol 3, p. 100) considers *Pimpla continua* Brullé a synonym of this.

THERONIA ZEBRA (Vollenhaven).

One female, Buitensong, Java. Reared from pupa of *Cricula trifenestrata*, May, 1911, by Dr. K. W. Dammerman.

APANTELES (PROTAPANTELES) BATAVIENSIS, new species.

Female and male.—Compared with the type of *Protapanteles colemani* Viereck, the following are the only differences noted: The vertex is shining; the scape and flagellum are yellowish-brown beneath. The black abdomen and coxae readily distinguish it from *creatonoti* Viereck.

Type-locality.—Batavia, Java.

Described from many specimens reared from the larva of *Odonestis plagifera* by S. Leefmans and presented to the United States National Museum by K. W. Dammerman.

Type.—Cat. No. 21492, U.S.N.M.

Were it not for the difference in host and locality I would hesitate to consider this different from *colemani*, as the differences are so minute. These differences are constant for the series examined.

APANTELES BELIPPAE, new species.

The smooth shining thorax and longer ovipositor will readily separate this from *Apanteles creatonoti* Viereck.

Female.—Length, 2.75 mm. Supraclypeal foveae small, deep, punctiform; face shining, with a few irregularly defined punctures below the antennae; vertex and posterior orbits shining and impunctate; ocelli in a low triangle; postocellar line slightly shorter than the ocellocular line; posterior orbits not narrowing posteriorly, their width subequal with the cephalo-caudad diameter of the eye; mesoscutum shining, with only a few setigerous punctures; the suture in front of the scutellum opaque below with close punctuation and with a narrow median ruga; scutellum shining, impunctate, depressed lateral areas oqaque; metanotum with a U-shaped median area; propodeum shining, impunctate; first tergal plate slightly narrower posteriorly, nearly twice as long as its anterior width; second tergal plate trapezoidal in outline, its posterior width a little less than its length; the third tergal plate triangular in outline, the anterior width greater than its length; the entire abdomen shining, without sculpture; ovipositor nearly half as long as the abdomen. Black; the legs except the posterior trochanters and apices of the posterior tibiae, bright yellow; sides of the first three tergites and all of the sternites yellow; wings hyaline, iridescent, costa and stigma dark brown, the rest of the venation pale brown.

Male.—Length 2 mm. The male agrees very well with the female.

Type-locality.—Bandoeng, Java.

Described from 29 females (one, type) and 5 males (one, allotype) reared from the larva of *Belippa ohor* by K. W. Dammerman.

Type.—Cat. No. 21507, U.S.N.M.

APANTELES JAVENSIS, new species.

This species differs from *plusiae Viereck*, which it resembles, by having the first tergal plate smoother and more rounded apially and by the sparse punctures on the mesoscutum.

Female.—Length, 2 mm. The area between the eyes much broader than the length of the eye; face opaque, with irregular punctures; inner margins of the eyes nearly parallel; eyes hairy; frons, vertex, and posterior orbits with close, rather well-defined punctures; ocelli in a curved line; postocellar line subequal with the ocellocular line; posterior orbits narrowing posteriorly, subequal in width to the cephalo-caudad diameter of the eye; mesoscutum opaque, with close, sometimes confluent punctures; the suture in front of the scutellum plain; scutellum smooth and shining, the lateral depressed area foveolate; propodeum shining, with two median carinae which converge posteriorly; first tergal plate narrowing somewhat behind the middle, anterior width slightly less than its length; second tergal plate trapezoidal in outline, anterior width nearly twice as great as the length; third tergite normal; all of the abdomen shining, smooth; ovipositor about one-third the length of the abdomen. Black; tegulae, anterior femora except at base above, anterior tibiae and tarsi, intermediate femora beneath apically, intermediate tibiae and tarsi, basal half of the posterior tarsi and a narrow ring at base of the tarsal joints, white; wings clear hyaline, iridescent, venation yellowish brown.

Type-locality.—Buitenzorg, Java.

Described from 24 females (one, type) reared from the larva of *Hesperia conjuncta*, October, 1911, by K. W. Dammerman under his number 253.1.

Type.—Cat. No. 21506, U.S.N.M.

AMYOSOMA LEUZERAE, new species.

This species is very like the genotype *Amyosoma chilomis* Viereck, but it is slightly larger and darker, the front legs are black and the ovipositor is longer than the abdomen. It is probably very closely allied to, if not the same as, the Braconid figured on plate 16, figure 3, by van Deventer, Handboek ten dientse van de Suikerriet-Cultur on de Rutsuiker-Fabricage op Java, 1906.

Female.—Length, 4 mm.; length of ovipositor, 2 mm. Eyes slightly converging below, the distance between them at the vertex subequal with the length of the eye; clypeus finely granular, the rest of the head smooth, shining; ocelli in nearly an equilateral triangle; postocellar orbits sharply narrowing posteriorly, about half as wide as the cephalo-caudad diameter of the eye; thorax shining, without sculpture; the suture in front of the scutellum plain; first tergal plate about three times as long as its posterior width, nearly parallel-sided, anteriorly with two raised lines which diverge posteriorly; second tergal plate triangular in outline; the entire abdomen smooth and without sculpture, nervulus interstitial; recurrent interstitial; first abscissa of the radius slightly less than the first intercubitus, the second abscissa subequal in length to the first abscissa of the cubitus; radius leaving the stigma distinctly before the middle; legs normal. Black the entire mesothorax and lateral margins of the pronotum rufo-piceous; the sides of the first tergites white; body with sparse rather long gray hair; wings hyaline, iridescent, venation dark brown.

Type-locality.—Ambarawa, Java.

Described from three females (one, type) reared from the larva of *Zeuzera coffeae*, August, 1913, by K. W. Dammerman, under his number 389.

Type.—Cat. No. 21508, U.S.N.M.

PLATYBRACON JAVENSIS, new species.

Judging from descriptions this seems close to *Platybracon cariniceps* Cameron, yet it does not agree sufficiently well with his description to be considered that species. It is the second species known from Java.

Male.—Length, 6 mm. Face with a median nearly quadrate depression; a distinct carina from anterior ocellus to between bases of antennae, head somewhat narrowing behind eyes; posterior orbits as broad as cephalo-caudad diameter of eyes; head and thorax shining without sculpture; first tergal plate nearly parallel-sided, a little more than twice as long as apical width, its surface with irregular raised lines; second, third, and fourth tergites irregularly, longitudinally striate; the suture between the second and third crenulate; recurrent antefurcal by about one-third the length of the first intercubitus; second cubital cell quadrangular, about one-third longer than the first abscissa of cubitus; nervulus interstitial. Entirely reddish yellow; interocellar area and scape blackish; flagellum brownish; wings yellowish hyaline nearly to basal, beyond that brownish; along the anterior margin of first abscissa of cubitus and basal margin of second discoidal clear hyaline; venation the color of wing; stigma yellow basally, black apically.

Cocoon.—9.5 mm. by 4.5 mm. by 1 mm. Thin brownish, papery; single walled; parallel-sided with the ends rounded; flat, of uniform thickness throughout.

Type-locality.—Cheribon, Java.

Described from one male reared from a cocoon collected under bark and believed to be parasitic on *Chrysobotheris sexnotatus.* Reared by K. W. Dammerman under his number 396.

Type.—Cat. No. 21504, U.S.N.M.

ONCOPHANES HESPERIDIS, new species.

In Szepligeti's key[1] this space runs to the genus *Clinocentrus* Haliday. In Ashmead's key[2] it agrees better with *Oncophanes*, but even here the venation is somewhat at variance with the characters given. In habitus and abdominal structure it is more like *Oncophanes*, and it seems to congeneric with *O. launceolator* Nees, even though the venation is different.

Female.—Length, 2.75 mm.; length of ovipositor, .75 mm. Head shining, polished, distinctly narrowing behind the eyes; eyes large, subreniform, and slightly converging below; antennae with more than 30 joints; ocelli in nearly an equilateral triangle; thorax shining; prescutum with a median depression; suture in front of the scutellum with a few poorly defined rugae; propodeum with a median longitudinal carina, which becomes forked posteriorly; the area along this carina and the posterior face irregularly reticulate; first tergite short, the posterior width as great as the length, sharply margined laterally, its surface rather uniformly finely striate, with two carinae near the middle more prominent; second tergite fully one and two-thirds times as wide as long, shining without sculpture; the following tergites without sculpture, soft; ovipositor not half as long as abdomen; nervulus postfurcal by nearly its length; recurrent received in first cubital well before the intercubitus; first abscissa of radius two-thirds the length of first intercubitus; second abscissa of radius fully one and one-half times as long as the first intercubitus. Uniformly reddish-yellow; interocellar area and sheaths, brown, wings hyaline; venation pale brown.

In one paratype the tergites are brownish.

Type-locality.—Buitenzorg, Java.

Described from three females reared from a Hesperid larva, February, 1916, by K. W. Dammerman.

Type.—Cat. 21503, U.S.N.M.

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[1] Genera Insectorum, fas. 22, 1904, p. 76.
[2] Proc. U. S. Nat. Mus., vol. 23, 1900, p. 142.

HORMIOPTERUS CHOENOBIVORUS, new species.

The sculpture of the second tergite readily differentiates this species from all other species of this genus, which are in the United States National Museum collection. This is the first species of this genus from the East Indies and does not seem to be closely allied to any of the described forms.

Female.—Length, 3.5 mm. Length of ovipositor, 1.25 mm. Face shining, practically without sculpture, the lateral margin with a number of long, pale hairs; frons irregular reticulate; vertex and posterior orbits shining, very finely granular; ocelli arranged in nearly an equilateral triangle; mesocutum and prescutum opaque, closely granular; notauli complete and without distinct foveolations; prescutum posteriorly and the scutum on the posterior middle with a few large irregular punctures; the suture in front of the scutellum with a few rugae; scutellum opaque; propodeum granular, the middle areas somewhat shining, the posterior face coarsely reticulate, the carinae sharply defined, the median one two-thirds the length of the lateral ones, due to the deep V made by the transverse carinae; abdomen shining, the first, second, and third segments with regular well-defined longitudinal striae, the base of the fourth segment with a few irregular striae, the apical margin of the second and third narrowly, most of the fourth and all of the following smooth and without sculpture; the second tergite with a median more more or less lens-shaped area defined by foveolate furrows (this area is not quite as heavily striate); radius leaving the stigma at the middle; first abscissa one-fifth shorter than the first intercubitus; second abscissa but very little shorter than the first intercubitus; recurrent slightly beyond first intercubitus. Brownish yellow; head posteriorly and dorsally, mesoscutum, prescutum, and propodeum (medianly) brownish; legs pale yellow; wings hyaline, iridescent, venation including the stigma yellowish.

Type-locality.—Buitenzorg, Java.

Described from one female reared from pupa of *Choenobius bipunctifera* by K. W. Dammerman under his number 417.

Type.—Cat. No. 21501, U.S.N.M.

NEW MARINE SHELLS FROM PANAMA.

By Paul Bartsch,

Curator, Division of Marine Invertebrates, United States National Museum.

The United States National Museum has for a number of years been receiving mollusks collected by Mr. James Zetek in Panama. Most of these, however, have represented the larger, well-known species. It has been only recently that he has given attention to the securing of minute forms, among which no less than eight new species were discovered: Three *Epitoniums*,[1] which have already appeared in a paper by Dr. W. H. Dall,[2] and the five mollusks described in the present paper.

In addition to these there are fragments of several other species, which appear to belong to undescribed forms, diagnoses of which will be postponed until better material comes to hand.

CYLICHNELLA ZETEKI, new species.

Plate 88, fig. 4.

Shell small, thin, semitranslucent, bluish-white, or in dead shells cream-yellow. The early whorls always covered by the succeeding turns, so that in adult shells the last turn only is visible. Apex with a shallow umbilicus about one-fifth the diameter of the shell. Surface of the shell marked by slender lines of growth and very numerous, exceedingly fine, and exceedingly closely spaced spiral striations. In addition to this there are 12 strongly incised spiral grooves, which are subequal and subequally spaced and situated on the anterior two-fifths of the shell, and four incised spiral lines of similar spacing and similar strength situated on the posterior fifth of the shell. Aperture pyriform anteriorly, then forming a slender channel, which is almost of equal width from the anterior two-fifths to the posterior portion; outer lip thin, extending considerably posterior to the body whorl, strongly rounded at the posterior extremity, slightly concave in the middle, then strongly rounded anteriorly; columella

[1] *Epitonium zeteki, imbex,* and *thylax.*

[2] Notes on the Shells of the Genus Epitonium and its Allies of the Pacific Coast of America, Proc. U. S. Nat. Mus., vol. 53, pp. 486–487, 1917.

short, twisted, and truncated anteriorly to resemble a fold; a strong, oblique fold encircles the insertion of the columella; parietal wall covered by a thin callus.

The type (Cat. No. 216840, U.S.N.M.) and six specimens of this species were collected by Mr. James Zetek at Panama City, Panama. The type measures—length, 2.5 mm.; diameter, 1.2 mm.

ODOSTOMIA (CHRYSALLIDA) ZETEKI, new species.

Plate 88, fig. 5.

Shell of medium size, elongate-ovate, bluish-white. Nuclear whorls deeply immersed in the first of the succeeding turns, which gives the apex a truncated appearance; postnuclear whorls appressed at the summit, the later ones overhanging, marked by exceedingly strong, very distantly spaced axial ribs, of which 16 occur upon the second and third, 14 upon the fourth, and 12 upon the penultimate turn. These ribs are well rounded and have a slightly retractive slant. The spiral sculpture consists of five raised bands, which are a little wider than the spaces that separate them. The first of these is at the appressed summit of the whorls, while the fifth is immediately posterior to the angulated periphery (for in the adolescent stage, as shown by the overhanging portion of the whorls the periphery is angulated, though this is not the case in the last whorl of the adult shell), while these raised threads pass upon the sides of the ribs they do not pass over their summit in sufficient strength to render these tuberculated. The spiral pits between the axial ribs and spiral threads appear as oblong impressions, their long diameter being parallel with the spiral sculpture. Suture rather poorly marked, not at all channeled. Periphery of the last whorl well rounded. Base slightly produced, well rounded, narrowly umbilicated, marked by the continuations of the axial ribs, which extend feebly almost to the umbilical region, and eight spiral threads, of which the first two below the periphery are as strong as those occurring on the spire, while the rest become successively weaker and more flat anteriorly. Aperture ear-shaped; posterior angle decidedly channeled; outer lip thin and slightly reflected; inner lip curved, somewhat sinuous and slightly reflected over the umbilicus; parietal wall covered by a very strong callus, which is free at the edge and renders the peristome complete by connecting the posterior angle of the aperture with the insertion of the columella.

The type (Cat. No. 216905, U.S.N.M.) was collected by Mr. Zetek at Panama City, in sand siftings and rock washings at low-water mark. It has 5.8 postnuclear whorls and measures—length, 2.8 mm.; diameter, 1.3 mm.

This species is at once distinguished from all the others so far described from the West Coast by its very strong axial ribs, which are more distantly spaced than in any other form.

HELIACUS PANAMENSIS, new species.

Plate 88, figs. 6, 7, 8.

Shell small, chestnut brown, lenticular. Nuclear whorls well rounded, smooth, separated by a strongly impressed suture. Postnuclear whorls slightly rounded, marked by spiral cords and axial ribs, the junction of which forms nodules. The first spiral cord forms a shoulder that marks the highest elevation of the whorls. It is situated at some little distance anterior to the suture, which is located in a decidedly impressed groove. Following the nuclear turn, the whorls are sculptured with three spiral cords, of which one marks the summit as indicated, another the periphery, while the third is about midway between the two. As the whorls increase in size three additional cords make their appearance, first as slender threads, then increasing in size until they almost equal the median cord in strength. These three are located between the summit and the median cord. The first of these begins about a half turn behind the beginning of the postnuclear turn, and is situated a little posterior to the middle between the two. The second one begins about one and a fifth turns behind the beginning of the postnuclear turn and is a little nearer to the intercalated cord than the median. The last one has its inception about a half turn behind the aperture, and is about midway between the second intercalated cord and the median one. The axial ribs are well rounded and retractively slanting. There are 24 of these on the first whorl, 35 on the second, and 40 on the remaining half turn, on the latter part of which they are rather closely crowded. The spaces inclosed by the ribs and the spiral cords are well-impressed rhomboidal pits. Suture strongly channeled. Last whorl rendered keeled by a strong spiral cord, which is covered up in the preceding whorls. This is really the true peripheral cord, but on the preceding turns, the one anterior to it, is the last one visible.

Base well rounded, openly umbilicated, marked on the anterior half by four equal and equally spaced spiral cords, while the inner half bears three additional spiral cords, of which the one bordering the umbilicus is very broad. The two anterior to this are about twice as strong as the four anterior to these two, and they are also spaced about doubly as wide as the four preceding. Near the aperture a slender spiral thread appears between these two. The axial sculpture of the base is a continuation of the axial ribs on the upper surface, which extend strong and undiminished to the umbilicus. Here, however, we usually have two ribs fused in the cord bordering the umbilicus with a strong callus between, forming a series of very strong nodules. The junction of the four anterior spiral keels of the base and the axial ribs forms well-rounded nodules, while those of the two succeeding spiral turns are about twice as strong and those of the cord bordering the umbilicus are about four times as strong as those on the four anterior cords. The parietal wall bordering the umbilicus is concave and crossed by the axial ribs. Aperture subcircular; peristome rendered sinuous by the spiral sculpture; parietal wall covered by a thin callus.

The type (Cat. No. 216838, U.S.N.M), was collected by James Zetek at Punta Paitilla, near Panama City, Panama, in siftings from sand and worm burrows. It measures—greater diameter, 3.8 mm.; lesser diameter, 3 mm.; altitude, 1.2 mm.

DISCOPSIS PANAMENSIS, new species.

Plate 88, figs. 9, 10, 11.

Shell lenticular, thin, semitransluscent, bluish-white. Nuclear whorls two, strongly rounded, forming an elevated mucronate apex; succeeding turns one and three-fourths, decidedly depressed, gently rounded. The part following the nuclear turn is ornamented by two strong, spiral cords, one of which is at the periphery and the other halfway between this and the summit, where it forms a decidedly strong angle. Soon after this various other spiral cords make their appearance at intervals, resulting eventually in 10 subequal and subequally spaced cords between the suture and the peripheral keel. These cords are rendered nodulose by the somewhat irregularly developed and distributed, decidedly protractedly bent axial riblets which pass undiminished from the summit of the whorls to the periphery. Suture strongly channeled. Periphery rendered angulated by the limiting cords. Base with a very broad funnel-shaped umbilicus, well rounded, the greatest convexity falling on the posterior limit of the anterior third, marked by the irregular axial riblets and numerous very fine closely spaced incised spiral lines which pass equally over the intercostal spaces and ribs. This sculpture passes over the parietal wall into the umbilicus. Aperture very large, pyriform, decidedly oblique; outer lip rendered sinuous by the external sculpture, which is also apparent through the mass of the shell; inner lip evenly curved; parietal wall very narrow, almost crossed by the two ends of the aperture.

The type (Cat. No. 216839, U.S.M.N.) was collected by Mr. James Zetek at Punta Paitilla, near Panama City, Panama, from sand and worm burrow siftings. The type measures—greater diameter, 2.3 mm.; lesser diameter, 1.8 mm.; altitude, 1 mm.

DISCOPSIS ARGENTEA, new species.

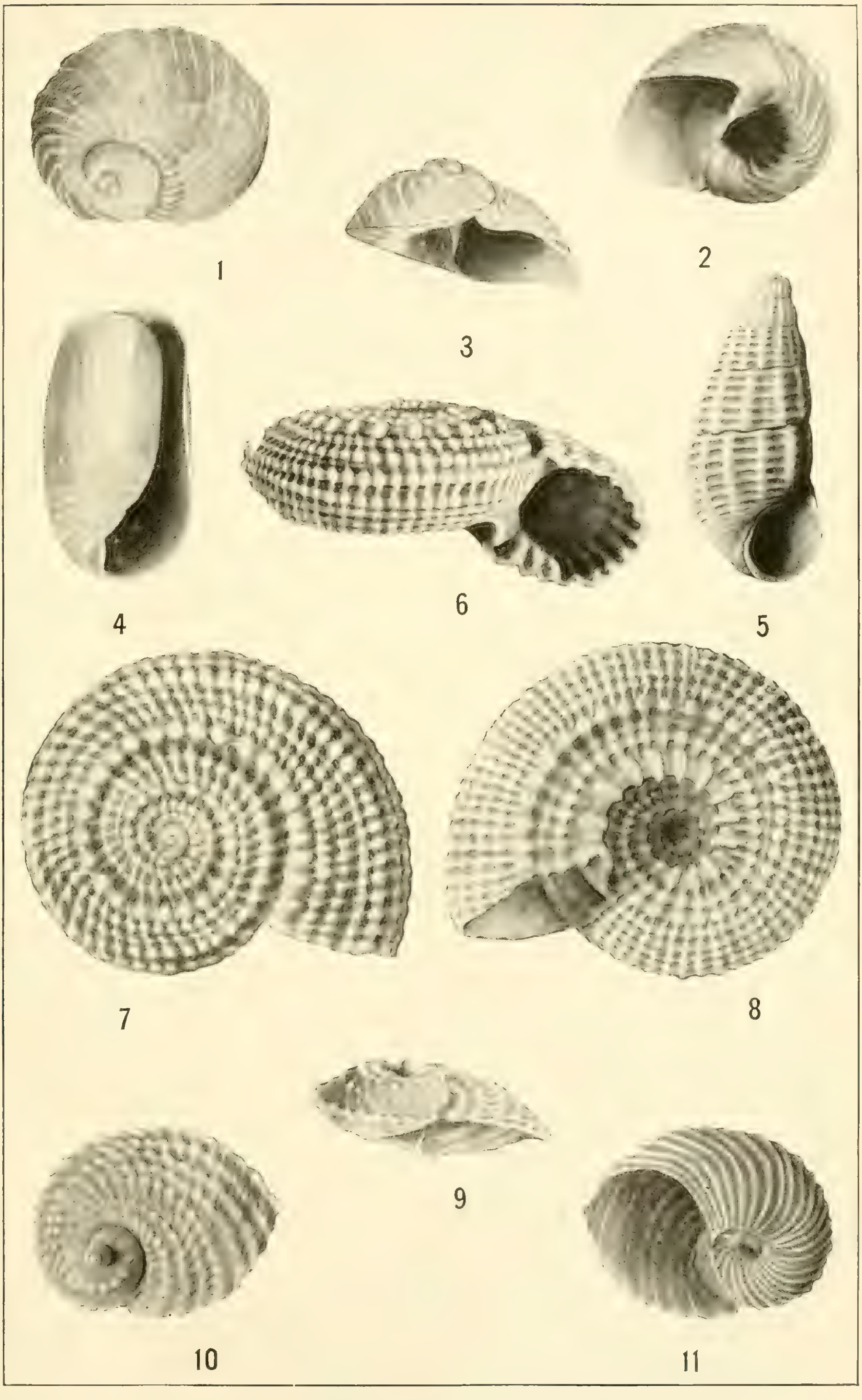
Plate 88, figs. 1, 2, 3.

Shell small, discoid, thin, semitranslucent. Nuclear whorls three, smooth, small, forming a quite elevated spire, the axis of which is obliquely tilted to that of the succeeding turns. Postnuclear whorls two, well rounded above, the first one and a half marked with a strong keel about one-third of the distance between the suture and the periphery, anterior to the suture. This keel becomes enfeebled on the last half of the last whorl and practically completely disappears before the edge of the aperture is attained. In addition to this keel the upper surface is marked by rather distantly spaced, slender, recurvedly slanting axial riblets, of which 19 occur upon the first turn and 22 upon the last; these riblets are about one-sixth as wide as the spaces that separate them in the region of the keel and much more distantly spaced at the periphery. In addition to the axial sculpture, the whorls are marked on the upper side by slender, raised spiral threads, which are separated by fine, incised lines; of these threads 50 occur between the summit and the periphery of the last whorl. Sutures strongly impressed. Periphery of the last whorl strongly carinated. Base very broadly, openly unbilicated, marked by the continuations of the axial riblets which become condensed within the umbilicus and somewhat irregularly spaced. The spiral sculpture on the base is even finer than on the upper surface. In fact, it is so fine that we have found it best not to indicate it in our sketch. Aperture very large, oblique; with a decided angle at the periphery and another at the junction of the columella and the basal lip; parietal wall very narrow, covered by a thin callus.

The type (Cat. No. 216920, U.S.N.M.) comes from shell siftings of sand and worm burrows collected at Punta Paitilla, near Panama City. It measures—altitude, 1 mm.; diameter, 2.2 mm.

EXPLANATION OF PLATE 88.

FIGS. 1, 2, and 3. *Discopsis argentea.*
4. *Cylichnella zeteki.*
5. *Odostomia* (*Chrysallida*) *zeteki.*
6, 7, and 8. *Heliacus panamensis.*
9, 10, and 11. *Discopsis panamensis.*



New Marine Shells from Panama

For explanation of plate see page 575

ON THE ANATOMY OF NYCTIBIUS WITH NOTES ON ALLIED BIRDS.

By Alexander Wetmore,

Of the Biological Survey, United States Department of Agriculture.

The sternum and foot of the genus *Nyctibius* have been described by P. L. Sclater,[1] and an account of the palate was given many years ago by Huxley,[2] but little has been published on the anatomy of the soft parts of these birds so far as is known. Through the courtesy of Dr. C. W. Richmond, acting curator in the Division of Birds, United States National Museum, the writer has been permitted to dissect the body, preserved in alcohol, of the type-specimen of the Potoo described recently as *Nyctibius griseus abbotti*.[3] This bird (Cat. No. 225851, U.S.N.M.), a male, was collected by Dr. W. L. Abbott at Port de Pimenti, northwest Hayti, on March 9, 1917. Though this specimen comprised the trunk and viscera alone, several points of interest were brought out by critical examination. An account of the dissections made is given in the following pages.

The esophagus was contracted, and in this state had strong thickened walls, with the inner surface thrown into a series of longitudinal folds or rugae that expanded anteriorly to join the broader surface of the pharynx. Apparently the esophagus was capable of great distension in life, and the bird must have been able to swallow any object that could pass the opening guarded by the furculum and the vertebrae at the anterior end of the body cavity. The proventriculus was large and glandular, and the stomach proper was comparatively thick walled and strong. This bird probably regurgitates pellets composed of chitinous fragments of insects and other indigestible matter, as the pyloric opening of the ventriculus was too small to allow particles of any size to pass. In the present instance the stomach contained insect jaws and other fragments too large to pass through into the small intestine and too firm in texture to permit of trituration.

[1] Notes upon the American Caprimulgidae, Proc. Zool. Soc. London, 1866, pp. 123–130.
[2] On the Classification of Birds, Proc. Zool. Soc. London, 1867, p. 454.
[3] Richmond, C. W., Descriptions of two new Birds from Haiti, Smiths. Misc. Coll., vol. 68, No. 7, July 12, 1917, p. 1.

Proceedings U. S. National Museum. Vol. 54—No. 2251.

The convolutions of the gut were of the isocoelous type. When removed from the body and dissected out, a large duodenal loop (see fig 1) was found, in which the intestine was larger in diameter than elsewhere. The remainder of the small intestine was thrown out in one large loop with three smaller divisions indicated. The remnant of the vitelline duct apparently was near the summit of the second of these smaller divisions, but it could not be made out exactly and the position assigned to it in the accompanying figure is somewhat uncertain. The caeca were paired and much elongated. At the open end each caecum was slender, while for its posterior half each was much dilated. The intestine was somewhat narrowed at the point where the caeca were given off, and then expanded into the rectum. Measurements of the intestine were taken as follows:

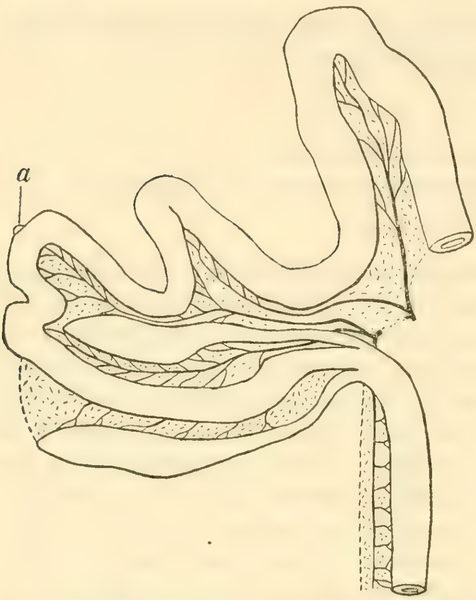


Fig. 1.—Diagram of the intestinal convolutions in Nyctibius griseus abbotti (about natural size). *a*, Remnant of vitelline duct.

	mm.
Total length	250
Distance from caeca to anus	30
Length of caeca	42

The liver (fig. 2) was bilobate, with the left division only about one-fifth the size of the right. The left lobe was elongate and flaplike, and measured 20 mm. long by 11 mm. wide. The right lobe was somewhat triangular in outline, with a broad, square-angled lower margin. The width of this lobe decreased toward its anterior end, where it was more or less squarely truncated. The external margin was straight and the internal border, forming one side of the cavity to receive the lower end of the pericardium, was sinuate. Through the center this lobe was 33 mm. long. The tips of the two lobes converged toward one another, though medially the right and left divisions were separated by a comparatively broad space. At

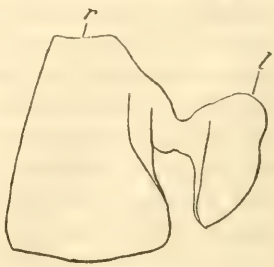


Fig. 2.—Outline of liver lobes of Nyctibius griseus abbotti from the ventral surface (slightly less than natural size). *r*, Right lobe; *l*, left lobe.

the anterior end the two lobes were connected by a band of liver tissue 7 mm. long. This band was broad where it joined the left lobe, expanded by a rounded process on its lower margin, and then contracted to a narrow neck to join the right lobe. The small size of the left liver lobe is unusual, as in allied forms concerning which information or specimens are available (*Podargus*, *Caprimulgus*, *Phalaenoptilus*, *Setochalcis*, *Nyctidromus*, and *Chordeiles*) the left lobe is much larger, being from one-third to more than one-half the bulk of the right hand division.

A small elongate gall bladder similar to that found in other Caprimulgi (including *Chordeiles* [1]) underlaid the right lobe of the liver in a notch near the external margin. The pancreas was small, consisting of a single lobe that was rounded and full at the lower end, elongate and attenuate above. It was not possible to trace the hepatic and pancreatic ducts in this specimen to the point where they entered the intestine.

The spleen was placed against the anterior end of the gizzard on the right side, beneath the upper end of the right liver lobe. It was elongate with bluntly rounded ends, flattened somewhat from side to side, but in general form was cylindrical. The spleen measured 10 mm. long and the flattened face was 2.5 mm. broad.

There was only one carotid artery, a character in which *Nyctibius* resembles *Podargus* and differs from the Caprimulgidae. The left carotid passes up out of the body cavity, and then swings over to run on up the neck through the hypapophysial canal, as in a specimen of *Podargus strigoides* (Cat. No. 19361, U.S.N.M.) examined. In *Nyctibius* there is a small artery on the right side that extends to the right thyroid gland. A branch of this artery then proceeds inwards as a vertebral artery but extends no farther up the neck.

In the specimen of *Nyctibius* at hand the trachea was injured so that a detailed study of it was not practicable. It was ascertained, however that the syrinx was tracheo-bronchial, in which character this genus resembles the Caprimulgidæ.

The sternum has been studied so no details of the trunk skeleton need be given save to note that the procoracoidal process is small, not reaching the clavicle, and that there are 14 cervical vertebrae of which three bear free ribs.

There is some confusion in published accounts as to the number of cervical vertebrae in this group. Beddard [2] states that *Chordeiles* possesses 13. Gadow [3] gives 14 for *Podargus* and *Batrachostomus* and 13 for *Caprimulgus*. Fürbringer [4] says that *Caprimulgus* has 13

[1] Wetmore, Proc. Biol. Soc. Washington, vol. 28, 1915, pp. 175–176.

[2] Structure and Classification of Birds, 1898, p. 241. See also Oberholser, A monograph of the Genus Chordeiles, U. S. Nat. Mus. Bull. 80, 1914, p. 9.

[3] Bronn's Klassen and Ordnungen des Thier-Reichs, Vögel, vol. 1, 1891, p. 950.

[4] Untersuchungen zur Morphologie and Systematik der Vögel, vol. 1, 1888, table 23. pp. 780–781.

and *Batrachostomus* 14. In the following table is given the number of cervical and cervico-dorsal vertebrae (those possessing free ribs) and the number of complete ribs reaching the sternum in the species at hand at the present time:

List of species.	Cervical vertebrae.	Free ribs.	Complete ribs.
Steatornis caripensis U.S.N.M. No. 18309	15	3	4
Podargus strigoides U.S.N.M. No. 18572	13	2	5
Podargus strigoides U.S.N.M. No. 19361	13	2	5
Nyctibius griseus U.S.N.M No. 225851	14	3	4
Chordeiles acutipennis A.W. No. 1265	14	3	4
Chordeiles virginianus A.W. No. 1269	14	3	4
Chordeiles virginianus U.S.N.M. No. 224500	14	3	4
Phalaenoptilus nitidus U.S.N.M. No. 19146	14	3	4
Nyctidromus albicollis U.S.N.M. No. ——	14	3	4
Caprimulgus europaeus U.S.N.M. No. 19359	14	3	4
Setochalcis vocifera U.S.N.M. No. 17478	14	3	4
Antrostomus carolinensis A.W. No. 914	14	3	4
Thermochalcis cayennensis A.W. No. 1280	14	2	5

It will be noted that *Podargus* has only 13 cervical vertebrae, instead of 14, as given by other authors, and that (with the exception of *Steatornis*) all of the other genera available (including *Chordeiles* and *Caprimulgus*) possess 14.

There is enough of the base of the skull present in the specimen of *Nyctibius* examined to show that well-developed basipterygoid processes are present, a fact not previously known, as Huxley[1] figured only the palatal portion of the skull in this bird, possibly from a specimen taken from a study skin.

In addition to this the writer is unable to find a trace of an oil gland in this alcoholic specimen or in a series of skins of *Nyctibius* that are available in the collections of the United States National Museum.

The tongue (fig. 3) of *Nyctibius* is small in proportion to the size of the mouth cavity as in other Caprimulgi. In form it differs considerably from the tongues of related genera. The tip of the tongue in *Nyctibius* is somewhat elongate, with the lateral outlines at first concave. The postero-lateral margins are produced as elongate points that equal the anterior portion in length. The outline of the lateral margin of these is convex. In general the form of the tongue is that of the head of a spear point, with a deeply incised base, spreading posterior angles, and slender point. The margins of the tongue at the tip are smooth. A short distance behind small spine-like papillae appear, with the points directed backward. These increase greatly in size toward the posterior end of the tongue and extend around on the inner margins of the posterior elongations. These points are not wholly symmetrical in their arrangement upon the opposite sides of the tongue. They are firm in texture and are

[1] Proc. Zool. Soc. London, 1867, p. 454, fig. 6.

sharply pointed, but bend readily. The upper surface of the tongue appears smooth to the unaided eye, but when examined with a hand lens it is found to have a few minute spines scattered over its surface. The tongue measured 20 mm. long and the posterior prongs were 12 mm. apart.

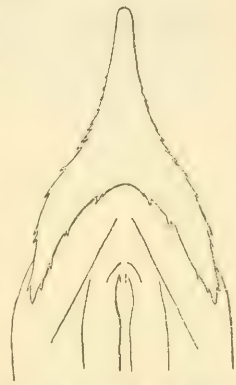


FIG. 3.—TONGUE OF NYCTIBIUS GRISEUS ABBOTTI (×2. CAT. NO. 225851, U.S.N.M.).

Examination of other species available belonging to the suborder Nycticoraciae shows four main types of tongue structure in this group. The material available includes the following: *Steatornis caripensis*, *Podargus strigoides*, *Nyctibius griseus*, *Chordeiles acutipennis*, *Chordeiles virginianus*, *Phalaenoptilus nitidus*, *Nyctidromus albicollis*, *Caprimulgus europaeus*, and *Setochalcis vocifera*. The form of tongue peculiar to *Nyctibius griseus* has been described above. Of the remaining forms *Podargus* (fig. 4) possesses a tongue most remarkable in form. This organ has been briefly described by Beddard[1] as "a curious tough but transparent membranous organ," but no other reference to its peculiarities has been found in literature available. The tongue in *Podargus* is elongate and much larger in proportion to the size of the mouth cavity than in other forms examined. The anterior end of the hyoidean apparatus forms a thickened, pointed projection in the tongue base, as shown by the line *x* in the text figure. Anterior to this strong base the tongue is thin and translucent, being not much thicker than a sheet of ordinary writing paper. The lateral outlines of this portion are slightly convex, and are somewhat irregular, due to wear of the thin, delicate margins. The tip forms an obtuse point. At the base the tongue is dilated on either side, and terminates in two pointed projections. The margins of these projections are armed with spinose papillae projecting backward, which continue around on the inner side. These papillose points are not symmetrically developed on the opposing side. The base of the tongue lies only a short distance in front of the glottis. It seems questionable whether the thin anterior portion of the tongue can serve any purpose in feeding, although that is a point to be settled only by observation of living specimens. The

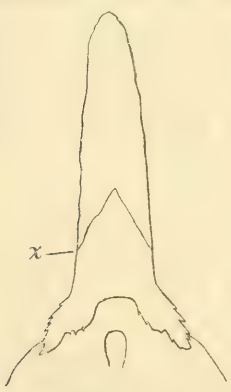


FIG. 4.—TONGUE OF PODARGUS STRIGOIDES (ABOUT NATURAL SIZE. CAT. NO. 19361, U.S.N.M.). *x*, LINE MARKING BOUNDARY BETWEEN STRONG BASE AND THIN, PAPER-LIKE TIP.

[1] Structure and Classification of Birds, 1898, p. 234.

tongue in *Podargus strigoides* is certainly one of the most curious found in the Class of Birds.

The tongue of *Steatornis caripensis* (fig. 5) has been briefly described by Garrod.[1] In two alcoholic specimens in the United States National Museum collections the tongue is shaped like an arrowhead with a rather elongate bluntly pointed tip, convex lateral outlines, and spreading, somewhat slender posterior processes that project beyond the hinder border. The margins of these posterior processes are armed with soft, slender, backward projecting papillae, and smaller papillae of the same nature are found on the upper surfaces of these projections. The arrangement of these papillose points is not symmetrical and the tongue is somewhat thickened basally, becoming thin at the anterior end. In the specimen figured (a male, Cat. No. 18309, U.S.N.M.) the tongue measured 19.5 mm. along the sides by 12 mm. broad across the spreading base. These measurements are slightly in excess of those given by Garrod.

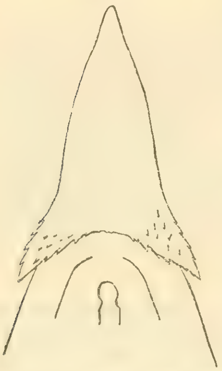


FIG. 5.—TONGUE OF STEATORNIS CARIPENSIS (×2. CAT. NO. 18309, U.S.N.M.).

The remaining genera examined all belong in the family Caprimulgidae, and in all the tongue is small, more or less triangular in form, with the posterior lateral margins and upper surface armed with papillae of varying sizes. Various modifications of this general type mark the different genera, as may be noted in the following pages. Though the tongue is small in all these forms, it must be considered that it plays a definite part in manipulating food in swallowing; otherwise the development of the basal papillae would be less marked.

In a treatise on the anatomy of *Phalaenoptilus* that species as "slender and pointed. Posteriorly it is *nitidus* Miss M. E. Marshall,[2] describes the tongue of bifid and fimbriated." In a specimen at hand this organ (fig. 6) is small, measuring 9.5 mm. long by 3 mm. broad. The postero-lateral spinose processes are elongate and pointed. The lateral margins in outline are approximately straight lines. Spinose, backward projecting papillae begin at a point anterior to the center and become stronger and heavier toward the base of the tongue. The upper surface of the tongue for its basal two-thirds is thickly set with small horny papillosities, all projecting backward. Because of

FIG. 6.—TONGUE OF PHALAENOPTILUS NITIDUS (×2. CAT. NO. 19146, U.S.N.M.).

[1] Proc. Zool. Soc. London, 1873, p. 531.

[2] A Study of the Anatomy of Phalaenoptilus Ridgway, Proc. Amer. Philos. Soc., vol. 44, 1905, p. 215. (See pl. 4, fig. 10.)

the posterior elongation of the lateral processes, the basal margin appears deeply incised, in this respect exceeding any of the other genera examined save *Nyctidromus*. The arrangement of the lateral papillary processes is not bilaterally symmetrical.

In a specimen of *Nyctidromus albicollis* the tongue is very similar to that just described and figured in *Phalaenoptilus*. Strong backward directed papillae are found on the lateral margins posterior to the middle and the arrangement of the papillae on the upper surface is somewhat different than in *Phalaenoptilus*. A row of strong spicules, four or five in number is developed on either side, and at the base the number of papillae is reduced to two or three. A slender papillus arising on the inside, at the tongue base, is about two-thirds as long as the postero-lateral process. The margins of the latter are smooth, and the processes are elongate as in *Phalaenoptilus*. The tongue measures 10.5 mm. long by 2.5 mm. broad at the base.

The tongue of *Caprimulgus europaeus* has been described briefly by William MacGillivray[1] who notes (p. 634) that it "is extremely small, slender, slightly papillate at base, having also some papillae on its upper surface, tapering to an obtuse point." In a specimen at hand (Cat. No. 19359, U.S.N.M.) the tongue resembles that of *Phalaenoptilus nitidus*, but has the postero-lateral spines much less elongate. The tongue in this specimen measures 10 mm. long by 3 mm. broad at the base. In outline the lateral margins are nearly straight, so that in profile the tongue is like an elongate triangle. Pointed papillae projecting backward begin on the margins at a point anterior to the middle and continue to the base. The last in the series toward the base of the tongue are the largest. The postero-lateral spines are moderately elongate and there are no other projections from the posterior margin. Small scattered conical papillae cover the posterior half of the upper surface. Toward the base there is one row on either side of the center composed, respectively, of two and three papillae each that point in toward the center.

The tongue of *Setochalcis vocifera* has likewise been described by MacGillivray[2] who notes that it is "slender, tapering to a point, very thin, with two long-pointed papillae at the base, and numerous small papillae on its upper surface." In specimens examined by the writer the tongue in this species also resembles that described in *Phalaenoptilus nitidus*. In form it is slender and elongate with a triangular outline. One specimen seen (Cat. No. 223661, U.S.N.M.) is 10.5 mm. long by 3 mm. broad at the base. Spinose processes appear on the margin about one-half of the distance back from the tip; these increase slightly in size toward the posterior part of the

[1] History of British Birds, London, vol. 3, 1840, pp. 630 and 634.
[2] In Audubon, J. J., Ornitholigical Biography, Edinburgh, 1839, vol. 5, p. 306.

tongue. The postero-lateral spines are elongated as slender, pointed processes, and there are six or seven small backward-projecting papillae on the upper surface of the tongue near the base. The hyoidean muscles in this species are very slight in development.

No alcoholic specimen of *Antrostomus carolinensis* is at hand, but the tongue in this species (also described by William MacGillivray [1]) is said to be " very small, * * * attenuated, tapering, flat above, covered with papillae, of which there is a large one at the base on each side; the tip is narrow, but rather obtuse." No drawing showing the tongue is given, but from the description quoted it is evident that it resembles in general type the tongues of *Phalaenoptilus*, *Caprimulgus*, and *Setochalcis*.

The tongue of *Chordeiles virginianus*, while similar to that of other Caprimulgidae, shows a slightly different development. This organ in the nighthawk (fig. 7) is small in comparison to the size of the mouth opening, but is strong and heavy. It measures approximately 9 mm. long by 4.7 mm. broad at the base, so that it is short and broad in comparison with the lingual appendages of other genera in this family that have been described. This difference was noted by MacGillivray [2] in his dissections of birds made for Audubon. In outline the tongue of *Chordeiles virginianus* is triangular, with the lateral margins slightly concave. The postero-lateral angles are produced as curved spinose processes, and the line of the base is incised at the center. The lateral margins of the tongue are armed with spinose papillae, which are small and weak anteriorly and become strong and heavy toward the base. Stronger processes arm the posterior margin, and the broadened basal third of the tongue has its dorsal surface covered with pointed, harsh papillosites, all directed toward the pharynx. The hyoidian muscles are fairly strong and well developed.

FIG. 7.—TONGUE OF CHORDEILES VIRGINIANUS (×2. CAT. NO. 225265, U.S. N.M.).

In *Chordeiles acutipennis* the tongue resembles that described in *C. virginianus* but is smaller, measuring only 7.5 mm. long by 4.5 mm. broad at the base. The postero-lateral spines are somewhat longer so that the posterior margin appears more deeply incised. The lateral outlines and the arrangement and size of the spines are practically the same as in the larger nighthawk. The tongue is these birds, though small, appears so much stronger than in the other Caprimulgidae and is so heavily armed with papillae that it must be supposed that it plays an important rôle in the swallowing of food. Certainly the development of spines is so striking that the tongue in this genus can not be considered rudimentary or functionless.

[1] Audubon, J. J., Ornithological Biography, Edinburgh, 1839, vol. 5, pp. 402–403.
[2] Idem, p. 407.

The relationships of the goatsuckerlike birds of the groups characterized by the genera *Podargus*, *Nyctibius*, and *Caprimulgus* have been interpreted in various ways by different authors. Sharpe[1] placed *Podargus* in a suborder Podargi of the Coraciiformes, while he united *Nyctibius*, which he considered as the type of a distinct family, the Nyctibiidae, with the Caprimulgidae in another suborder, the Caprimulgi. Beddard[2] and Gadow[3] on anatomical grounds joined all these with *Steatornis* under one suborder known as the Caprimulgi.

Mr. Ridgway[4] in his recent treatment of the group has proposed a suborder Nycticoraciae to include the superfamilies Caprimulgi (Caprimulgidae + Nyctibiidae), Podargi (Podargidae) and Steatornithes (Steatornithidae).

The grouping of *Steatornis*, *Podargus* and its allies, *Nyctibius*, and the various genera belonging to the Caprimulgidae in one suborder under the Coraciiformes is one that seems logical in view of the facts known through modern research into the affinities of these birds. *Steatornis* as an outlying aberrant form, though seeming to belong to this suborder, is so different from the other genera included in the Nycticoraciae that it is readily separated from them in a well circumscribed division, and may be dismissed without further comment. A survey of the facts now known concerning the anatomy of *Nyctibius*, however, together with the structural characters of this genus previously recorded, serve to show that the gap between the two remaining superfamilies recognized by Mr. Ridgway is less trenchant and sharply defined than has been supposed. In the following table are given the details of 12 of the main structural characters of use in the classification of the members of this group remaining after *Steatornis* is removed.

	Podargus.	*Nyctibius.*	Caprimulgidae.
Oil gland	Absent	Absent	Present.
Powder down patches	Present	Present	Absent.
Carotid arteries	One (left)	One (left)	Two.
Syrinx	Bronchial	Tracheo-bronchial	Tracheo-bronchial.
Left liver lobe	More than one-half as large as right.	One-fifth as large as right.	One-third to one-half as large as right.
Tongue	Large, with transparent paperlike tip, spinose basally.	Medium, shaped like a spearhead, feebly papillate.	Small, triangular in outline, more or less spinose.
Cervical vertebrae	13	14	14.
Sternum	Four notched	Four notched	Two notched.
Procoracoidal process	Large, reaching furculum and scapula.	Small, not reaching furculum.	Small, not reaching furculum.
Basipterygoid processes	Absent	Present	Present.
Palatines	Broad throughout, slightly expanded posteriorly.	Narrow anteriorly, greatly expanded posteriorly.	Narrow anteriorly, greatly expanded posteriorly.
Number of phalanges in fourth toe.	Five	Five	Four.

[1] Review of Recent Attempts to Classify Birds, 1891, pp. 79, 81.

[2] Structure and Classification of Birds, 1898, pp. 231–244.

[3] Classification of Vertebrata, 1898, pp. 36–37.

[4] Birds of North and Middle America, Bull. 50, U. S. Nat. Mus., part 6, 1914, pp. 487–489.

It will be noted that in five of the characters outlined, *Nyctibius* agrees with the Podargidae, and in five with the Caprimulgidae. In the absence of an oilgland, presence of powder down patches, single carotid artery, four notched sternum, and the possession of five phalanges in the fourth toe *Nyctibius* resembles *Podargus* (here taken as typical of the family Podargidae). While in its tracheobronchial syrinx, 14 cervical vertebrae, presence of basipterygoid processes, development of the procoracoidal process, and the form of its palatines *Nyctibius* is similar to the Caprimulgidae. It is seen from a study of these points then, that, as Gadow stated,[1] the Nyctibiidae seem to form an intermediate group between the other two. Study and comparison of the known characters of *Aegotheles* which forms another family of this group, the Aegothelidae, serves to narrow the gap between Podargidae and Caprimulgidae still more.[2] It is thought that the two major groups will be found still more closely allied when more is known of *Aegotheles*, and when *Batrachostomus* has been more carefully investigated. From present knowledge *Batrachostomus* seems to belong in the family Podargidae as it is said to have a four-notched sternum, a bronchial syrinx, and a desmognathous palate, while it lacks basipterygoid processes. It differs from *Podargus* in possessing an oil gland.

From the facts outlined above it seems that the suborder Nycticoraciae of the Order Coraciiformes may be divided into two superfamilies, the Steatornithoidae with the single genus *Steatornis* and the Caprimulgoidae with the families Podargidae, Nyctibiidae, Aegothelidae, and Caprimulgidae. In the second superfamily the Podargidae, though specialized, are considered lowest and the Caprimulgidae highest in development. The Nyctibiidae and the Aegothelidae seem to be about on the same level, though on the whole the latter seems the more primitive.

[1] Bronn's Klassen und Ordnungen des Thier-Reichs, Vögel, vol. 2, p. 243.

[2] As alcoholic specimens or skeletons of *Aegotheles* are not available, the writer is indebted for information on this genus and on *Batrachostomus* to the following: Beddard, Structure and Classification of Birds, 1898, pp. 231–244; Gadow, Bronn's Klassen und Ordnungen des Thier-Reichs, Vögel, vol. 2, pp. 242–243; to brief notes gleaned from other sources, and to such characters as are available from the study of skins.

FOUR NEW AFRICAN PARASITIC HYMENOPTERA BELONGING TO THE SUBFAMILY MICROGASTERINAE.

By A. B. Gahan,

Of the Bureau of Entomology, United States Department of Agriculture.

The following four species of parasitic Hymenoptera were received in 1916 by the Bureau of Entomology from Mr. C. C. Gowdey. All the specimens were reared, but in only two cases are the names of the host caterpillars known. Very few Microgasterinae appear to have been recorded from Africa and these will form an interesting addition to the known fauna.

Family BRACONIDAE.

Subfamily Microgasterinae.

MICROGASTER FASCIIPENNIS, new species.

Female.—Length, 2.9 mm. Black; palpi and scape reddish testaceous; flagellum fusco-testaceous basally, becoming piceous toward the apex; anterior femora, narrow apex of median femora, anterior and median tibiae and tarsi, and a broad basal annulus on the hind tibiae pale reddish testaceous; remainder of legs black or blackish; first and second ventral abdominal segments pale; apical one-fourth of the forewing distinctly clouded, the basal three-fourths hyaline, stigma and veins dark brown. Head, mesoscutum, and scutellum closely, strongly punctured, the punctures not confluent; face with a delicate median carina from the base of antenna half way to clypeus; frontal depression smooth and polished; posterior orbits more sparsely punctured than the face; mesoscutum without parapsidal furrows; mesopleura punctate above and below with a nearly impunctate area medially; propodeum rugoso-punctate, with a strong median carina, the anterior margin nearly smooth; hind coxae large, strongly punctured, subopaque, extending backward to the middle of the abdomen; hind femora sculptured like their coxae; hind tibiae slightly curved, the longer tibial spur equal to two-thirds the length of the basal tarsal joint; second cubital cell of forewing very minute, triangular; abdomen about equal to the thorax in length, compressed from the sides, its greatest width not more than half the width of thorax at the tegulae; first tergite twice as long as broad, the apex scarcely broader than the base, the lateral apical angles slightly rounded; tergites all polished; ovipositor slightly exerted but not extending beyond the apex of abdomen, very slightly curved downward.

Male.—Agrees with the female except that the middle femora and the hind tibiae are mostly testaceous.

Type-locality.—Kampala, Uganda, British East Africa.

Type.—Cat. No. 21598, U.S.N.M.

Host.—*Deilemera apicalis* Walker.

Sixteen females and three males received by the Bureau of Entomology from Mr. C. C. Gowdey and on his authority reared from the above-named host.

The cocoons of this species are pure white and arranged side by side in a compact mass like the cells in honeycomb. The arrangement of the cocoons is similar to that of some species of *Microplitis* and the nonsculptured abdomen also suggests that genus, but the long spurs on hind tibiae and the absence of crenulate episternauli place the species in *Microgaster.*

APANTELES PALLIDOCINCTUS, new species.

Female.—Length, 2.9 mm. Black; mouthparts, scape, legs, including all coxae, venter of the abdomen and the first and second dorsal segments pale testaceous; wings hyaline, veins and stigma dark brown. Head polished with sparse weak punctures on face; antennae about as long as the body, the first six flagellar joints subequal and three times as long as thick, following joints gradually shorter. Thorax smooth, polished, the mesoscutum anteriorly and the mesopleura anteriorly and below moderately punctured, the sternauli smooth and not deeply impressed; propodeum smooth, impunctate, without a median carina; hind coxae extending backward beyond the middle of the abdomen and sparsely punctured; abdomen smooth and polished, narrow, its greatest width only a little more than half the width of thorax at tegulae; first tergite slightly narrower at apex than base and about twice as long as broad at base; second tergite with a short oblique furrow on each side of the middle extending backward and laterally from the angles of the first tergite; ovipositor not exerted beyond the apex of abdomen. Male unknown.

Type-locality.—Kampala, Uganda, British East Africa.

Type.—Cat. No. 21599, U.S.N.M.

Host.—*Papilio demodocus* Esper.

Six female specimens received by the Bureau of Entomology from Mr. C. C. Gowdey, and on his authority reared from the above-named host.

APANTELES UGANDAENSIS, new species.

Female.—Length, 2.2 mm. Black; mouthparts, scape, pedicel, three or four basal flagellar joints, tegulae, and the legs except the hind coxae pale testaceous, the apex of hind tibiae and their tarsi slightly infuscated; ventral abdominal segments one and two also testaceous; wings hyaline, stigma and costa dark brown, the other veins paler. Head smooth or nearly so, with obscure punctures on the face; face rather narrow, the greatest distance between the eyes below the antennae very slightly less than the distance from the base of antennae to clypeus; antennae shorter than the body, the first flagellar joint about two and one-half times as long as thick, second to the sixth joints each about one and one-half times as long as thick, joints beyond the sixth to the apex slightly shorter, the apical four or five joints more or less pedicellate; malar space not greater than the width of a mandible at base; thorax for the most part impunctate, the mesoscutum anteriorly and the pleura anteriorly, with some very weak punctures; propodeum polished without a median carina; hind coxae with some obscure punctures along the upper side; transverse part of discoideus distinct; abdomen about equal to the thorax in length, smooth, polished throughout, distinctly narrower than the thorax, first tergite about twice as long as broad at base, slightly broader at base than apex; second tergite with an oblique furrow each side extending from the lateral angles of the first tergite backward and toward but not reaching the lateral margins; ovipositor not extending beyond the apex of abdomen.

Male.—Unknown.

Type-locality.—Kampala, Uganda, British East Africa.

Type.—Cat. No. 21600, U.S.N.M.

Host.—A Pyralid on *Hibiscus.*

Four females received by the Bureau of Entomology from Mr. C. C. Gowdey.

APANTELES GOWDEYI, new species.

Female.—Length, 2 mm. Black; palpi and scape beneath pallid; coxae all black; anterior and median femora, tibiae, and tarsi and the posterior femora and tibiae, except apex of latter, pale testaceous; apex of hind tibiae and their tarsi brownish black; abdomen black, except ventral segments one and two, which are concolorous with the legs; wings hyaline, the costal and radial veins and stigma dark brown, other veins paler. Head smooth, with very obscure weak punctures on the face and posterior orbits; distance from the antennae to the base of clypeus not more than two-thirds the shortest distance between the eyes below the antennae; antennae longer than the body, flagellar joints one to six subequal and nearly three times as long as thick, following joints gradually shortening toward the apex, the apical joints about twice as long as thick and not distinctly pedicellate; mesoscutum anteriorly, mesopleura along the anterior margin, and the mesosternum obscurely punctured, smooth; remainder of thorax polished impunctate or practically so; propodeum smooth, without a median carina, the longitudinal carina laterad of the spiracles rather weak; transverse abscissa of discoideus obsolete; hind coxae impunctate polished, attaining the middle of the abdomen; abdomen polished, narrow, its greatest breadth not more than half the width of thorax at tegulae, first tergite narrower at apex than base and about twice as long as broad at base, second tergite with an oblique furrow from the posterior lateral angles of the first tergite to the lateral margins; ovipositor extending very slightly beyond apex of abdomen.

Male.—Agrees with female except in the usual sexual characters.

Type-locality.—Kampala, Uganda, British East Africa.

Type.—Cat. No. 21601, U.S.N.M.

Ten specimens received by the Bureau of Entomology from Mr. C. C. Gowdey and reared according to the label from an unknown caterpillar.

DESCRIPTIONS OF TEN NEW ISOPODS.

By Pearl L. Boone,

Aid, Division of Marine Invertebrates, United States National Museum.

The 10 new species herein described are accumulations from various collections of Isopods transmitted to the United States National Museum.

The one new genus, *Pterisopodus*, is so widely different from all previously known forms of the suborder Cymothoidea that it has been necessary to establish a new family for it, the Pterisopodidae.

The illustrations were made by Mrs. E. Bennett Decker, under my direction.

Suborder GNATHIDIE.

Family GNATHIIDAE.

GNATHIA TRIOSPATHIONA, new species.

Plate 91, fig. 3.

Male.—Body elongate, 2.9 mm. wide, 8.8 mm. long, head and thorax of nearly uniform breadth, about 2.8 mm.; abdomen quite narrow, 0.9 mm., gradually tapering posteriorly. Head large, subquadrangular, dorsal surface deeply carinated; a median dorsal groove-like depression divides the head into two lobes; this depression widens anteriorly forming a deep V-shaped excavation, enhancing the bilobed impression; below this depression the frontal margin is produced triangularly into a rostral process with a tooth-like projection on either side of the median point; the frontal margin of each supraocular lobe is recurved, having a tricrenulate aspect. The superior antennae have a peduncle of four stout, subequal articles, and a flagellum of four short, fine articles, and extend to the flagellum of the inferior antennae; the inferior antennae have a peduncle of four unequal articles and a flagellum of eight small articles, and are one and one-half times as long as the mandibles. The eyes are elongate-oval, composite, moderately large, and placed in the extreme anterolateral margins.

The mandible is 2 mm. long with the outer margin a smooth, thickened ridge, broad at the base and decidedly tapering toward the tip which is acutely incurved; the inner margins are produced into three distinct blades—a superior, which is very narrow and slightly expanded at the base, where it is about half as wide as the middle blade; thence narrowing to a mere line with the inner margin produced into three low, blunt undulations. The superior and middle blades are separated by a comparatively straight groove; the middle blade is subovate, broadly expanded in the middle, with the inner margin recurved, giving the appearance of four conical teeth; the area between the middle and inferior blades is a deeply excavated, twisted groove; the inferior blade is three-fourths as long as the middle blade, is broadly expanded, subtriangular, with the apex produced and truncate, and the inner margin undulating. The maxilliped has a palp of four articles.

Thorax: The first segment is rudimentary, united with the head as indicated by a suture line on the median dorsal area; the second and third segments are each about 1 mm. long with the lateral parts curved and expanded anteriorly; the fourth segment is slightly less than 1 mm. wide, with the anterior margin straight, the postlateral parts very little produced; the fifth segment is extremely long, about 3½ mm., subconvex, marked anteriorly by a ridge-like carination from side to side and longitudinally by a median depression; the sixth is similar to the fifth, but slightly longer and tapering posteriorly; the seventh segment is abruptly narrower than the preceding segment and is surrounded by the projections of the sixth segment.

Abdomen: This has the first five segments distinct, similar, each almost 0.6 mm. long, subconvex, and the terminal segment triangular, 2½ times as long as the preceding segment. The uropoda have the peduncle extremely short; the inner branch, long, narrow, posteriorly obtusely truncated; the outer branch is similar but is obtusely pointed posteriorly.

The holotype, an adult male, and two additional specimens (Cat. No. 50408, U.S.N.M.) were collected by the United States Bureau of Fisheries steamer *Fish Hawk* at station 7282, Gulf Stream off Key West, Florida, February 19, 1902, in a depth of 109 fathoms.

This species is readily distinguished by its unique mandibles and the curiously excavated head.

Suborder CYMOTHOIDEA.

Family CIROLANIDAE.

CIROLANA HERMITENSIS, new species.

Plate 91, fig. 2.

Body oblong-ovate, 9 mm. long, 4.9 mm. wide. Head wider than long with the frontal margin widely, evenly rounded.[1] The first pair

[1] The frontal margin is evenly rounded. The cleft appearance in plate 3, figure 2, is caused by the artist's representation of the antennae.

of antennae have the first and second articles about equal, 0.4 mm. long, the third short and a flagellum of 10 articles, and extends about to the first article of the flagellum of the second antennae. The second pair of antennae has the first, second, and third articles very short, stout, subequal; the fourth and fifth articles about equal, each as long as the first three articles taken together; the flagellum is long, slender, tapering, consists of 18 articles and extends to the anterior margin of the fourth thoracic segment. The eyes are small, round, complex, and situated in the anterolateral angles of the head. The frontal lamina is conspicuous, with the anterior margin triangulate. The maxilliped has a palp of five articles.

Thorax: The first segment is wide, with the lateral margin produced around the head to the posterior end of the eye. There are no epimera on the first segment. The second to seventh segments are similar, subequal, each about 1 mm. long; the epimera are distinct on all six segments and have the outer postlateral angles gradually acutely produced, those of the last three extending considerably beyond the segments. The first three pairs of legs are prehensile, the last four ambulatory; the inner margins of all seven pairs are furnished with strong spines.

Abdomen: This has the first segment, except a small area on each side, entirely concealed by the seventh thoracic segment; the second, third, and fourth segments are each about 1 mm. long, subequal, with the postlateral angles incurvate; the fifth segment is slightly longer than the fourth, but abruptly narrower and with the lateral parts not produced; the sixth segment is 2 mm. long, subtriangular, with the apex roundly truncate, crenulated, and ornamented with a row of spines. The peduncle of the uropod is not quite 1 millimeter long on the outer margin, but is nearly three on the inner, with the margin between recurved; the inner branch is about as long as the sixth abdominal segment, with the outer part evenly rounded and the inner part broadly expanded and rounded posteriorly. The outer branch is oval and about half as long as the inner. The entire margins of both branches are decidedly crenulate and fringed with spines.

Color: The specimen is heavily banded crosswise with light brown stripes, with an equal light creamy area between them on the head, thorax, and first five abdominal segments; the sixth segment and uropoda are similarly marked but have the bands longitudinally placed.

The holotype, an adult male (broken), and another specimen were collected in August, 1912, at Home Lagoon, Hermite Island, Montebello Islands, Australia (Orig. No. 116), and are in the collections of the Cambridge Museums, England.

This species resembles *Cirolana harfordi*[1] (Lockington), but is readily distinguished from it by the bizarre color pattern and the different posterior margination of the head. The present species has the first abdominal segment only partly concealed and the second abdominal segment not at all concealed, while *Cirolana harfordi* has the first two abdominal segments entirely concealed.

Family EXCORALLANIDAE.

EXCORALLANA BERBICENSIS, new species.

Plate 92, fig. 1.

Body ovate, three and one-fourth times as long as wide, 13 mm., 4 mm.

Head wider than long, 3 mm., 2 mm., with the anterior margin widely, evenly rounded, and the posterior margin straight. The eyes are large, composed of large ocelli, occupy the sides of the head, and are separated in front by a distance equal to the length of one eye. The first pair of antennae have a peduncle of two articles each about 0.5 mm. long and a flagellum of 11 short, subequal articles, and extends almost to the fifth article of the second antennae. The second pair of antennae has the first, second, and third articles very short, subequal, the fourth and fifth articles about equal, each as long as the first three taken together, a flagellum of 25 short, subequal articles, and extends to the middle of the fourth thoracic segment.

The left mandible is distinctly bidentated, interlocking with the right mandible.

Thorax: The segments are subequal; the epimera are distinct on all except the first segment; the first two are rounded posteriorly, the last four have the outer posterior angle gradually more acutely produced. The first three pairs of legs are prehensile, the last four are ambulatory; all have the inner margin beset with short, stout spines.

Abdomen: The first segment is about half concealed by the thorax; the second, third, and fourth are subequal in length but have the outer posterior angle gradually more produced; the fifth is longer than the preceding segment, by which it is almost entirely overlapped on either side; it is ornamented by two blunt tubercles, one on either side of the median line; the posterior margin is produced to a median point, giving the segment a triangular appearance; the sixth segment is triangulate with the apex evenly rounded and ornamented near the base with four almost invisible tubercles, one on either side of the median line and one near the base of the peduncle of each uropod.

The peduncle of the uropod is short and bears a tubercle near the outer angle; the larger, inner branch is broadly rounded posteriorly,

[1] *Aega harfordi* Lockington, Proc. Cal. Acad. Sci., vol. 7, 1877, pt. 1, p. 46. *Cirolana harfordi* Richardson, Proc. U. S. Nat. Mus., vol. 21, 1899, pp. 822–823.

the smaller, outer branch is very narrow, obtusely pointed posteriorly, and bears six teeth in the outer margin. The terminal segment and both blades of the uropoda are heavily fringed with fine, closely set hairs.

Pleopoda: Four pairs, subequal, similar in structure; the outer branch is the larger and is broadly evenly rounded; the inner branch is about two-thirds the size of the outer and of similar shape.

The holotype and an additional specimen (Cat. No. 50402, U.S.N.M.) were collected in the Rio Berbice, British Guiana, by the Rev. James Aiken, February, 1913.

This species is at once recognized by the simplicity of the sculpture of the telson.

Family CYMOTHOIDAE.

BRAGA OCCIDENTALIS, new species.

Plate 91, fig. 1.

Female.—Body ovate, 17 mm. long, 11 mm. wide. Head triangulate with the apex produced and slightly truncate, forming a blunt rostral process about 1 mm. long. Eyes large, complex, elongate-ovate, and located in the extreme postlateral angles of the head. The first antennae are composed of seven short, stout, subequal articles and are about three-fourths as long as the second pair. The second antennae consist of eight short, stout, subequal, articles and extend almost to the first thoracic segment.

The first thoracic segment is 3 mm. long and has the anterolateral margins slightly produced and the postlateral margins obliquely truncated; the second and third segments are each 1.5 mm. long, the fourth is 2 mm. long, the fifth and sixth are each 1.2 mm. long, and the seventh is 0.9 mm. long.

All of the segments except the first have the lateral area divided by a diagonal carination, which causes the postlateral angles to appear as elevated, horn-like projections; these segments have distinct epimera extending along the lateral borders; the epimera gradually increase posteriorly in breadth and have the external postlateral angles roundedly produced. All seven pairs of legs are strongly prehensile and have the dactyl extremely curved, the tip being excavated, somewhat resembling an arrowhead.

The marsupial pouch is composed of three pairs of plates. These are thoracically attached and are very convex, overlapping each other like rosebud petals.

Abdomen: This has the first segment entirely and the second partly concealed by the seventh thoracic segment, the second segment appears about 1 mm. long and has the lateral parts concealed, the third and fourth segments are each about 1.1 mm. long, the fifth is about 1.4 mm. long in the median area but narrows toward the sides and has the posterior margin recurved. The terminal segment is 4.8 mm. long and 5 mm. wide, slightly asymmetrical, shield-shaped. The uropoda have the peduncle quite flexible and the inner posterior angle decidedly elongated; the inner blade is elongate-ovate, fringed with hairs; the outer blade is about 1 mm. longer than the inner, has the outer margin decidedly curved and the inner nearly straight. The uropoda are not quite as long as the terminal segment.

The pleopoda are rather thick, ovate, leaf-like structures, but are too broken in the type-specimen to permit of critical diagnosis.

The holotype, an ovigerous female, was collected off the coast of California by Messrs. LeConte and Dana in 1866 and is in the collections of Yale Museum, Cat. No. 302.

This species is the first representative of the genus recorded from the west coast of North America, all previously recorded species being from the east coast of South America.

PTERISOPODIDAE, new family.

Body strongly depressed, oval. Mandibles small, with a palp of three articles. Cutting edge broad, dentate. First maxillæ with outer lobe slender, tipped with small spines; inner lobe feeble. Maxilliped with a palp of two articles. Eyes feebly developed, inconspicuous.

Thorax: All seven segments with lateral extremity widely expanded and produced distally into an acute, roughly triangular process with apex directed posteriorly, this formation becoming more conspicuous on the last three segments. Epimera perfectly fused with segments. Legs: All seven pairs strongly prehensile. The first joint strongly produced into a curious wing-like process which is roughly triangular, with the apex directed outward and posteriorly; that of the first leg fused with the thorax; those of second to seventh free, conspicuous.

Abdomen: Compressed, decidedly narrower than thorax, composed of six segments, strongly curved and produced posteriorly, overlapping each other; sixth segment large. Uropoda lateral, fan-like.

PTERISOPODUS, new genus.

With characters of family, only genus known, of which the type is *Pterisopodus bartschi*, new species, collected in Bahia Honda, Cuba.

PTERISOPODUS BARTSCHI, new species.

Plate 89, figs. 2–5.

Body strongly depressed, oval, 14 mm. long, 10.8 mm. wide; thoracic margins produced acutely into roughly triangular, wing-like formations. A broad, median dorsal black band extends the length of the body; followed on either side by a narrower creamy band, then a broader black band which widens posteriorly extending to the extreme lateral margin from the fifth thoracic backward; the lateral margins of the head and first three thoracic segments are tipped with cream color.

Head wider than long, 3.5 mm., 2.5 mm., anterolateral margin oval; median posterior margin oval, less curved postlaterally. Eyes very feeble, located in postlateral angles of head. The antennae are short and attached so far on the ventral surface of the head that they are scarcely visible dorsally. The first pair consist of eight, short, stout, subequal articles and extend almost to the middle of the first thoracic segment. The antennae are similar but slightly longer, consisting of ten articles. Mandibles small, with a palp of three articles. First maxillae with outer lobe slender, tipped with small spines; inner lobe feeble. Maxilliped with palp of two articles.

Thorax: First segment 2.5 mm. long, anterior margin excavated, anterolateral angles bluntly produced beyond the angles of the head; second, three-fifths as long as first; third, a little less than second; fourth as long as second; fifth and sixth slightly longer than the fourth; seventh slightly less than sixth. Epimera perfectly coalesced with segments, line of fusion wanting; the lateral parts widely expanded and produced distally into an acute, roughly triangular process with apex directed posteriorly. Legs: Seven pairs, subequal, strongly prehensile, similar in structure. The first joint strongly produced into a curious wing-like process, which is roughly triangular with acute apex directed outwardly and posteriorly; this process on the first leg fused with the first thoracic segment, those of second to seventh legs, inclusive, distinct; those of the second and third legs are so produced as to be conspicuous on the dorsal side; the second process equals in length the produced extremity of the second segment; the third is slightly less than the extremity of the third segment; the fourth to seventh, inclusive, are not visible dorsally; the fourth and fifth are stout and not quite so long as the third; the sixth is slenderer and longer than the fifth; the seventh is slender and quite pointed; the second joint of the leg is very small; the third is the longest with unique basal curvature adapted to sculpture of the first joint; the fifth is slightly longer than the fourth; the sixth is a strongly curved claw folding over on the fifth, with a tip reaching the basal part of the fifth joint.

Abdomen: This consists of six segments, the first of which is hidden, except the postlateral extremity, by the thorax; the second, third, fourth, and fifth segments are subequal, about 1 mm. long; they are decidedly curved posteriorly and overlap each other. the postlateral angles are acutely produced, the sixth segment is shield-shape, wider than long (4 mm., 3.1 mm.), its length being slightly greater than that of the first five segments; the postlateral margin is evenly rounded. Uropoda 2 mm. long, biramous; peduncle triangular, posterior margin bluntly toothed, with inner postlateral angle acutely produced; outer branch slender, curved, terminating in a bluntly rounded point; the inner branch is about the same length, more oval basally, but also bluntly pointed distally. Pleopoda five pairs, natatory, biramous, outer branch larger, oval, folding over the smaller but similar inner blade.

The holotype, a single specimen (Cat. No. 50406, U.S.N.M.), was collected in Bahia Honda, Cuba, June 7, 1914, by Dr. Paul Bartsch and Mr. John B. Henderson of the *Tomas Barrera* Expedition to Northwestern Cuba. (Coll. No. 504.)

Family SPHAEROMIDAE.

SPHAEROMA EXOSPHAEROMA, new species.

Plate 90, figs. 1, 3.

Body oval, twice as long as wide, 11 mm., 5.5 mm. Head twice as wide as long, anterior margin evenly rounded, posterior margin between the eyes straight, deeply, widely carinated. Eyes very large, round, compound, located in the postlateral angles of the head. The first antennae have the first segment inconspicuous, the second elongated, the third not quite as long as the second; the flagellum, which is broken, retains seven articles and extends midway to the first thoracic segment. The second antennae have the basal article inconspicuous, the second about 1 mm. long, the third about 1.5 mm., the fourth about 1.75 mm., and the fifth about 2 mm. long; the flagellum, which is broken, retains 16 articles, the first to ninth inclusive, each bearing on the outer distal margin a stiff brush of setae. The second antennae (broken) extend to midway the first thoracic segment. The maxilliped has a palp of five lobes; the second, third, and fourth of these are more lobed than are previously described *Sphaeromas*, but this lobing is less pronounced than is found in typical *Exosphaeromas*. The second, third, fourth, and fifth lobes of the maxilliped are furnished with brushes of long hairs.

The thorax has the first segment about 0.5 mm. wider than the rest, with the lateral margin widely expanded anteriorly, curving around the eye to the anterior margin; posteriorly expanded acutely and produced, overlapping the anterior half of the second thoracic segment; the posterior margin is deeply carinated. The second to fifth segments are subequal, the seventh is nearly as wide as the first segment. The legs are all ambulatory.

The abdomen is composed of two segments. The first has suture lines indicating the coalescence of several segments. The terminal segment is domelike with the posterior margin evenly rounded. The two branches of the uropoda are about of equal length; the fixed inner branch is oar-blade shaped; the movable outer branch is more tapering posteriorly and has the outer margin distinctly tridentate on the right uropod, and bidentate on the left. The margins of the terminal segment of the abdomen of both branches of the uropoda are fringed with very minute, closely set hairs.

The entire body surface is marked with fine brown pigment spots; dense granulations arranged in longitudinal ridges occur on either side of the thoracic segments, and a double row of coarse granulations borders the posterior margin of each thoracic segment, which is distinctly carinated.

The holotype (Cat. No. 50407, U.S.N.M.), comes from Mariveles, Luzon, Philippine Islands, and was collected by Mr. Albert M. Reese.

The species is unquestionably a form intermediate between the two genera *Sphaeroma* and *Exosphaeroma*, more pronouncedly so than *Exosphaeroma crenulatum* Richardson [1] or *Sphaeroma globicauda* [2] Dana, and after a critical examination of the types of many species of both genera, I feel it is probable that the finding of additional specimens will make it imperative to unite these genera.

EXOSPHAEROMA BARRERAE, new species.

Plate 90, figs. 2, 4.

Body elongate-ovate, convex, very contractile; length, 13.5 mm., width 7 mm.

Head subcrescentic, anterolateral margins produced, entirely concealing the antennae. Eyes large, round, compound, situated in the extreme postlateral region of head; the posterior margin of head between the eyes is decidedly carinated. The first antennae are about four-fifths as long as the second pair, and have the first and second articles of the peduncle decidedly swollen, the second being much shorter than the first; the third is long and slender and the flagellum consists of 20 articles. The second antennae extend backward and lie under the epimeral plates of the first to third thoracic segments, reaching to the anterior margin of the second thoracic segment; the peduncle consists of five subequal articles and the flagellum of 19 articles. The maxilliped has a palp of three articles. The mandible has a palp of three articles.

Thorax: The first segment is 2 mm. long, with the lateral margins decidedly expanded and produced anteriorly, surrounding the anterolateral margin of the head; also expanded and acutely produced

[1] *Exosphaeroma crenulatum* Richardson, Trans. Conn. Acad. Sciences, vol. 11, 1902, pp. 292–293, pl. 39, fig. 40.

[2] *Sphaeroma globicauda* Dana. Stebbing., T. R. R., The Fauna and Geography of the Maldive and Laccadive Archipelagos, vol. 2, pt. 3, 1905, p. 710.

postlaterally. Second segment 1 mm. long. Second, third, and fourth segments subequal, fifth, sixth, and seventh segments narrower and subequal, the lateral margins decidedly, acutely produced into a toothlike process; epimera completely coalesced with segments, but with line of fusion very distinct.

Legs: All six pairs are ambulatory, subequal, similar in structure; the third, fourth, and fifth joints are heavily fringed along the inner margin; the dactyl of each is distinctly bifid.

Abdomen: This is biarticulate; the first five segments are fused, the first is entirely and the second almost entirely hidden by the thorax; three suture lines on either side mark the areas of the third, fourth, and fifth segments, respectively; these suture lines are lost on the median region; the terminal segment is smooth, domelike, with two indistinct blunt tubercles posteriorly; the postlateral margin is triangularly produced, pointed acutely at the median extremity and with a distinct, small, pointed tooth on either side of the median point. The uropoda are shorter than the terminal segment, the immovable inner branch is the larger, and has its outer postlateral angle truncate; the inner movable branch is three-fourths as broad, lanceolate, and with its outer postlateral angle very acute and the entire outer branch minutely crenulated on the lateral margins. There are five pairs of pleopoda, which are biramous and heavily fringed with fine hairs.

The holotype (Cat. No. 50404, U.S.N.M.) was collected at Cabanas, Cuba, by Dr. Paul Bartsch and Mr. John B. Henderson, of the *Tomas Barrera* Expedition to Northwestern Cuba, 1914. (Coll. No. 512.)

This species is readily recognized by the unique sculpturings of its domelike telson.

Suborder IDOTHEOIDEA.

Family ARCTURIDAE.

ASTACILLA CALIFORNICA, new species.

Plate 89, fig. 1.

Body narrowly elongated, 6.1 mm. long, exclusive of antennae, and 2.2 mm. wide. A distinct median dorsal ridge is present, which attains its greatest prominence in a bluntly conical tubercle on the anterior part of the fourth thoracic segment. Segments decidedly convex dorsally. Fourth thoracic segment two-fifths the length of entire body. Sutures deeply constricted.

Head slightly wider than long (0.9 mm., 0.75 mm.), with decided anterior excavation between the produced anterolateral angles; lateral margins lobate, swollen anteriorly by prominent ocular lobes. Eyes composite, suboval, 9.6 mm. long., situated anterolaterally.

Superior antennae about 1.5 mm. long, basal joint short, stout; second and third article slightly longer, very slender; flagellum short, four-ringed, bearing olfactory filaments. Inferior antennae very slender, as long as the body, (6.1 mm.), basal joint short, anterior margin produced into serrations which encup the base of the second article; second article slenderer posteriorly, slightly swollen anteriorly, twice the length of the first; third and fourth articles of equal length, one-third longer than the second; fifth and sixth extremely short, subequal, flagellum less than last peduncular segment. The maxilliped has a palp of five articles.

Thorax: First, second, and third segments of equal length but of gradually increasing width; lateral parts of first segment expanded, surrounding the posterior part of head, anterolateral angles extending to the eyes; epimera of the second and third segments distinct, lateral margin broadly expanded, lobate; fourth 2.5 mm. long, decidedly wider anteriorly than the preceding segments, thence narrowing posteriorly (greatest width 2.2 mm., least width 0.9 mm.), a prominent median dorsal tubercle summits the greatest width and a similar less prominent one the least width of this segment; the boarder epimera occupy the anterolateral angles; posterior margin deeply excavate; fifth segment 0.3 mm. long, the sixth less, the seventh equals the sixth; epimera on last three segments small, angular, occupying the anterolateral angles.

Abdomen: This consists of two segments, the first of which is short and evenly vaulted above, while the terminal segment is long, narrow, and produced on the sides near the base into an acute process or expansion of the lateral margin, and a second similar but less prominent process two-thirds of the length of the last near the posterior end; the extreme termination being blunt and triangular.

First four pairs of legs slender, forward-directed, densely hirsute, each successive pair longer than the preceding; the last three pairs ambulatory, gradually decreasing in length.

The holotype (Cat. No. 50401, U.S.N.M.), an adult female, was collected by the Venice Marine Biological Station, on seaweed, at Venice, California.

This species is at once distinguished from previously described *Astacillas* by its greater size and the unique pyramidlike shape of the fourth thoracic segment.

Suborder ONISCOIDEA.

Family ONISCIDAE.

PHILOSCIA MINUTISSIMA, new species.

Plate 92, fig. 2.

Body elongate-ovate, about two and a half times as long as wide, 4 mm., 1.6 mm. Head about twice as wide as long, with the frontal margin broadly, evenly rounded, and the anterolateral angles rounded, the eyes being so situated on a ridge as to produce the appearance of a small lobe in front of each eye. The eyes are small, compound, lateral. The first pair of antennae are inconspicuous, rudimentary, consisting of one small joint, tipped with a few bristles. The first, second, and third articles of the second antennae are short, stout, subequal; the fourth article is twice as long as the third; the fifth is slightly greater than the fourth; the flagellum is biarticulate; the second pair of antennae extends to the anterior margin of the third thoracic segment. The maxilliped has a palp of three articles. The first maxilla has the inner plate furnished with several small spines; the outer plate is quadridentate.

Thorax: The first segment is the longest, about as long as the head, with the anterolateral margins decidedly curved and extending around the head to the posterior margin of the eye; the second to seventh segments are subequal; the epimera are completely fused with the segments. The lateral margins of the first three segments are straight, the postlateral angles of the fourth, fifth, sixth, and seventh segments are gradually, acutely produced, that of the seventh entirely concealing the sides of the first and second abdominal segments; also the anterior margin of the third segment. The legs are all ambulatory, similar and subequal.

Abdomen: This is decidedly narrower than the thorax; the first and second segments are strongly compressed and partly concealed by the seventh thoracic segment; the third, fourth, and fifth segments are subequal, each about equal to the first and second segments taken together, and having the postlateral angle gradually acutely produced; the sixth segment is small, triangular, with the apex bluntly pointed. The peduncle of the uropoda extends to the extremity of the abdomen; the inner branch is very slender, pointed, and extends about 1 millimeter beyond the abdomen; the outer branch is about 1 mm. long and 0.2 mm. wide, and is bluntly pointed at the end.

Color: yellowish with irregular fuscous patches and with a longitudinal light area or band in the middle of the dorsal surface.

This species is nearest to *Philoscia culebrae* Moore,[1] but differs in the following: (1) The biarticulate flagellum of the second antennae; (2) the head is more rectangular, and the lobed aspect of its frontal margin is less decided; (3) the appendages are less setiferous; (4) the abdomen, as a whole, is wider and shorter, its lateral line being approximately continuous with that of the thorax.

The holotype and six additional specimens (Cat. No. 50403, U. S. N. M.), secured "on bat guano" in Hunt's Cave, New Providence, Bahamas, June 29, 1914, were presented to the United States National Museum by Mr. George P. Englehardt.

[1] ***Philoscia culebrae*** **Moore, Bull. U. S. Fish Commission, vol. 20, pt. 2, 1902, p. 176, pl. 11, figs. 13–17.**

LEPTOTRICHUS VEDADOENSIS, new species.

Plate 92, fig. 3.

Body elongate-ovate, subconvex, twice as long as wide, 6 mm., 3 mm., densely granulated. Head produced in front in a conspicuous median lobe which is squarish with the anterior margin rounded and is tilted upward and outward; the lateral lobes are large and divergent and broadly rounded. The eyes are moderately large, oval, complex, and situated at the base of the lateral lobes. The second antennae have the first four articles of the peduncle subequal; the fifth is much longer, about 1 mm.; the flagellum is biarticulate, the first article being about two-thirds as long as the second and terminating in a minute hook-like point; the flagellum is about as long as the fifth joint; the second antennae extend to the anterior margin of the second thoracic segment.

Thorax: The first segment is slightly longer than the others, about 1.1 mm., with its lateral margins expanded and surrounding the head, the second to seventh segments, inclusive, are similar, subequal, with their lateral parts moderately expanded and the post-lateral angles gradually, acutely produced. The legs are similar, subequal, and have the inner margin ornamented with brushlike tufts of spines.

Abdomen: The first and second segments are compressed and have the lateral parts concealed by the seventh thoracic segment; the third, fourth, and fifth segments are broadly expanded, forming a continuous curve with the margin of the thoracic segments; the sixth segment is abruptly narrow, triangulate, with the posterior margins recurved. The peduncle of the uropod is broad, about two-thirds as long as the terminal segment; the inner branch is minute, placed at the inner distal angle of the peduncle; the outer branch is broken off.

The posterior margins of the head, thorax, and first five abdominal segments are heavily carinated. The entirely dorsal surface is densely granulated, has scattered minute pigment spots, and is finely setiferous.

The holotype (Cat. No. 50405, U.S.N.M.) and two paratypes come from La Puntilla, Vedado, near Habana, Cuba, and were secured and donated to the United States National Museum by Dr. Mario Sanchez Roig. All these specimens are slightly broken.

This species is very near *Leptotrichus granulatus* Richardson,[1] but differs from it in the following: (1) Greater length of the second antennae, (2) in having the central lobe of the head longer or greater, (3) in the shape of telson, (4) the carinated aspect of the margins of the segments is more pronounced and the entire specimen is more compact than is *Leptotrichus granulatus*.

[1] *Leptotrichus granulatus* Richardson, Trans. Conn. Acad. Sciences, vol. 11, 1902, p. 303, pl. 40, fig. 58.

EXPLANATION OF PLATES.

PLATE 89.

FIG. 1. *Astacilla californica*, new species, type, lateral view.
2. *Pterisopodus bartschi*, new species, type, dorsal view.
3. *Pterisopodus bartschi*, new species, type, ventral view.
4. *Pterisopodus bartschi*, new species, type, maxilliped.
5. *Pterisopodus bartschi*, new species, type, mandible.

PLATE 90.

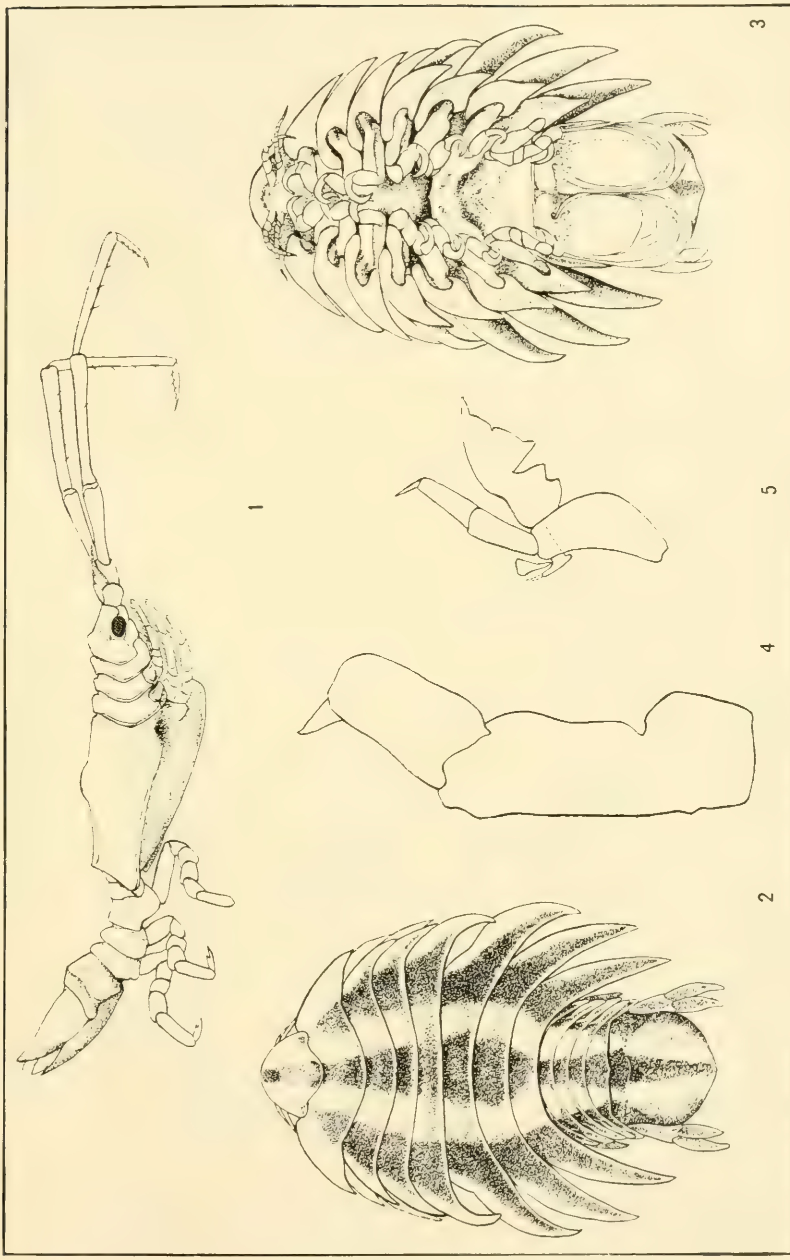
FIG. 1. *Sphaeroma exosphaeroma*, new species, type, dorsal view.
2. *Exosphaeroma barrerae*, new species, type, dorsal view.
3. *Sphaeroma exosphaeroma*, maxilliped.
4. *Exosphaeroma barrerae*, ventral view of head.

PLATE 91.

FIG. 1. *Braga occidentalis*, new species, type, dorsal view.
2. *Cirolana hermitensis*, new species, type, dorsal view.
3. *Gnathia triospathiona*, new species, type, dorsal view.

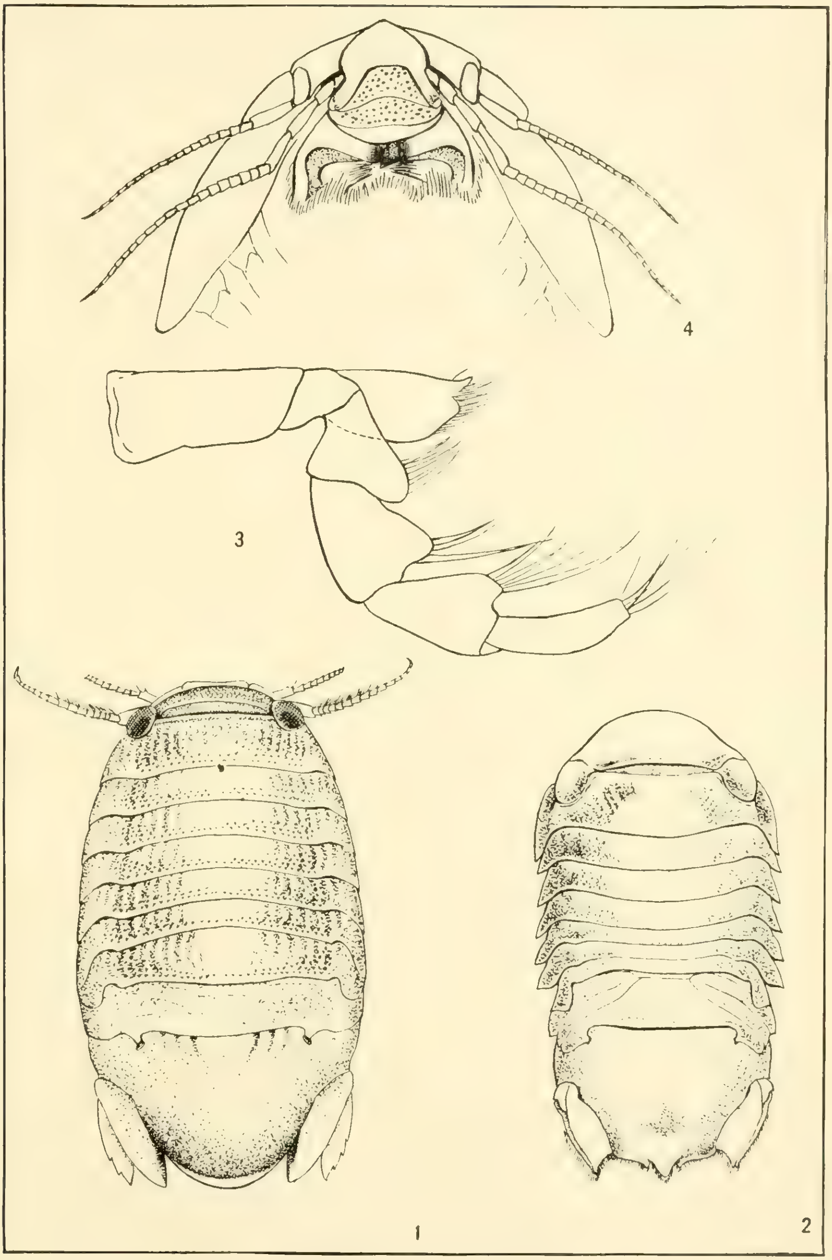
PLATE 92.

FIG. 1. *Excorallana berbicensis*, new species, type, dorsal view.
2. *Philoscia minutissima*, new species, type, dorsal view.
3. *Leptotrichus vedadoensis*, new species, type, dorsal view.



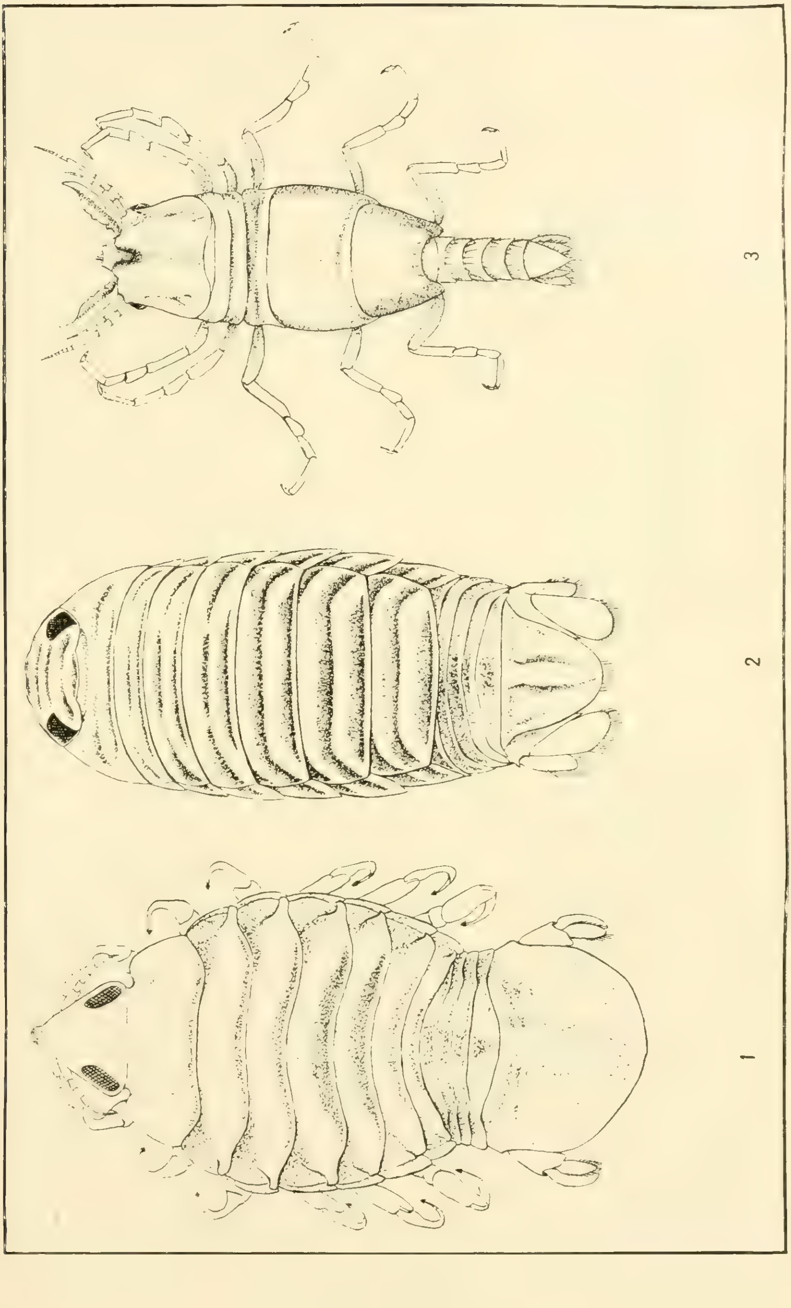
NEW SPECIES OF ISOPODS

FOR EXPLANATION OF PLATE SEE PAGE 604



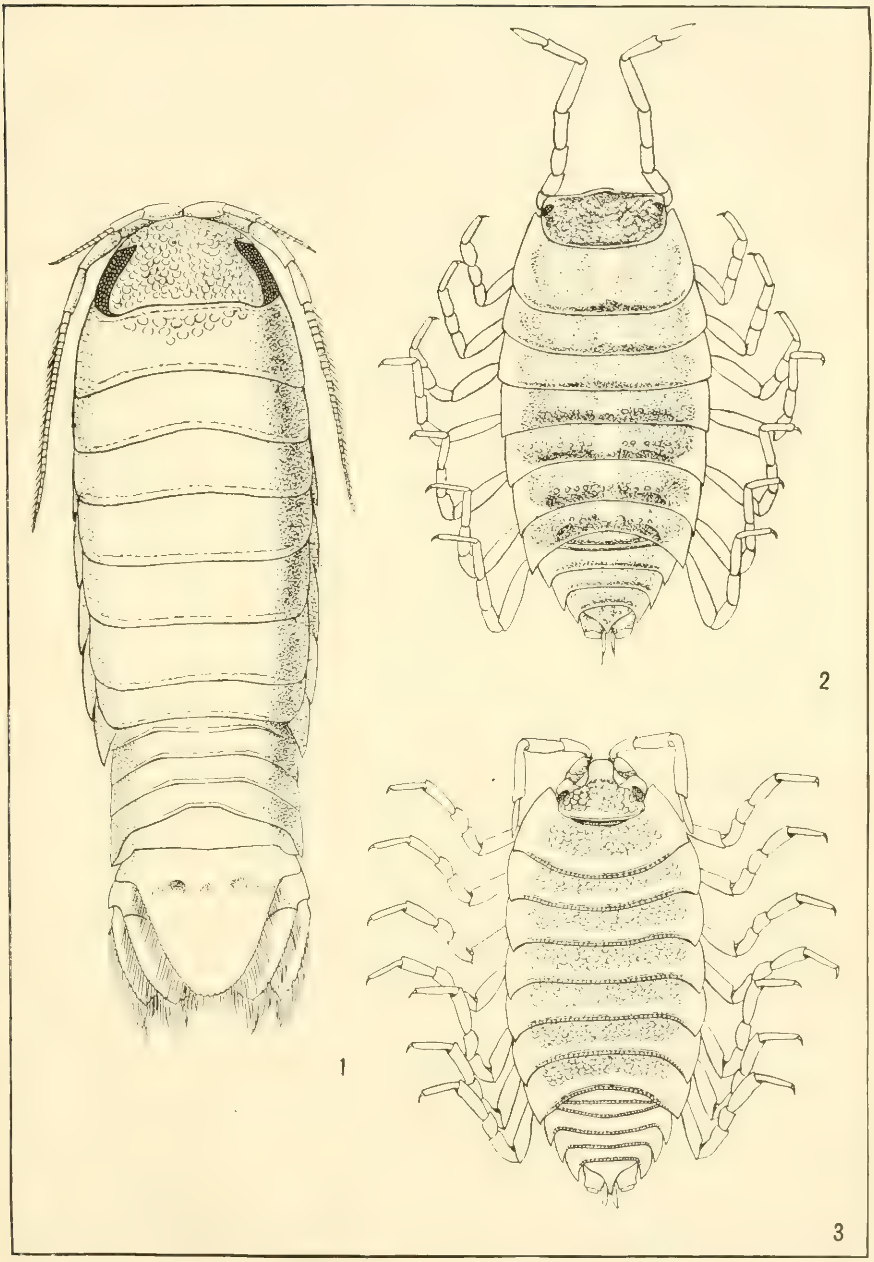
NEW SPECIES OF ISOPODS

FOR EXPLANATION OF PLATE SEE PAGE 604



NEW SPECIES OF ISOPODS

FOR EXPLANATION OF PLATE SEE PAGE 604



NEW SPECIES OF ISOPODS

FOR EXPLANATION OF PLATE SEE PAGE 604

A NEW WEST INDIAN FOSSIL LAND SHELL.

By Paul Bartsch,

Curator of Marine Invertebrates, United States National Museum.

Among a lot of kitchen midden marine shells collected by Theodoor de Booy on Salt River, North Coast of St. Croix, and submitted to the United States National Museum for determination, is the shell of a *Pleurodonte* belonging to the Section *Caracollus*. A critical comparison shows it to be quite distinct from all the other known members of the group. I therefore name it:

PLEURODONTE DEBOOYI, new species.

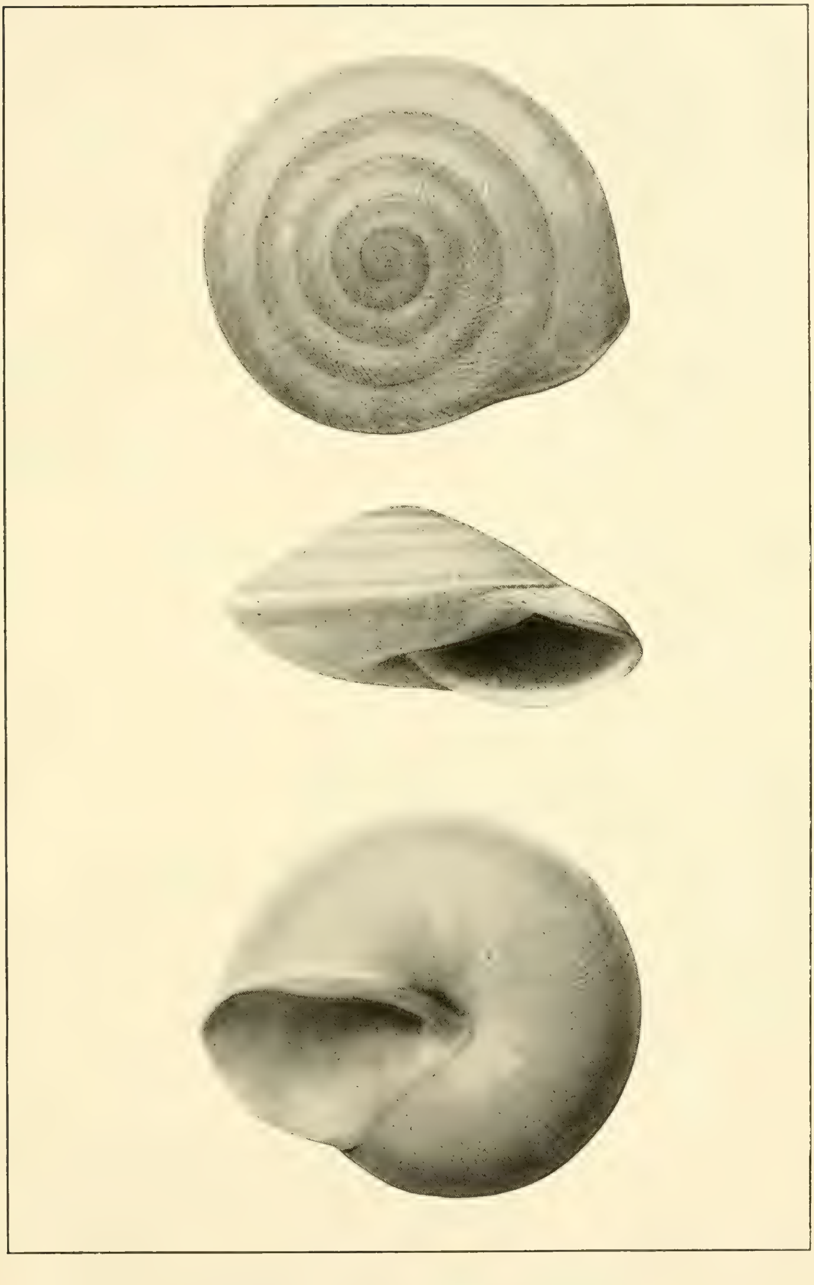
Plate 93.

Shell large, very broadly conic, depressed above and well rounded below. Upper surface grayish-white excepting the nuclear turns, which are rusty brown; and a band of the same color about one-fifth as wide as the whorl situated about half the width of the dark band posterior to the periphery. The basal side is of the same general color as the upper and bears a rusty spiral band a little distance anterior to the periphery. All the whorls are flattened. Suture scarcely indicated, not at all impressed. Periphery strongly carinated. Base slightly inflated, strongly rounded, with a narrow, shallow, impressed umbilical pit. Aperture subtriangular, oblique; outer lip thickened at the edge, the upper less so than the basal, the latter as well as the columellar portion much thickened and reflected; parietal wall covered with a thin callus. Entire surface both above and below marked by moderately strong, decidedly retractively curved incremental lines and the exceedingly fine, crinkly, crisscross markings characteristic of all the members of the section.

The type (Cat. No. 218039, U.S.N.M.), was collected by Mr. Theodoor de Booy in kitchen midden deposits on Salt River in northern St. Croix, West Indies. It has six whorls and measures—altitude, 26 mm.; greater diameter, 58 mm.; lesser diameter, 49 mm.

In the flattening of the upper surface of the whorls the present species suggests *Pleurodonte* (*Caracollus*) *angistoma* Ferussac from Haiti, but the under surface is entirely different, for in *Pleurodonte* (*Caracollus*) *angistoma* there is no umbilical depression. The only other form which approaches it in the flattening of the whorls is the Haitian *Pleurodonte* (*Caracollus*) *sarcocheila* but even in that they are not so flat as in the new form, nor does it have as strong an umbilical depression as the present species; in that character this approaches most nearly *Pleurodonte* (*Caracollus*) *caracolla.*

It is quite possible that the present species is the fossil *Pleurodonte carocolla* previously reported from St. Croix. The existence of a member of the *Caracollus* section on this island argues strongly for a former land connection from St. Croix to Porto Rico and the island of Vieques, in both of which it is also represented, in spite of the deep water existing at this present time between them and St. Croix. Likewise, the presence of members of the group in Haiti and Santo Domingo is equally strong evidence of former land connection across the channel that now separates them.



A NEW WEST INDIAN FOSSIL LAND SHELL.

FOR DESCRIPTION OF PLATE SEE PAGE 605

ANNOTATED CATALOGUE OF A COLLECTION OF BIRDS MADE BY MR. COPLEY AMORY, JR., IN NORTHEASTERN SIBERIA.

By J. H. Riley,

Aid, Division of Birds, United States National Museum.

Mr. Copley Amory, jr., accompanied the Koren Expedition to the Kolyma River region of northeastern Siberia in 1914, where the 228 specimens of birds and few sets of eggs listed in the following report were collected, and generously presented to the United States National Museum.[1]

While the collection contains no novelities, it included a number of forms previously unrepresented in the museum, and the series of hazel grouse from the Kolyma has enabled me to describe a new form from further south.[2]

A brief sketch of Mr. Amory's route has already been published[3] and Mr. B. Alexander, who accompanied the expedition, collecting fossils for the Smithsonian Institution, has published in the same number (pp. 31–40) an account of the country along the lower Kolyma and the Little and Big Annuj rivers, tributaries of the Kolyma. Mr. Amory, besides collecting on the two Annuj rivers, the lower Kolyma, and the coast, collected further up the Kolyma in the wooded area at Verkhni and in the foot hills of the Tomus Chaja mountains to the west of Verkhni.

Mr. Koren had previously made a trip to the same region, the birds of which have been reported upon by Thayer and Bangs,[4] who

[1] On his way north along the Alaskan coast Mr. Amory collected examples of the following species:

Puffinus tenuirostris (Temminck). (Bristol Bay.)
Larus brachyrhynchus Richardson. (Kodiak Island.)
Heteractitis incanus (Gmelin). (Kodiak Island.)
Histrionicus histrionicus pacificus Brooks. (Kodiak Island.)
Passerculus sandwichensis sandwichensis (Gmelin). (King's Cove.)
Melospiza melodia insignis Baird. (Kodiak Island.)
Corvus caurinus Baird. (Kodiak Island.)
Pica pica hudsonica Sabine. (Kodiak Island.)

[2] Proc. Biol. Soc. Wash., vol. 29, 1916, p. 17.

[3] Smiths. Misc. Coll., vol. 66, No. 3, 1916, pp. 46–51.

[4] Proc. New England Zool. Club, vol. 5, April, 1914, pp. 1–48, with an outline map of the region.

have described most of the novelties not previously named by Buturlin. The latter spent some time near the mouth of the Kolyma and made large collections there but has published no connected account of his work, to my knowledge, though in his paper on the Rosy Gull[1] a good description of the country is given and many species of birds are mentioned.

Thayer and Bangs's list is so well done that little can be added to what they have already said, but as Mr. Amory seems to have reached a higher point on the Kolyma than Koren did on his previous trip, he naturally secured a number of forms not obtained by the latter, and it has been thought advisable to publish this list, with the field notes of the collector, as a supplementary contribution to the ornithology of a little-known region.

For convenience of comparison the species are listed in the order followed by Thayer and Bangs.

The author is indebted to the authorities of the Museum of Comparative Zoology for the loan of a series of *Phylloscopus trochilus eversmanni* for comparison.

Family TETRAONIDAE.

1. LAGOPUS LAGOPUS KORENI Thayer and Bangs.[2]

Seventeen specimens from the following localities: Annuj River, September 12, 18, and 23, 1914; Little Annuj River, September 23, November 9, and 26, 1914; Nijni Kolymsk, January 20, February 11, and June 12, 1915; Verkhni Kolymsk, April 12, 17 and 20, 1915; 7 miles north of Nijni Kolymsk, May 19, 1915; 30 and 33 miles west of Verkhni Kolymsk, May 23, 1915; Kolyma Delta, July 11, 1915.

This series bears out the characters ascribed to it by the describers, and to their account I can add nothing. In measurements it comes very close to *Lagopus l. ungavus* as the following table will show:

Locality.	Wing.	Tail.	Culmen.	Depth of bill.
	mm.	*mm.*	*mm.*	*mm*
Six males from the Kolyma	260	128.2	20.6	13
Ten males from Ungava	197	121.9	20.9	13.5
Five males, west side of Hudson Bay	200.6	126.7	19.1	11.8
Six males, northern Alaska	196.8	119.9	18.9	12.8
Five females, Kolyma	195.6	125.8	17.8	11.3
Ten females, Ungava	179	110	19.3	12.9
Three females, west side of Hudson Bay	191.2	116.7	18.3	10.8

Winter resident throughout the Kolyma Valley.—C. A.

[1] Ibis, 1906, pp. 131–139, 333–337, 400, 661–666.

[2] Proc. New England Zool. Club, vol. 5, Apr. 9, 1914, p. 4.

2. LAGOPUS RUPESTRIS, subspecies?

Three males and one female, 67 miles west of Verkhni Kolymsk, May 6, 8, 14, and 19, 1915; one male and one female, 60 miles west of Verkhni Kolymsk, May 20, 1915.

All of these are in the white winter plumage and only in two males and one female are there any feathers of the summer plumage appearing; in the case of the males (taken May 19 and 20) only a few feathers on the top of the head, but in the female (May 20) there are numerous feathers on the back, head, wing-coverts, and upper breast, mostly concealed by the white feathers, however.

After comparing these with a series from Alaska I can find no differences in size; they are not in the right stage of plumage to show whether there is any difference in color, so for the present the Kolyma form will have to remain in doubt.

In the Tomus Chaja Mountains; winter resident.—C. A.

3. TETRAO PARVIROSTRIS PARVIROSTRIS Bonaparte.

The head of a male, Verkhni Kolymsk, April 13, 1915, and a female, Verkhni Kolymsk, April, 1915.

We saw one in September on the Lesser Annuj, 50 versts [33 miles] east of the Kolyma, where the larch increases in size and quantity; and another in the same locality in October. None around Nijni Kolymsk and they are not common anywhere in the lower valley. They are common in the upper valley and are used for food by the Yakuts. In April in the foothills of the Tomus Chaja Mountains one morning a boy killed three males with his rifle. During a three weeks' visit to the priest at Verkhni Kolymsk several were brought in to him by the natives.—C. A.

4. TETRASTES BONASIA KOLYMENSIS Buturlin.[1]

Four males, Verkhni Kolymsk, April 12 and 20, 1915; two males and one female, 67 miles west of Verkhni Volymsk, May 8 and 17, 1915.

This series is very uniform and quite different from any of the forms with which I have been able to compare it. The form I named *Tetrastes bonasia amurensis*[2] approaches it in certain particulars, but is quite distinct, and as the differences have already been pointed out in the description they need not be repeated here. Since I published the above description Mr. S. A. Buturlin has publishd a paper quoted in the footnotes, revising the birds of this genus. In this revision he renames the bird I described from Manchuria, but fortunately gave it the same name. He also names the bird from Ussuriland, calling it *Tetrastes bonasia ussuriensis*.[3] Seebohm's description[4] of *Tetrao septentrionalis* is very unsatisfactory. He does

[1] Messager Ornith., vol. 7, No. 4, 1916, p. 226.
[2] Proc. Biol. Soc. Wash., vol. 29, 1916. p. 17.
[3] Messager Ornith., vol. 7, No. 4, 1916. pp. 222 and 227.
[4] Ibis, 1884, p. 430.

not give any definite locality, but Buturlin[1] seems to restrict Seebohm's form to the "middle course of the Yenisei, from Krasnoyarsk to the confines of the forest and westward to the Government of Tobolsk and southeast to the Government of Sokutsk." Seebohm's type should be in the British Museum, but until some competent ornithologist examines it and fixes the name there is nothing to do but accept Buturlin's disposition of it. Fortunately the United States National Museum possesses a female from the Yenisei of Seebohm's own collecting. This is the bird I referred to[2] as probably representing a new form when I was under the impression that the Manchurian bird was true *T. b. septentrionalis.*

The Yenisei specimen when compared with *T. b. kolymensis* is not so gray above and the white markings on the wings and the white bars on the feathers below are more restricted; the dark bars to the feathers on the underpart of *T. b. kolymensis* are also darker and heavier. The United States National Museum has recently acquired two specimens of *Tetrastes* from Sakhalin Island. They agree with a specimen from the mouth of the Amur River (near Nikolaievsk). This Amur specimen is slightly grayer above than the two males from I-mien-po, Manchuria (the type and cotype of my *T. b. amurensis*), but not different enough in my opinion to warrant a separate designation. From the above I would also place the *T. b. ussuriensis* Buturlin in the synonymy of *T. b. amuriensis*, as it hardly seems probable that two forms can inhabit practically the same country. Nearly all species of grouse have two phases of plumage, a red and a gray; but they are not distinct forms in the general acceptation of the term, as Buturlin seems to imply, but variations. In some parts of a species' range one of the phases may be lacking. This seems to be the case with *T. b. kolymensis*, as there are no birds of the red phase in the series before me.

Does not occur below Sredne Kolymsk, but not common until Verkhni is reached. Saw them constantly there in April and May, near the Kolyma and in the foothills of the Tomus Chaja Mountains before leaving the timber. Winter resident south of Sredne Kolymsk.—C. A.

Family GAVIIDAE.

5. GAVIA ADAMSI (Gray).

One female, Cape Bolshaja Baranov, July 19, 1915; and one without data from the Kolyma Delta region.

6. GAVIA STELLATA (Pontoppidan).

One male, Kolyma delta, July 16, 1915.

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[1] Messager Ornith., vol. 7, No. 4, 1916, p. 226.
[2] Proc. Biol. Soc. Wash., vol. 28, 1915, p. 162.

Family PROCELLARIIDAE.

7. FULMARUS ROGERSI Cassin.

Two males, off Indian Point, August 8, 1914.

These two specimens are very dark on the back, in fact darker than any specimens of the light phase of *Fulmarus g. glupischa* with which I have been able to compare them, but in measurements they are nearer *Fulmarus rogersi*, which averages larger with a heavier bill. The type of *F. rogersi* is a light-colored bird, in fact aberrant. It is pure white, the interscapular region and scapulars with a pale neutral gray wash; wing-coverts with a few pale neutral gray spots; bend of the wing, border, and primary-coverts, mouse gray; primaries and outer secondaries chaetura drab, with inner portion of the inner web white; tail feathers mouse gray, white on the inner web, except on the central pair. It is unsexed and measures: wing, 314; tail, 120; culmen, 38.5; depth of bill at base, 19.5.

For comparison I append the following averages:

Locality.	Wing.	Tail.	Culmen.	Depth of bill at base.
	mm.	*mm.*	*mm.*	*mm.*
Four males of *F. rogersi*	323.5	126.6	38.5	19.4
Two males, off Indian Point	321	123.7	39	19.5
Four males of *F. g. glupischa*	313	124.6	37.7	17.6

Family ALCIDAE.

8. FRATERCULA CORNICULATA (Naumann).

One male, Emma Harbor, July 28, 1914.

9. AETHIA CRISTATELLA (Pallas).

One male, Emma Harbor, July 29, 1914.

10. AETHIA PUSILLA (Pallas).

One male, off Indian Point, August 8, 1914.

11. CEPPHUS MANDTII (Mandt).

One male, Cape Bolshaja Baranov, August 9, 1915.

12. CEPPHUS COLUMBA Pallas.

Four males and two females, Emma Harbor, July 22, 28, 29, August 5 and 8, 1914.

Very common, Emma Harbor.—C. A.

Family LARIDAE.

13. LARUS VEGAE Palmén.

One male and one female, Emma Harbor, August 4 and 5, 1914; one female, Ajan Island, August 17, 1914.

14. RHODOSTETHIA ROSEA (Macgillivray).

On August 20, 1914, Capt. Koren saw four young Ross' gulls as we passed north of Ajan Island.—C. A.

15. STERNA PARADISAEA Brünnich.

Two males, Ajan Island, August 17, 1914; one female, Nijni Kolymsk, June 18, 1915.

Family STERCORARIIDAE.

16. STERCORARIUS POMARINUS (Temminck).

One male, Cape Bolshaja Baranov, August 1, 1915.

17. STERCORARIUS PARASITICUS (Linnaeus).

Two males, Kolyma Delta, July 12 and 15, 1915.

Family PHALAROPODIDAE.

18. PHALAROPUS FULICARIUS (Linnaeus).

Two males, Kolyma Delta, July 7, 1915; one female, Cape Wankarem, August 12, 1914; one male, Cape Bolshaja Baranov, August 11, 1915; one male (?), three females, and one unsexed, mouth of the Baranika River, August 16, 1915.

The two males taken July 7, have begun to turn white down the center of the breast, and a small white spot is appearing on the throat; the male taken August 11 has the lower parts particolored red and white, the latter prevailing, and the dusky of the chin has almost entirely disappeared; all the other specimens are white below with a band of light brownish drab across the foreneck. None of the specimens, except one male, taken August 11 show any great change above from the breeding plumage; the foreheads have become white and a few of the feathers of the winter plumage have begun to appear along the scapular region. The male collected August 11, has more of the gray of the winter plumage appearing on the back than any other specimen in the series.

19. LOBIPES LOBATUS (Linnaeus).

Two males, Kolyma Delta, July 7, 1915; one male, Sucharin, Kolyma Delta, July 9, 1915; and one unsexed, Baranika River, August 16, 1915.

Mr. Amory obtained a set of four eggs nearly hatched from a low, flat, bare island at the mouth of the Kolyma, July 16, 1915. The nest was situated on a tuft of wet moss among swampy "niggerheads."

Family SCOLOPACIDAE.

20. GALLINAGO GALLINAGO RADDEI (Buturlin).

One male, 7 miles north of Nijni Kolymsk, June 1, 1915; one male and one unsexed, Nijni Kolymsk, June 24, 1915.

The three specimens listed above are lighter, both above and below than in a series of five specimens from western Europe. The axillaries, though, are as heavily barred as in any European bird in the series, so this can not be a very reliable character. As there seems to be some doubt of the applicability of Hodgson's name *Gallinago uniclavus* as given by Thayer and Bangs,[1] it is probably better to use Buturlin's name.[2]

There seems to be little or no difference in size between European and east-asiatic birds, as the following will show:

Locality.	Wing.	Tail.	Culmen.
	mm.	*mm.*	*mm.*
Four males from Europe	129	58.2	65.9
Ten males from eastern Asia	127.4	57.6	69.5
Three females from Europe	128	57.7	70.3
Eight females from eastern Asia	127.9	56.3	65.9

21. PISOBIA ACUMINATA (Horsfield).

Two females, Sucharin Island, Kolyma Delta, July 9, 1915; one female, Kolyma Delta, July 14, 1915.

22. PISOBIA MACULATA (Vieillot).

One female, immature, Koliutschin Bay, August 10, 1914.

23. PISOBIA RUFICOLLIS (Pallas).

One male and one female, Emma Harbor, August 4, 1914.

24. PISOBIA TEMMINCKII (Leisler).

One female, Nijni Kolymsk, June 22, 1915.

25. ARQUATELLA COUESI Ridgway.

One immature female, Koliutschin Bay, August 10, 1914.

26. CANUS CANUS ROGERSI Matthews.[3]

One immature female, Chaun Bay, August 17, 1914.

Mathews, in his great work cited below, has divided the knots into three races—an European, an Asiatic, and an American. The series at my command seems to confirm this arrangement, except that birds from Alaska seem to belong to the Asiatic form. Birds from the eastern United States seem to be paler above, with more rufous and less black, when compared with European specimens. Asiatic birds are, as Mathews says, somewhat intermediate, darker than American specimens, but not so dark as those from Europe. With the Asiatic race I would include the Alaskan specimens as above stated, since they seem to be identical.

[1] Proc. New England Zool. Club, vol. 5, Apr. 9, 1914, p. 14.

[2] *Scolopax* (*Gallinago*) *gallinago raddei* Buturlin, "Limicolae of the Russian Empire." Pt. I, Tula, 1902, p. 54.

[3] Birds, Australia, vol. 3, pt. 3, Aug. 18, 1913, p. 270.

There is an adult male specimen in the United States National Museum collection (No. 109097) taken at Fort Simpson, Mackenzie, May 13, that seems also to agree with Alaskan and Asiatic birds; in point of size it is the largest male example measured. It must be confessed that the eastern United States specimens are in fresh unworn plumage; while the Alaskan, Asiatic, and European birds mostly have the gray edges of the back feathers abraded, but there are three unsexed individuals from Greenland before me that are about in the same stage of abrasion as the series from the three latter localities. These Greenland birds have less black and more rufous on the back than in either the European or Asiatic-Alaskan series, and the rufous below is especially dark and extensive, particularly so in No. 18628. The shade and extent of the rufous below varies considerably in the same series and I do not attach much importance to this character. My series of fall plumages of both the American and Asiatic forms are much too small to show anything. The differences in size between the series are small and covered by the variations; American birds average slightly smaller than the other two races. Besides an extensive series of spring birds from eastern United States there are a few unsexed specimens from the old world, not given in the measurements below, though useful for comparison. The various series average as follows:

Locality.	Wing.	Tail.	Culmen.	Tarsus.	Middle toe.
	mm.	*mm.*	*mm.*	*mm.*	*mm.*
Ten males from eastern United States	163.4	60.7	35.3	30.7	21.1
Four males from Alaska	166.2	63.9	34.5	31.7	21.2
One male from Mackenzie	177	64	36.5	34.5	22.5
Two males from Asia	166.2	62.5	33	31	20.5
One male from France	166.5	65	36	31	21
Ten females from eastern United States	167.8	62.1	37.1	31.6	21.6
One female from Alaska	169.5	63.5	39	32.5	21.5
Four females from Europe	168.6	62.9	36.1	31.5	21.3

27. LIMOSA LAPPONICA BAUERI Naumann.

One male, Cape Bolshaja Baranov, August 9, 1915.

28. RHYACOPHILUS GLAREOLA (Linnaeus).

One male and three females, Nijni Kolymsk, May 27, June 16, 17, and 27, 1915; one male, 7 miles north of Nijni Kolymsk, June 1, 1915.

29. TOTANUS ERYTHROPUS (Pallas).

One immature female, Little Annuj River, September 9, 1914.

Thayer and Bangs [1] when they found it impossible to accept *Tringa erythropus* Scopoli [2] for this bird, evidently overlooked the older name of *Scolpax erythropus* Pallas.[3]

[1] Proc. New England Zool. Club, vol. 5, 1914, p. 20.
[2] Annus 1, Hist. Nat., 1769, p. 102.
[3] Vroeg's Cat., Adumbr., 1764, p. 6.

30. TEREKIA CINEREA (Güldenstädt).

Two males, 7 miles north of Nijni Kolmsk, June 2 and 9, 1915; one female, Nijni Kolymsk, June 22, 1915.

These three specimens measure as follows:

U.S.N.M. No.	Sex.	Date.	Wing.	Tail.	Culmen.
			mm.	*mm.*	*mm.*
237348	Male	June 9	132.5	51	44
237347	do	June 2	130.5	54.5	45
237349	Female	June 22	139.5	56	50

31. MACHETES PUGNAX (Linnaeus).

Two males, 7 miles north of Nijni Kolymsk, May 26 and 30, 1915; one female, 8 miles west of Verkhni Kolymsk, May 24, 1915; five females, Sucharin Island, Kolyma Delta, July 7 and 9, 1915.

Family CHARADRIIDAE.

32. PLUVIALIS DOMINICUS FULVUS (Gmelin).

One female, Nijni Kolymsk, September 1, 1914.

33. CHARADRIUS MONGOLUS (Pallas).

One female, Emma Harbor, July 22, 1914.

34. MORINELLA INTERPRES INTERPRES (Linnaeus).

Three immature specimens, Cape Wankarem, August 12, 1914.

Family ANATIDAE.

35. MERGUS SERRATOR Linnaeus.

One immature, not sexed, Kolyma River, September 12, 1914.

36. MARECA PENELOPE (Linnaeus).

One male and one female, 7 miles north of Nijni Kolymsk, June 3, 1915; one immature male, Annuj River, September 5, 1914.

37. NETTION CRECCA (Linnaeus).

One male and one female, 7 miles north of Nijni Kolymsk, June 3, 1915.

38. NETTION FORMOSUM (Georgi).

One male, Nijni Kolymsk, June 10, 1915; two males and one female, 7 miles north of Nijni Kolymsk, May 27 and 31, and June 3, 1915; and one female, Kolyma Delta, July 7, 1915.

Mr. Amory secured a set of seven eggs, with incubation advanced five or six days, on Sucharin Islands, Kolyma Delta, July 9, 1915. The nest was on a "niggerhead" in open swamp, a hundred yards from a pond. It is composed of willow leaves, broken grass, and trash gathered apparently on the spot and the sides are lined with blackish down and a few feathers. The egg cavity is four inches in diameter and about the two and a half inches deep. The eggs are pale olive-buff and measure as follows: 47.6 by 35.3, 47.7 by 35, 47.4 by 33.8, 46.2 by 34.8, 47.4 by 35.7, 46.4 by 35, 47.3 by 34.4 mm.

39. DAFILA ACUTA ACUTA (Linnaeus).

One male, 7 miles north of Nijni Kolymsk, May 25, 1915.

40. CLANGULA CLANGULA CLANGULA (Linnaeus).

One specimen, Annuj River, October 4, 1914.

41. HARELDA HYEMALIS (Linnaeus).

Four males, Cape Bolshaja Baranov, July 22 and 23, 1915; one female, Kolyma Delta, July 14, 1915.

Three of the males have lost the long central tail feathers, and the remainder of the tail is much worn, and in all four the scapulars are mostly molted, and the fulvous of the upper back is much faded and worn.

We saw this back in September (1914) on the Lesser Annuj River. This year (1915) we saw great quantities of them at the delta of the Kolyma and along the Chorchee coast. They were by far the commonest duck observed.—C. A.

42. POLYSTICTA STELLERI (Pallas).

One male, Emma Harbor, August 8, 1914, and four females, near Cape North, August 13, 1914.

The male is commencing to assume the adult plumage. The forehead and sides of the face are becoming dusky white, and there is considerable white appearing in the scapulars.

Large flocks about the boat near Cape North.—C. A.

43. ERIONETTA SPECTABILIS (Linnaeus).

Two females, Ajan Island, August 18, 1914; and one female, near Karpe River, August 13, 1914.

Large flocks seen from the boat not far from shore, near Karpe River. During the trip in and trip out we observed no eiders of any kind west of Ajan Island.—C. A.

44. SOMATERIA V-NIGRA Gray.

One male in "eclipse plumage," Emma Harbor, July 7, 1914; one young male, near Karpe River, August 13, 1914, the latter is in the down and with the feathers of the first plumage appearing on the flanks and posterior scapulars; one downy young, not long from the nest, Plover Bay, August 8, 1914.

Very common at Emma Harbor.—C. A.

45. ANSER ERYTHROPUS (Linnaeus).

One female, Verkhni Kolymsk, May 26, 1915. It measures—wing, 406; tail, 114; culmen, 36.

46. MELANONYX SEGETUM SERRIROSTRIS (Swinhoe).

One male, Annuj River, September 6, 1914; one male, Kolyma Delta, July 18, 1915.

Family PHALACROCORACIDAE.

47. PHALACROCORAX PELAGICUS PELAGICUS Pallas.

One female (?), Emma Harbor, July 22, 1914.

Very common at Emma Harbor.—C. A.

Family STRIGIDAE.

48. ASIO FLAMMEUS FLAMMEUS (Pontoppidan).

One male, Little Annuj River, September 7, 1914; one unsexed, 7 miles north of Nijni Kolymsk, no date.

49. SCOTIAPTEX NEBULOSA BARBATA (Pallas).

One male, Verkhni Kolymsk, April 26, 1915.

This specimen is grayer on the back, the face is whiter, and the mark above the eye is darker and better defined than in any European specimen with which I have been able to compare it but it must be admitted my series of the latter is small, consisting of three specimens only. It measures—wing, 430; tail, 305; culmen, 23.5.

Very common just north of Sredne Kolymsk; not seen or heard around Nijni Kolymsk.—C. A.

50. NYCTEA NYCTEA (Linnaeus).

One adult female, Kolyma River, October 11, 1914. It measures—wing, 441; tail, 255; culmen from cere, 28.

51. SURNIA ULULA PALLASI Buturlin.

One female, Nijni Kolymsk, January 25, 1915; one female, Verkhni Kolymsk, April 22, 1915; one female and three males, 67 miles west of Verkhni Kolymsk, May 10, 12, and 16, 1915.

Specimens of this series, when compared with a male, a female, and an unsexed specimen of *S. u. ulula* from Europe, present a quite different appearance on the upper surface; *S. u. pallasi* seems to have more white; the nape patch, the patch over the shoulder, and the ear coverts and mark on the sides of face are darker and more pronounced; and the brown is of a different shade nearer hair brown, while in *S. u. ulula* it is olive. Below there does not seem to be much difference. There is a specimen in the collection from Petropaulski, Kamtschatka (No. 41010) that does not seem to differ from European specimens and it may be that the differences in the color of the back pointed out for *S. u. pallasi* are due to the fresher condition of the specimens.

The series measures as follows:

U.S.N.M. No.	Sex.	Locality.	Wing.	Tail.	Culmen from cere.
			mm.	*mm.*	*mm.*
237393	Male	67 miles west of Verkhni	240	190	17
237394	do	do	223	185	18
237395	do	do	239.5	172.5	18
237392	Female	do	235	180	18
237391	do	Verkhni Kolymsk	230	170	16.5
237390	do	Nijni Kolymsk	240	187.5	18
109868	Male	Archangel, Russia	243	187	19
98031	Female	Bergen, Norway	244	182	18.5
1821		Kinberg, Lapland	240	177	19
41010		Petropaulski, Kamtschatka	220.5	165	15.5

52. CRYPTOGLAUX FUNEREA MAGNA (Buturlin).

One male, Verkhni Kolymsk, April 17, 1915.

This specimen, when compared with European birds, is more nearly hair brown on the back, in sharp contrast to the olive of the European series before me; it also seems to have more white spotting on the top of the head. The color of the back may be due to the freshness of the specimen, however. It measures as follows: Wing, 169; tail, 101.5; culmen, 14.

Family PICIDAE.

53. DRYOCOPUS MARTIUS REICHENOWI Kothe.

One male, 8 miles west of Verkhni Kolymsk, May 22, 1915; one female, 80 miles from mouth of Little Annuj River, November 23, 1914.

These are of the same deep black as a male specimen from Manchuria and a female from north China, but have smaller bills.[1] They measure as follows:

U.S.N.M. No.	Sex.	Locality.	Wing.	Tail.	Culmen.
			mm.	*mm.*	*mm.*
237397	Male	8 miles west of Verkhni	253	168	57.5
237296	Female	Little Annuj River	245	174	56

A winter resident in the Kolyma. The first one observed was in November, 100 versts [67 miles] from Nijni Kolymsk on the Lesser Annuj (collected by Axel Sändmark) in a larch next the river. In the winter I saw two skins brought in by Chorkches, one to Nijni Kolymsk, the other to Verkhni Kolymsk. The specimen taken 12 versts [8 miles] west of Verkhni Kolymsk had a nest 10 feet from the ground in the heart of the largest white birch I saw in the valley. The nest tree was in a swampy, willow-covered locality, near the

[1] See Proc. Biol. Soc. Wash., vol. 28, Sept. 21, 1915, p. 162.

shore of a large lake. The nest contained four white eggs. I watched for awhile, but did not observe the mate. This one was working at the nest and the ground at the foot of the birch was sprinkled with pickings from the tree. The form is shy.—C. A.

Only one egg from the set mentioned above by Mr. Amory is in his collection. It measures 34.3 by 25.3 mm.

54. PICOIDES TRIDACTYLUS CRISSOLEUCUS (Reichenbach).

One male 80 miles from mouth of Little Annuj River, November 18, 1914. It measures—wing, 120.5; tail, 82; culmen, 30. This is so distinct from *P. t. tridactylus* that I do not see the utility of making it a form of that species, unless it is known to intergrade.

Saw three of these woodpeckers on the Little Annuj in November. I did not see any but was told at Verkhni Kolymsk they were there throughout the year.—C. A.

Family HIRUNDINIDAE.

55. HIRUNDO URBICA WHITELEYI (Swinhoe).

Three males, Nijni Kolymsk, June 15, 16, and 17, 1915.

Family TURDIDAE.

56. TURDUS MUSICUS Linnaeus.

Two males, 7 miles north of Nijni Kolymsk, May 18 and 23, 1915; one female, Nijni Kolymsk, June 10, 1915.

These three birds when compared with a series from Europe are more nearly hair brown on the back, while in European birds it is bistre. There appears to be no difference in size.

57. CYANOSYLVIA SUECICA ROBUSTA (Buturlin).

One male, Nijni Kolymsk, June 27, 1915.

It measures as follows: Wing, 73; tail, 51; culmen, 13.

58. OENANTHE OENANTHE OENANTHE (Linnaeus).

One male, immature, Ajan Island, August 17, 1914; one male(?), immature, Cape Bolshaja Baranov, August 11, 1915.

Family SYLVIIDAE.

59. PHYLLOSCOPUS TROCHILUS EVERSMANNI (Bonaparte).

One male, Nijni Kolymsk, June 27, 1915; one male, 7 miles north of Nijni Kolymsk, June 10, 1915; and one female, Kolyma River, opposite Nijni Kolymsk, June 18, 1915.

The above specimens, along with the series reported upon by Thayer and Bangs,[1] kindly loaned me by the authorities of the Museum of Comparative Zoology, when compared with a series of

[1] Proc. New England Zool. Club, vol. 5, Apr. 9, 1914, p. 39.

Phylloscopus t. trochilus appear quite different. *P. t. eversmanni* differs from *P. t. trochilus* in being gray on the back (between hair brown and drab) with only a very slight yellowish tinge, this latter color being confined mostly to the rump and wings, quite different from the buffy olive upper parts of the latter. *P. t. eversmanni* is grayish white below with only a slight buffy tinge on the jungulum, in sharp contrast to the yellowish tinge, more or less pronounced on the under parts of *P. t. trochilus*, and the loral streak is more sharply defined and more distinctly yellow in the latter. In size there is little or no difference, as the following will show:

	Wing.	Tail.	Culmen.
	mm.	*mm.*	*mm.*
Six males of *P. t. eversmanni*	70.9	53.3	9.4
Four males of *P. t. trochilus*	68	50	9.5
Four females of *P. t. eversmanni*	65.5	48	9.2
Four females of *P. t. trochilus*	66.8	49	9.5

Mr. Amory took a nest and seven slightly incubated eggs on the Kolyma, directly opposite Nijni Kolymsk, June 18, 1915. The nest was in swamp and willows on one side of a "niggerhead," with water directly below the nest and a leaning dead willow stick directly above. The nest outwardly is composed of rather coarse grass with a few pieces of sphagnum moss, loosely woven; internally of finer grass and lined with white ptarmigan feathers. The outer covering extends up over the egg cavity, forming a roof. In fact, the nest has the appearance of two nests, the outer one composed of dark-colored coarse grass and the inner of finer yellowish grass. Outwardly the nest measures about 6½ by 5 inches; the egg cavity which is rounded 2 inches. The inner nest is placed in the front of the mass that composes the outer nest.

The eggs are short, ovate in shape; white, rather evenly spotted with larger and smaller spots of vinaceous russet in two tints; the spots more numerous on the larger end. They measure as follows: 16.7 by 12.6, 16.4 by 12.5, 15.5 by 12.4, 16.4 by 12.5, 16.7 by 12.7, 16.5 by 12.6, 16.2 by 12.4 mm.

60. REGULOIDES SUPERCILIOSUS SUPERCILIOSUS (Gmelin).

One male, Nijni Kolymsk, June 10, 1915. It measures—wing, 58.5; tail, 40; culmen, 9.

Family LANIIDAE.

61. LANIUS EXCUBITOR MOLLIS Eversmann.

One immature, Nijni Kolymsk, September 8, 1914.

Family PARIDAE.

62. PENTHESTES CINCTUS KOLYMENSIS (Buturlin).

Two males and one unsexed, 80 miles from the mouth of Little Annuj River, November 13 and 14, 1914; one male, Verkhni Kolymsk, April 14, 1915; one male and one female, 67 miles west of Verkhni Kolymsk, May 12, 1915.

These birds appear to be paler than *Penthestes c. alascensis*, especially on the flanks.

These remain even in the lower Kolyma throughout the year.—C. A.

This series measures as follows:

U.S.N.M. No.	Sex.	Locality.	Date.	Wing.	Tail.	Culmen.
				mm.	*mm.*	*mm.*
237468	....	80 miles from mouth of Little Annuj River	Nov. 13	71	69.5	9.5
237469	Male....	.....do	Nov. 14	73	71.5	9.5
237470	...do....	.....do	...do....	70	69.5	9.5
237471	...do....	Verkhni Kolymsk	Apr. 14	74	71	10
237472	...do....	33 miles west of Verkhni	May 12	72.5	67.5	9
237473	Female..	.....do	...do....	67	68	9

Family MOTACILLIDAE.

63. MOTACILLA ALBA OCULARIS Swinhoe.

One male, 40 miles south of the mouth of the Kolyma River, July 6, 1915; one male, 7 miles north of Nijni Kolymsk, May 17, 1915.

64. BUDYTES FLAVUS PLEXUS Thayer and Bangs.[1]

One immature, in white plumage, Koliutschin Bay, August 10, 1914; one male, 7 miles north of Nijni Kolymsk, June 2, 1915; two males and two females, Nijni Kolymsk, June 16, 17, and 27, 1915.

In the above series of adults three have the narrow white superciliary as given by Thayer and Bangs,[2] and two are without it. The latter, when compared with *B. f. borealis*, are duller in color, not nearly so bright on the back. In a series of nine (seven breeding birds) of *B. f. simillima* from Kamchatka, the white superciliary extends forward to the bill in every case, and it would appear that any specimen in which it occurs only posterior to the eye is aberrant. *B. f. simillima* seems to be brighter above with the gray of the top of the head more sharply defined against the back than in *B. f. plexus.* I regard the latter as a good race, though I am aware that my remarks do not agree with what Thayer and Bangs have written. Below I give the measurements of a series of males of *B. f. simillima* and *B. f. plexus*, which suggests the possession of a longer bill by the former.

[1] Proc. New England Zool. Club, vol. 5, 1914, p. 41.
[2] Idem, p. 42.

Budytes flavus simillima.

U.S.N.M. No.	Sex.	Locality.	Date.	Wing.	Tail.	Culmen.
				mm.	*mm.*	*mm.*
89148	Male	Petropaulski, Kamchatka	July 11	79	67.5	13
89149	do	do	July 4	81	71.5	15
201498	do	do	June 18	79	66	14
201499	do	do	June 17	85	73.5	13
201497	do	do	June 19	83	70.5	13
201496	do	do	June 17	80	69	13.5
201500	do	do	do	80.5	70.5	13.5

Budytes flavus plexus.

U.S.N.M. No.	Sex.	Locality.	Date.	Wing.	Tail.	Culmen.
237462	Male	7 miles north of Nijni Kolymsk	June 2	82	72	12.5
237464	do	Nijni Kolymsk	June 17	79.5	68	13
237466	do	do	June 27	80	69.5	12.5

A nest with five nearly fresh eggs was taken at Nijni Kolmsk, June 16, 1915. It was placed in a tuft of grass, 10 feet inside the fringe of willows that lines the banks of the Kolyma. The nest is composed of rather course grass, lined with hair and one grayish-white feather. It is about 3½ inches in diameter outwardly and the egg cavity, which is rather shallow, about 2½ inches in diameter.

The eggs are olive buff in ground tint, profusely spotted rather evenly over the entire surface, with very minute spots of wood brown and some purplish shell markings. They measure as follows: 19.6 by 14.9, 20 by 14.8, 20.2 by 14.6, 19.5 by 14.4, 19.4 by 14.3 mm.

65. ANTHUS GUSTAVI Swinhoe.

One male, Nijni Kolymsk, June 17, 1915.

I have compared this specimen with a series from Bering and Copper Island; it appears to be more heavily streaked below, but does not seem to differ otherwise. It measures: Wing, 83; tail, 54; culmen, 13.

66. ANTHUS, species?

One immature, Emma Harbor, August 5, 1914.

This is a young bird not long from the nest; too young to be identified with any degree of certainty at present, except that it probably does not belong with the above species.

Family ALAUDIDAE.

67. OTOCORIS ALPESTRIS EUROA Thayer and Bangs.[1]

Six males, 7 miles north of Nijni Kolymsk, May 14, 15, and 16, 1915. I can add nothing to the account of the describers. The above series measures as follows:

[1] Proc. New England Zool. Club, vol. 5, 1914, p. 43.

U.S.N.M. No.	Locality.	Date.	Wing.	Tail.	Culmen.
			mm.	*mm.*	*mm.*
237400	7 miles north of Nijni	May 14	111	69	12.
237403	do	May 16	111	72	12.5
237404	do	May 15	116.5	73	12.5
237402	do	May 16	115	69.5	12.5
237401	do	May 14	116	73.5	11.5
237399	do	do	113.5	72.5	12

Family FRINGILLIDAE.

68. ACANTHIS HORNEMANNI EXILIPES (Coues).

Two males and one female, Nijni Kolymsk, June 10, 16, 25, 1915; one male and one female, 7 miles north of Nijni Kolymsk, May 21, 1915.

One of the males taken at Nijni Kolymsk (No. 237425, June 25) is very pale above, the centers of the feathers of the back and wings being light drab, edged with dirty white; tail smoke gray, edged with white. In fact, it is approaching albinism.

Very common in summer and autumn. Did not observe them around Nijni after the end of October, but was told at Verkhni they remain in the upper Kolyma Valley all winter.—C. A.

A nest and four eggs with incubation advanced about five days was taken from a willow about 2½ feet from the ground at Nijni Kolymsk, July 5, 1915. The nest is composed of cotton wool, rootlets, grass, and small sticks felted together and lined with cotton wool and feathers. The outside diameter of the nest is about 3½ inches, that of the egg cavity is about 1¾ inches, and the depth of the latter about 1¾ inches.

The eggs are etain blue with some light vinaceous-drab markings and a few spots and scrawls of taupe brown arranged principally around the larger end. They measure as follows: 16 by 12, 16.2 by 12.4, 16.4 by 11.9, 16.4 by 11.7 mm.

69. PLECTROPHENAX NIVALIS NIVALIS (Linnaeus).

Three males and five females, 7 miles north of Nijni Kolymsk, May 12, 13, and 14, 1915; one immature male and one female, Emma Harbor, July 22 and August 5, 1914.

These do not seem to differ from North American birds in size or color.

70. CALCARIUS LAPPONICUS ALASCENSIS Ridgway.

One adult and one young male, and four adult females, Emma Harbor, July 22 and 28 and August 8, 1914; one young, Koliutschin Bay, August 10, 1914.

These specimens are very much worn but seem to agree better with *C. l. alascensis* than with *C. l. coloratus*, as has been already remarked by Thayer and Bangs.[1]

[1] Proc. New England Zool. Club, vol. 5, 1914, p. 46.

Locality.	Wing.	Tail.	Culmen.
	mm.	*mm.*	*mm.*
Three males from mainland Siberia	92.7	60.2	11.8
Ten males, *C. l. coloratus*	97.3	62.5	12.2
Twenty-two, *C. l. alascensis*[1]	95.7	63.2	11.6
Four females from mainland Siberia	87.2	59	11
Six females, *C. l. coloratus*	92.1	58.9	11.7
Twenty-four, *C. l. alascensis*[1]	86.1	58.4	10.9

[1] Ridgway, Bull. U. S. Nat. Mus. No. 50, Pt. i, 1901, p. 158.

The commonest perching bird at Emma Harbor.—C. A.

71. EMBERIZA PALLASI (Cabanis).

One male, 7 miles north of Nijni Kolymsk, June 9, 1915.

It measures—wing, 71.5; tail, 59; culmen, 9.5.

72. EMBERIZA PUSILLA Pallas.

Two males, Nijni Kolymsk, June 10 and 27, 1915.

These measures as follows: Wing, 73–69.5; tail, 57–54; culmen, 9.5.

Family CORVIDAE.

73. CORVUS CORAX KAMTSCHATICUS Dybowski.

One ("female"?), Verkhni Kolymsk, April 20, 1915.

It measures—wing, 415; tail, 238.5; culmen, 69. Counting from the outside, the third and fourth primaries are longest, the third longer than the fifth.

Compared with *C. c. behringianus*, *C. c. kamtschaticus* appears to be of a deeper black and the gloss of a different shade of purple (more steely) but I attribute these differences to season; *C. c. behringianus* has a heavier bill, however. A male of *C. c. ussurianus* from I-mien-po, Manchuria, October 14, 1914, before me, agrees very well with *C. c. kamtschaticus* in color, but has a shorter and weaker bill. It measures—wing, 410; tail, 257; culmen, 62.5.

As Stresemann[1] has shown, *Corvus corax sibiricus* Taczanowski, 1891, can not be used on account of *Corvus sibiricus* Boddaert, 1783, and Gmelin, 1788. I therefore follow Buturlin[2] in using *C. c. kamtschaticus* Dybowski for the eastern Siberian form.

We saw ravens along the coast of the Chorchee Peninsula. They are found throughout the Kolyma Valley, especially in the upper part.—C. A.

74. CORVUS CORONE ORIENTALIS Eversmann.

One female, Nijni Kolymsk, October 1, 1914.

This specimen agrees fairly well with a female bird from Tientsin, China, February 26, except it has a slightly longer bill. From Kamtschatcan specimens it differs in the same way that the raven

[1] Orn. Monatsb., vol. 21, 1913, p. 9.
[2] Messager Ornith., vol. 6, 1915, pp. 107, 114.

from Bering Island and the Kolyma differ in that the back is more steely blue not so purplish, and in my opinion, Dr. L. Stejneger[1] was justified in assigning the crow of this species from Kamtschatka to a different form. The measurements of the females given by Doctor Stejneger[1] with the two birds mentioned above are as follows:

U.S.N.M. No.	Sex.	Locality.	Date.	Wing.	Tail.	Culmen.
				mm.	*mm.*	*mm.*
97762	Female..	Petropaulski	Sept. 20	330	198	53
97761	...do....	....do	Oct. 10	324	195	52
236939	...do....	Tientsin	Feb. 26	315	183.5	45
237414	...do....	Kolyma River	Oct. 1	320	187	49

75. NUCIFRAGA CARYOCATACTES MACRORHYNCHOS Brehm.

One male, two females, and two unsexed, 80 miles from the mouth of the Little Annuj River, November 10, 11, 14, and 20, 1914; one male, 53 miles west, May 10, 1915; and one male, 67 miles west of Verkhni Kolymsk, May 21, 1915.

The majority of the Kolyma birds when compared with three males and one female from Korea look quite different; they are more nearly hair brown on the back, which is bistre in the Korean series. A male and female from Japan are rather odd in that the female (July 2) resembles the Kolyma birds in color, while the male (December 7) is like the Korean birds. It may be that the striking difference in color between Korean and Kolyma birds is due to the freshness of the specimens of the latter. This is the more probable as two of the Kolyma specimens resemble the Korean birds.

U.S.N.M. No.	Sex.	Locality.	Date.	Wing.	Tail.	Culmen
				mm.	*mm.*	*mm.*
237423	Male....	67 miles west of Verkhni Kolymsk	May 10	187	124.5	47
237424	...do....	53 miles west of Verkhni Kolymsk	May 21	177.5	117	44.5
237420	...do....	80 miles from mouth Little Annuj River.	Nov. 14	183.5	118	44
237422	Female..	.....do	Nov. 20	184	125	39.5
237421	...do....	.....do	...do....	177	117.5	40

Observed many on the Little Annuj in November but not around Nijni. In April and May observed them in the foothills of the Tomus Chaja Mountains. Was told at Verkhni they were to be found in this region regularly throughout the year; that is, near the mountains.—C. A.

76. PERISOREUS INFAUSTUS YAKUTENSIS Buturlin.[2]

Four males and one female, Verkhni, Kolymsk, April 14 and 22, 1915; one male, Little Annuj River, September 6, 1914; one male, 80 miles from mouth of Little Annuj River, November 5, 1914.

[1] Bull. U. S. Nat. Mus., No. 29, 1885, pp. 239–241.
[2] Messager Ornith., 1916, pp. 39, 43.

This series when compared with European specimens is so very different that it seems very doubtful whether it should be only accorded subspecific rank. They are clear slaty gray on the back without the brownish wash seen in *P. i. infaustus;* below they are lighter gray with a slight buffy wash, quite different from the tawny of *P. i. infaustus.* This series measures as follows:

U.S.N.M. No.	Sex.	Locality.	Date.	Wing.	Tail.	Culmen.
				mm.	*mm.*	*mm.*
237410	Male	Verkhni Kolymsk	Apr. 22	147.5	130	22.5
237411	...do	.....do	...do	148	137.5	23.5
237409	...do	.....do	...do	149.5	135	....
237408	...do	.....do	Apr. 14	146.5	137.5	22
237407	...do	80 miles from mouth Little Annuj River.	Nov. 5	149	138	23.5
237406	...do	Little Annuj River	Sept. 6	146	137.5	....
237412	Female	Verkhni Kolymsk	Apr. 22	148.5	134	22.5

This bird is common throughout the Kolyma Valley. Winter resident.—C. A.

FOSSIL PLANTS FROM THE LATE TERTIARY OF OKLAHOMA.

By Edward W. Berry,

Of the Johns Hopkins University.

The following short paper is based upon materials collected by Prof. E. C. Case, of the University of Michigan, and presented by him through the writer to the United States National Museum. These collections were incidental in the exploration of the red beds of Oklahoma in search for Permian vertebrates, under the auspices of the Carnegie Institution. They were made from an outcrop of chalk-like clay on the south side of Beaver Creek, near the since abandoned post office of Alpine, about 10 miles east of Beaver City. The matrix is a light-colored fluffy clay which appears to be largely a volcanic ash. No vertebrates were found associated with the plants except a few undeterminable fishbones. A small undetermined crustacean was also found in the clay.

Darton[1] in 1899 divided the Loup Fork of the central Great Plains into the Arikaree and the Ogallala formations, regarding the former as Miocene and the latter as possibly Pliocene in age. Various local subordinate divisions have been recognized by the field geologists in Kansas and Nebraska. Materials corresponding in a general way to those of the Ogallala formation of Kansas and Nebraska are widespread in western Oklahoma. These are clays, sands, and gravels of exceedingly variable character and proportions. They probably once covered the entire "panhandle" but are now preserved chiefly on the uplands where the argillaceous cliffs of these materials are locally known as "mortar beds" or "chalk." The thickness varies from place to place and ranges in Beaver County from thin remnants to upwards of 300 feet. These deposits are, in the latter region, usually underlain by the red beds of the

[1] Darton, N. H., U. S. Geological Survey 19th Ann. Rept., pt. 4, p. 734, 1899; Professional Paper 32, p. 176, 1905.

Permian, although locally traces of the Lower Cretaceous may be intercalated.

According to our present knowledge of the genesis of the continental Tertiary deposits it can not be expected that similarity of lithologic composition has any definite bearing upon correlation, and it must be understood that the conclusions of the present paper refer only to the fossiliferous outcrop which is discussed.

The florule collected from this outcrop represents but six determinable species, of which four are new, and three additional forms that are generically but not specifically recognizable. It includes two grass or sedge-like plants which are fragmentary and of no botanical value beyond indicating the presence of such plants in this region at that time. Willow leaves are present, but not specifically determinable. The most abundant forms are the *Platanus* and the *Sapindus*. The *Gymnocladus*, *Rhamnus*, *Bumelia*, and *Diospyros* are all represented by a scanty amount of material, but as the collection is a small one the individual abundance of the different species is probably without significance.

All of the forms appear to have been alluvial species of river bottoms, and most of them have their genera still represented in the valleys of the principal streams that enter eastern Oklahoma from the Coastal Plain of the Gulf States. This statement is true of *Platanus*, *Gymnocladus*, *Sapindus*, *Rhamnus*, *Bumelia*, and *Diospyros*. All these genera are normal constituents of the rich alluvial deciduous forests of the southeastern United States, and the presence of fossil representatives in western Oklahoma shows that climatic conditions in that region were more mesophytic toward the close of the Miocene than they are at the present time, with the stream valleys covered with a mixed deciduous forest, which may also have covered more or less of the interstream areas.

Regarding the age indicated by this florule, it may be said that the *Cyperacites*, *Caulinites*, and *Salix* are without significance. Only one of the nine forms—namely, *Rhamnus lesquereuxi*—is limited to a single outside horizon, and this species occurs in the late Miocene of Florissant, Colorado. *Platanus aceroides* and *Diospyros brachysepala* are recorded throughout the Tertiary in both this country and Europe, and while both are probably composite species, it is impossible to segregate them in the present state of knowledge. Both are, however, typically Miocene forms, the *Platanus* being found in the John Day Basin on the west coast and in the Calvert Miocene of the Atlantic coast, and indistinguishable leaves of the *Diospyros* occur at Florissant, Colorado. Moreover, the new species of *Sapindus* approaches closely to *Sapindus lancifolius* Lesquereux, another Florissant species. From this it would seem that the Oklahoma plants were of somewhat similar age to those of Florissant, the different physical conditions combined with the much less effective methods of preservation accounting for the sparseness of the flora recognized from Oklahoma. I believe that this is substantially true, and I am inclined to regard the Oklahoma outcrop as of upper Miocene age, although there is no conclusive evidence in existence that such a valley flora may not have continued in this region during the early Pliocene, there being no considerable American Pliocene floras, except that of the Gulf coast,[1] with which to make comparisons.

Subclass MONOCOTYLEDONAE.

Order GRAMINALES.

Genus CYPERACITES Schimper.

CYPERACITES, species.

Fragments of the foliage of an undeterminable species of a grass or sedge are not uncommon in the collection. Similar remains are not uncommon at many Upper Cretaceous and Tertiary outcrops and are without significance beyond indicating the presence of this order of plants.

Genus CAULINITES Brongniart.

CAULINITES, species.

Fragments of the impression of a rhizome of a grass or sedge are present in the collection. The impressions are 8 mm. in diameter, with nodes about 4 cm. apart, and indicate a grass or sedge of considerable size. Similar remains are not uncommon throughout the Tertiary.

Subclass DICOTYLEDONAE.

Order SALICALES.

Family SALICACEAE.

Geuus SALIX Linnaeus.

SALIX, species.

Several fragments of an undeterminable species of willow are contained in the collection. These represent a form with entire leaves

[1] Berry, E. W., U. S. Geological Survey Prof. Paper 98 L, pp. 193–208, pls. 44–47, 1916.

and about the size and shape of those of the existing *Salix nigra* Marsh.

Order PLATANALES.

Family PLATANACEAE.

Genus PLATANUS Linnaeus.

PLATANUS ACEROIDES Goeppert.

Plate 94, fig. 3; plate 95, fig. 5.

Platanus aceroides GOEPPERT, Zeits. Deutsch, Geol. Gesell., vol. 4, 1852, p. 492.

There is no need for me to redescribe this exceedingly well-known species. It is the most abundant form in the present collection where it is represented by counterparts of both small and large leaves beside numerous fragments showing petioles, tips, and lobes, so that collectively all parts of the leaf are well represented. Both the large and the small leaves are identical in proportions, lobation, marginal and basal characters with Goeppert's types [1] and with the leaves of this species figured by Heer [2] from the Tortonian of Oeningen, Baden.

This species has been identified from such a variety of horizons and localities that it would be fruitless to endeavor to make comparisons with all of the forms that stand in the literature as *Platanus aceroides.* Undoubtedly some of these represent distinct species, but it is impossible to make any rational segregation at the present time. As the records stand it has a range from the basal Eocene to the Pleistocene in this country, and from the Oligocene through the Pliocene in Europe.

Its typical development, however, is in the middle and upper Miocene, and although it has not been discovered in the deposits of the Miocene lake basin at Florissant, Colorado, it is present in the John Day Miocene of Oregon and in the Calvert Miocene of Virginia. A very similar form, questionably distinct, is *Platanus dissecta* Lesquereux [3] from the California Miocene which is said to be a larger and more coriaceous form.

Plesiotypes.—Cat. Nos. 35283, 35284, U.S.N.M.

[1] Goeppert, H. R., Tertairflora von Schossnitz, 1855, p. 21, pl. 9, figs. 1–3.

[2] Heer, O., Fl. Tert. Helv., vol. 2, 1856, p. 71, pl. 87; pl. 88, figs. 5–12, 15.

[3] Lesquereux, L., Mus. Comp. Zoöl., Memoirs, vol. 6, 1878, p. 13, pl. 7, fig. 12; pl. 10, figs. 4, 5.

Order ROSALES.

Family CAESALPINIACEAE.

Genus GYMNOCLADUS Lamarck.

GYMNOCLADUS CASEI, new species.

Plate 94, fig. 2.

Leaflets sessile, relatively small in size, somewhat inequilateral ovate in general outline, with a short acuminate tip and a rounded base. Margins entire. Texture subcoriaceous. Length 3.5 cm. Maximum width, below the middle of the leaflet, 1.7 cm. Midrib stout, prominent, slightly curved. Secondaries comprising about four subopposite to alternate pairs, camptodrome; they diverge from the midrib at angles of about 45 degrees and curve regularly upward subparallel with the lower lateral margins. The character of the matrix has obliterated the areolation.

The present material is clearly to be affiliated with the leaflets of the existing *Gymnocladus dioicus* Koch, the Kentucky Coffee tree, differing from the latter principally in the slightly smaller size of the fossil leaflets. *Gymnocladus* has but two existing species, the one just mentioned and a second in southern China. This distribution in itself and from the analogy furnished by other genera such as *Magnolia*, *Liriodendron*, *Sassafras*, and *Liquidambar*, likewise found in eastern North America and eastern Asia, and with more or less of their geological history known, is conclusive evidence that *Gymnocladus* had a Tertiary history during which it occupied intervening areas. However, with the exception of the species just described and some rather doubtful European records[1] no fossil remains have thus far been discovered.

Gymnocladus dioicus (*G. canadensis* Lamarck), the existing American species, is a member of the mixed deciduous forests of southeastern North America, ranging from central New York and western Pennsylvania and Maryland through southern Ontario and southern Michigan to the valley of the Minnesota River and to the bottoms of the larger rivers in eastern Nebraska, eastern Kansas, and eastern Oklahoma. It is distinctly an alluvial species throughout its range and while plant geographers record it and other species of like habitat as invaders into the prairie region from the east it is certain that they or their immediate ancestors had a much more extensive range in the late Tertiary in what is now the prairie country.

Holotype.—Cat. No. 35285. U.S.N.M.

[1] Heer, O., Fl. Tert. Helv., vol. 3, 1859, p. 103, pl. 134, figs. 9–12. Squinabol, S., La Flore de Novale, 1901, p. 71, pl. 4, fig. 15.

Order SAPINDALES.

Family SAPINDACEAE.

Genus SAPINDUS Linnaeus.

SAPINUS OKLAHOMENSIS, new species.

Plate 95, figures 1, 2.

Leaflets inequilateral, relatively large, sessile or subsessile, ovate-lanceolate and more or less falcate in outline. Apex and base about equally acuminate but the former more extended and the greatest width of the leaflets below the middle. Margins entire. Substance of the leaflets of medium consistency but hardly deserving the term subcoriaceous. Length 9.5 cm. to 13 cm. Maximum width 2.5 cm. to 3 cm. Midrib stout, fairly prominent, curved. Secondaries numerous, thin but prominent where the preservation is good; they diverge from the midrib at angles around 50 degrees at regular intervals of from 3 mm. to 5 mm., are indifferently opposite to alternate, rather straight and subparallel in their courses and camptodrome. The tertiary areolation, which was well marked in life and rather fine consisted of transversely or obliquely elongated polygonal meshes, and is shown in occasional patches on the specimens but is generally entirely obliterated by the character of the matrix.

This species next to *Platanus aceroides* is the most common form in the collection and indicates a vigorous and fairly large-sized tree. There are a number of described fossil species that approach it very closely. Thus *Sapindus lancifolius* Lesquereux[1] a common Florissant form, while prevailingly smaller, occasionally approaches it in size, as for example in figure 9 cited. The base is, however, more obtuse and the secondaries are somewhat less ascending. *Sapindus affinis* Newberry[2] which is a very common Eocene species, has been identified by Knowlton[3] from the Miocene of Yellowstone Park. The latter specimens are very similar to the Oklahoma species differing merely in their less extended form and fewer secondaries. The widespread European *Sapindus falcifolius* Al. Braun[4] is also very similar but generally smaller and relatively narrower, and the middle Miocene *Sapindus densifolius* Heer[5] of Europe is also very similar.

The geological record of *Sapindus* is a full one, many species having been described from the Upper Cretaceous onward. The genus

[1] Lesquereux, L., Cret. and Tert. Flora, 1883, p. 182, pl. 32, figs. 3–6; pl. 37, fig. 9.

[2] Newberry, J. S., U. S. Geol Survey Mon., vol. 35, 1898, p. 116, pl. 30, fig. 1; pl. 40, fig. 2.

[3] Knowlton, F. H., Idem, vol. 32, 1899, p. 736, pl. 102, figs. 1–3.

[4] Heer, O., Fl. Tert. Helv., vol. 3, 1859, p. 61, pl. 119; pl. 120, figs. 2–8; pl. 121, figs. 1, 2. figs. 1, 2.

[5] Heer, O., Idem, p. 62, pl. 120, fig. 1.

is particularly prominent in the Miocene, no less than 30 species of this age having been described from Europe, Asia, and North America. The genus is present in the Miocene of the United States in Oregon, Colorado, and the Yellowstone Park. The existing species number about two score and are widely distributed throughout the tropics of both hemispheres and are especially abundant in the Asiatic region. Several extend long distances into the North Temperate Zone. Three of these are found in the United States—two in Florida and *Sapindus drummondi* Hooker and Arnott as a considerable tree in moist clayey and dry calcareous soils ranges from western Louisiana to southern Kansas and through Texas to the mountain valleys of southern Arizona and northern Mexico. It occurs in the Wichita Mountains of Oklahoma, but I do not know of its presence in Beaver County, although it may occur there.

Cotypes.—Cat. Nos 35286, 35287, U.S.N.M.

Order RHAMNALES.

Family RHAMNACEAE.

Genus RHAMNUS Linnaeus.

RHAMNUS LESQUEREUXI, new species.

Plate 95, fig. 4.

Rhamnus notatus Lesquereux, Cret. and Tert. Flora, p. 189, pl. 38, fig. 15, 1883 (not Saporta, 1867).

Leaves relatively small and very short petioled, ovate in general outline, inclined to be slightly inequilateral. Apex short and obtusely pointed, as is also the base. Margins entire. Texture sub-coriaceous. Length about 3.5 cm. Maximum width, midway between the apex and the base, 2.1 cm. to 2.2 cm. Midrib stout, curved in the material seen, prominent on the lower surface of the leaf. Secondaries six to eight opposite to alternate, mediumly stout and prominent pairs. They diverge from the midrib at angles of over 45 degrees, are subparallel with the lower lateral margins and with one another, and are camptodrome in the maginal region. The areolation is not visible in the Oklahoma specimens. Lesquereux says of the Florissant material, "nervilles oblique, transversely reticulate."

This species was provisionally identified by Lesquereux with a form described by Saporta[1] from the Miocene of southeastern France. The latter is obviously different, being smaller, more coriaceous, subdentate apicad, and with fewer secondaries. It is, however, similar in appearance, and the two are possibly closely related. The material from Oklahoma appears certainly identical with that

[1] Saporta, G. de, Etudes, vol. 3, 1867, p. 108, pl. 11, fig. 5.

from Florissant. It may also be compared with various identifications of *Rhamnus rossmässteri* Unger, as, for example, the leaves figured by Heer [1] from the Miocene of Switzerland. The latter species is rather common in Europe from the Aquitanian to the Pliocene and shows considerable variation. It is, in general, a somewhat larger form than the present species.

Rhamnus is a rather common element in Miocene floras both in this country and abroad. Its known history extends from the Upper Cretaceous to the present, and it is especially abundant in the early Tertiary of the western United States. The existing species number about three score shrubs and small trees widely distributed in all temperate and many tropical parts of the world except Australia and the Pacific islands. There are eight species and three varieties in the existing flora of the United States of which the eastern *Rhamnus caroliniana* Walter, a stream bank and bottomland species, extends westward to eastern Nebraska, Kansas, Oklahoma, and Texas. I do not know of its occurrence in the "panhandle" region, however.

The humid demanding mesophytic species of the Cretaceous and Eocene appear to have given rise to two physiologically divergent lines—one dwellers in bottoms, along streams and as undershrubs in forests—the other becoming inured to scanty water conditions, bright sunlight, high evaporation, etc., and giving rise to the chaparral and montane species of the Rocky Mountains and Pacific coast region.

Lesquereux's material of *Rhamnus lesquereuxi* from Florissant is said to be in the collections of Princeton University. The Oklahoma material is in the United States National Museum.

Holotype.—Cat. No. 35288, U.S.N.M.

Order EBENALES.

Family SAPOTACEAE.

Genus BUMELIA Swartz.

BUMELIA OKLAHOMENSIS, new species.

Plate 94, fig. 1.

Leaves oblong-obovate in outline, with a rounded tip and a narrowly cuneate base. Length about 5 cm. Maximum width, at or slightly above the middle, 1.75 cm. Margins entire. Texture subcoriaceous. Extreme base and petiole missing in the present material. Midrib very stout and prominent, somewhat curved proximad. Secondaries extremely thin, numerous, subparallel; they diverge

[1] Heer, O., Fl. Tert. Helv., vol. 3, 1859, pl. 124, figs. 18–20.

from the midrib at rather regular intervals of about 3 mm. at angles of about 45°, and are camptodrome. Areolation not made out.

These leaves, in both form and venation, are allied to numerous fossil and living species of *Bumelia*, of which many have been described. In the existing flora about a score of species are known—all American, and distributed from the southern United States through the West Indies and Central America to Brazil. The fossil species are known from the Upper Cretaceous onward, and the genus is represented in the Miocene of Europe by seven or eight different forms. It occurs also in the Florissant lake bed.

The present fossil species is very similar to various existing subtropical forms, as for example *Bumelia angustifolia* Nuttall and *Bumelia tenax* Willdenow. It is also very much like the leaves of the existing *Bumelia lanuginosa* Persoon which ranges from Georgia and Florida to Illinois, Missouri, Arkansas, and Texas, and reaches its optimum development in the bottom lands of eastern Texas.

Holotype.—Cat. No. 35289, U.S.N.M.

Family EBENACEAE.

Genus DIOSPYROS Linnaeus.

DIOSPYROS BRACHYSEPALA Al. Braun.

Plate 95, fig. 3.

Diospyros brachysepala Al. Braun, Die Tert. Fl. v. Oeningen, Neues Jahrb., 1845, p. 170.—Heer, Fl. Tert. Helv., vol. 3, 1859, p. 11, pl. 102, figs. 1–4.—Lesquereux, Tert. Fl., 1878, p. 232, pl. 40, figs. 7–10, pl. 63, fig. 6; Cret. and Tert. Fl., 1883, p. 174, pl. 34, figs. 1, 2.—Knowlton, Proc. U. S. Nat. Mus., vol. 51, 1916, p. 285.

Diospyros princetonia Cockerell, Amer. Mus. Nat. Hist. Bull., vol. 24, 1908, p. 105, pl. 10, fig. 36.

This polymorphous species has been recorded from a very large number of localities and horizons. The type material came from both the earliest and the latest Miocene of Switzerland, but subsequently this species has been identified from all stages of the Tertiary of Europe. In America it has been recorded from beds of the late Upper Cretaceous and at different Teritary horizons. It seems incredible that all of these records should represent a single species and probably several are included, but their segregation on other than stratigraphic grounds is impossible at the present time. This being true I can not do otherwise than to refer the Oklahoma material to this species since it appears to be identical with that from Florissant, Colorado, so determined by Lesquereux and Knowlton. At the same time it should be kept in mind that many of the identifications of *Diospyros brachysepala*, of which an extended bibliography was published by me in 1916,[1] can not be accepted without reservation.

Practically all of the fossil species of *Diospyros* and most of the numerous existing species belong in mesophytic environments. Thus our American *Diospyros virginiana* Linnaeus is a member of the deciduous forest association of the southeastern United States, extending westward a short distance into the prairie States along the bottoms of the principal streams. Some modern species, as for example *Diospyros texana* Scheele of Texas and Mexico, are found under more arid conditions, but like certain existing species of *Rhamnus*, they are believed to indicate relatively modern specialization of habitat in a direction away from the normal habitat of the two genera.

Plesiotype.—Cat. No. 35290, U.S.N.M.

EXPLANATION OF PLATES.

PLATE 94.

FIG. 1. *Bumelia oklahomensis,* new species.
2. *Gymnocladus casei,* new species.
3. *Platanus aceroides* Goeppert.

PLATE 95.

FIGS. 1, 2. *Sapinus oklahomensis,* new species.
3. *Diospyros brachysepala* Al. Braun.
4. *Rhamnus lesquereuxi,* new species.
5. *Platanus aceroides* Goeppert.

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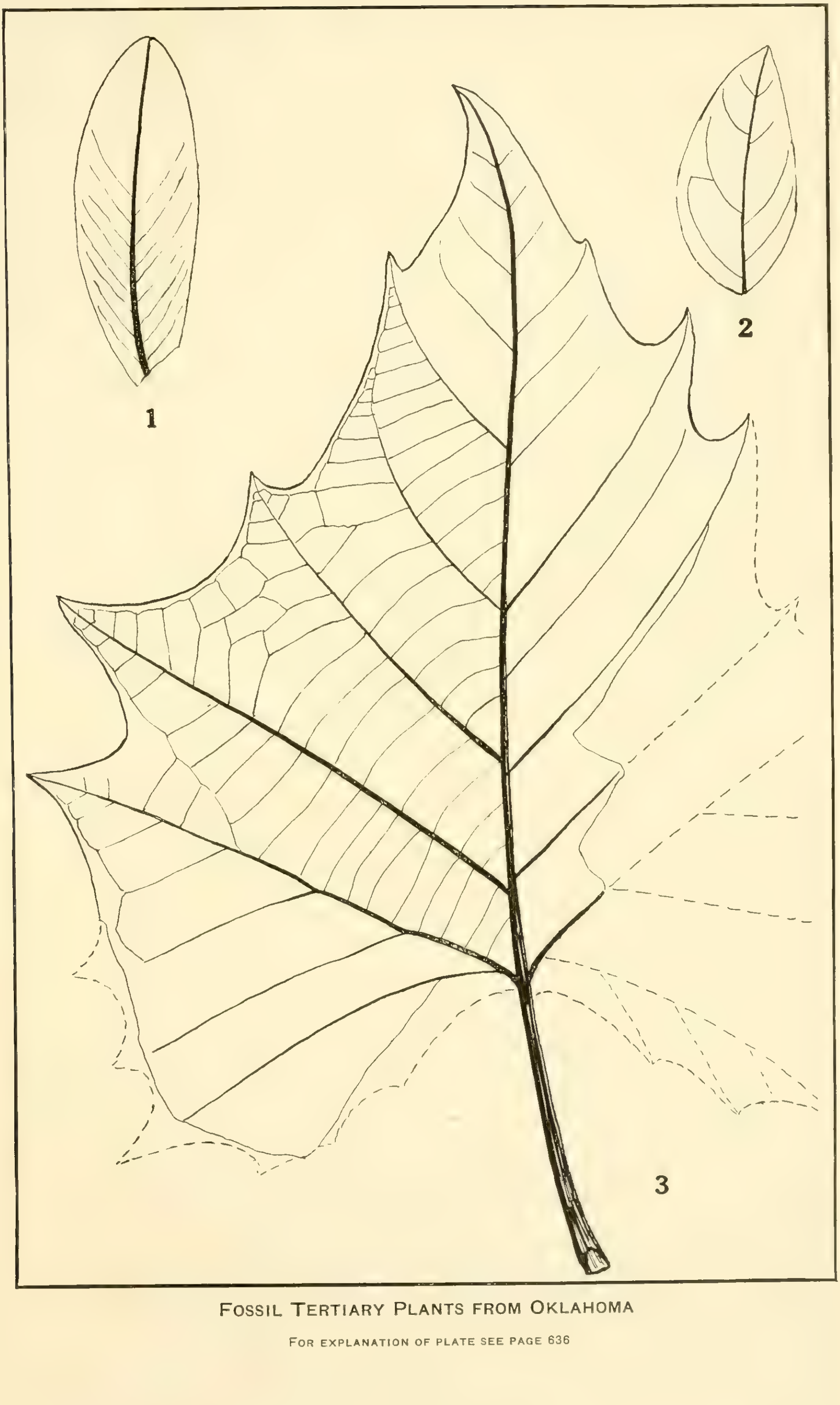
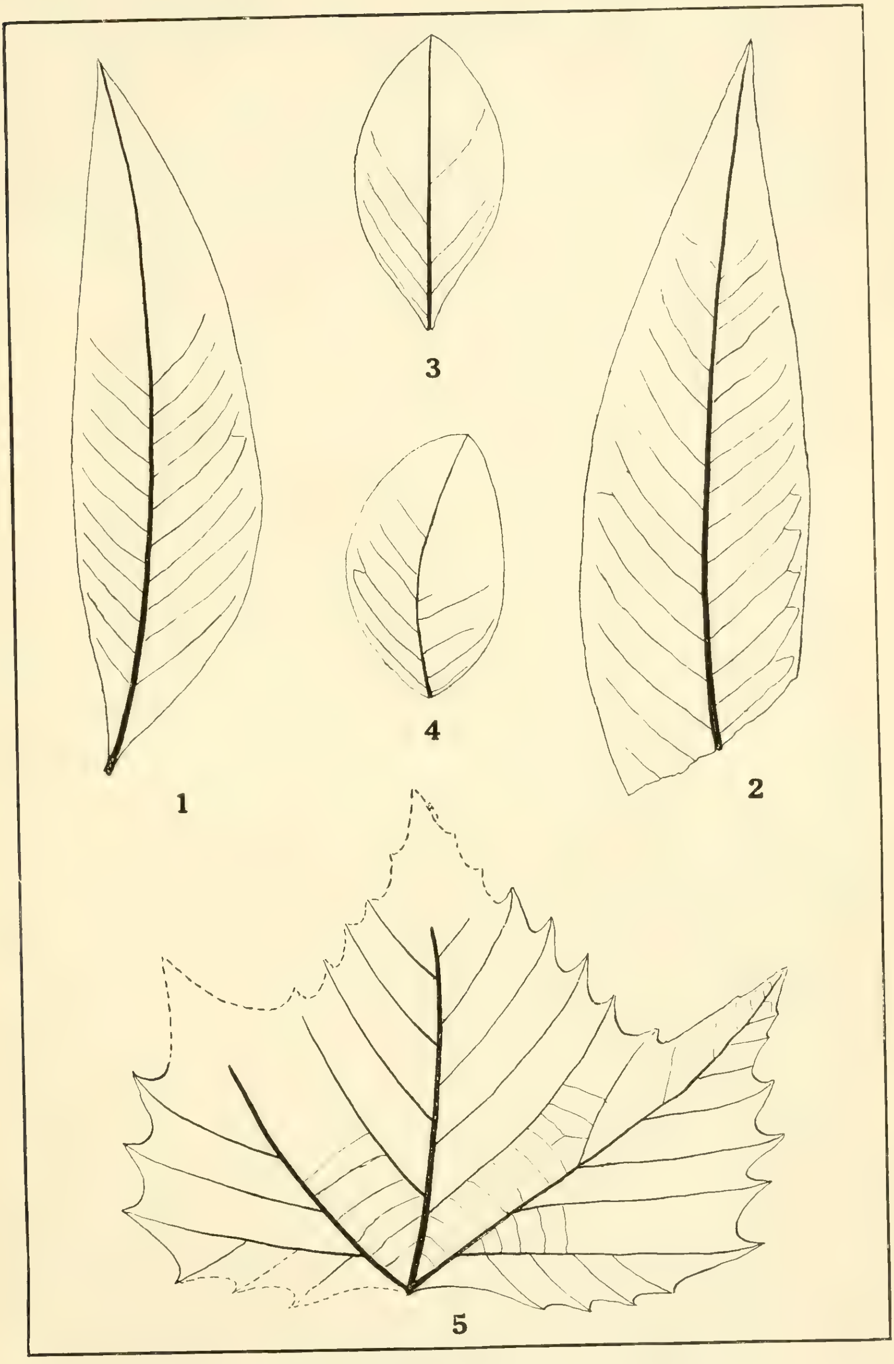
[1] Berry, E. W., U. S. Geol. Survey Prof. Paper 91, 1916, p. 333.



FOSSIL TERTIARY PLANTS FROM OKLAHOMA

FOR EXPLANATION OF PLATE SEE PAGE 636



Fossil Tertiary Plants from Oklahoma

For explanation of plate see page 636

A NEW GENUS AND SPECIES OF MULTIBRACHIATE OPHIURAN OF THE FAMILY GORGONOCEPHALIDAE FROM THE CARIBBEAN SEA.

By Austin H. Clark,

Assistant Curator, Division of Marine Invertebrates, United States National Museum.

While in certain localities in the north Atlantic and Arctic Oceans and over considerable areas in the north Pacific basket-fish are abundant and easily collected, they are as a rule but rarely found in other portions of the world, though they exist everywhere. In the tropics especially their habit of clinging most tenaciously to strongly rooted gorgonians renders their capture either by the dredge or by the fisherman's hook quite a matter of accident.

For this reason the numerous species have been, and still are, very poorly represented in even the largest museums of the world. The inevitable result of this has been to discourage intensive work upon the group, and until the last ten years our knowledge of the interrelationships of the various forms has remained where it was left by Lyman, most naturalists contenting themselves with assigning the species to one or other of the two genera *Astrophyton* and *Gorgonocephalus*, which in reality are synonymous terms.

But recently the group has been thoroughly and most carefully revised by Professor Döderlein, and the species distributed among no less than fourteen genera, *Astrindia*, *Astroboa*, *Astrochalcis*, *Astrocladus*, *Astroconus*, *Astrocyclus*, *Astrodactylus*, *Astrodendrum*, *Astrogordius*, *Astrophytum*, *Astrorhaphis*, *Astrospartus*, *Conocladus*, and *Gorgonocephalus*, by which their interrelationships have finally been made more intelligible.

The remarkable type herein described belongs to a peculiar group, including *Astrodactylus* from the East Indies and *Astrogordius* and *Astrocyclus* from the Caribbean Sea, which is characterized by the presence of a madreporic plate in each interradius. In the development of the tentacle papillae it is intermediate between the first and the two last, but in the development of articulated spinelets or teeth on the dorsal side of the disk and to the exclusion of the characteristic hooks on the dorsal side of the arms as far as the seventh branching it is absolutely unique.

ASTROCYNODUS, new genus.

Genotype—Astrocynodus herrerai, new species.

Diagnosis.—Five madreporic plates, one in the innermost corner of each interradius; tentacle papillae present from the second arm branch onward; eight or nine arm divisions; each arm segment as far as the seventh fork bears a conspicuous transverse band of closely appressed tubercles, each carrying an articulated conical tooth; the ribs of the disk bear numerous similar transverse bands; from the seventh fork onward each arm segment bears a double transverse row of closely appressed tubercles, each carrying a slender very strongly recurved glassy hook without accessory prongs; teeth, tooth papillae and mouth papillae very long, subequal.

Distribution.—Only known from the Caribbean Sea.

Depth.—Shallow water.

Included species.—Astrocynodus herrerai.

For the privilege of making known to science the following remarkable new species the museum is indebted to the kindness and generosity of Prof. A. L. Herrera, the director of the National Museum of Mexico:

ASTROCYNODUS HERRERAI, new species.

Plate 96.

Description.—The disk, 52 mm. in diameter, is rather deeply incised interradially. There is no peripheral girdle of plates. The ten radial ribs stand out prominently.

Aborally the disk is entirely covered with extremely small grains, very closely crowded, which become larger toward the periphery and are largest on the outer half of the ribs. In their inner halves the ribs bear about 10 more or less regular cross bands, each consisting of a single row of closely crowded and regular tubercles, considerably larger than the adjacent grains, each of which carries a short stout blunt conical spinelet or tooth attached to it by a movable articulation. On the outer half of the ribs these cross bands become somewhat more separated and irregular, breaking up into sections or running diagonally across the rib, and the conical articulated teeth which they bear become longer and more sharply pointed, though never exceeding half a millimeter in length. The ends of the ribs are occupied by an oval shield about twice as broad as long, covered with finer grains than those on the adjoining body surface. Between the ribs there are a few irregular patches of enlarged grains, and in the outer half of the disk scattering straight lines, running parallel to the periphery, of from 3 to 12 (usually from 6 to 12) closely appressed tubercles, some of which usually carry conical teeth similar to those borne by the transverse lines on the ribs. These lines become increasingly common outwardly.

Orally the interradial portions of the body are covered with very fine grains, among which are numerous larger and lighter-colored grains grouped in such a way as to form a close-meshed marbling or reticulation.

The entire under surface of the arms is covered with a uniform investment of fine grains, which become coarser proximally and largest beneath the disk, where, on account of their increased convexity, they are especially prominent in the interradial angles.

The five madreporic plates, which are short and broad and more or less reniform or crescentic, lie in the adoral angles of the interradial areas.

The teeth, tooth papillae, and mouth papillae are all very long, and do not differ greatly in length. The teeth distally become broadened and flattened, with chisel-like ends.

The genital slits are short, 3 mm. to 5 mm. in length, not more than one-fourth of the distance from the arm base to the adoral interradial angles in length.

The arms divide eight or nine times, the first fork being beneath the disk, and the second on its border. In the second division the outer branch is shorter, but stouter, than the inner; it consists of 6 or 7 segments, while the inner consists of about 10. In the third division the inner branches are longer and somewhat stouter than the outer, though both consist of 8, more rarely of 9, segments. The following divisions to the arm tips all consist of 8 or 9, more rarely of 10, 11, or 12, segments, and in each case the inner branch (in reference to the preceding division) is slightly stouter than the other.

The tentacle papillae appear immediately, or very shortly, after the second forking. At first they are one, or (usually) two, in number, and small and inconspicuous, but after the third fork they become longer and more prominent and the number increases to three, which seems to be the ultimate number. These tentacle papillae are almost identical in size and in appearance with the jointed conical teeth which extend in transverse bands across each arm segment, and merely form the ventral terminal portions of these bands. On a superficial examination it is impossible to differentiate them.

The dorsal and lateral surface of the arms is covered with a pavement of thickly set granules, which pass over uninterruptedly into the similar granules of the ventral surface.

Up to the seventh fork each brachial segment carries a very conspicuous transverse band, consisting of a single regular line of usually about 25 low closely appressed tubercles, each one of which bears a conical articulated tooth similar to those on the cross bands of the ribs, which may be slightly compressed in its outer portion, with a chisel-shaped tip.

Beyond the seventh fork, instead of these transverse bands of articulated teeth, the segments each bear a prominent and regular double row of tubercles carrying rather slender strongly curved hooks without supplementary prongs, resembling those of *Astrocyclus caecilia.*

Color (dry) yellowish brown, ventrally lighter and more grayish, the transverse bands of tubercles on the arms and disk, the groups of enlarged granules on the latter, and the terminal shields of the radial ribs, yellowish white.

Locality.—Yucatan.

EXPLANATION OF PLATE 96.

Abactinal (dorsal) view of *Astrocynodus herrerai*, × 2.

ASTROCYNODUS HERRERAI, NEW SPECIES

FOR DESCRIPTION OF PLATE SEE PAGE 638

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