PROCEEDINGS

OF THE

ACADEMY OF NATURAL SCIENCES

OF

PHILADELPHIA.

1896.

COMMITTEE ON PUBLICATION:

THOMAS MEEHAN, CHARLES E. SMITH,
EDWARD J. NOLAN, M. D., GEORGE H. HORN, M. D.,
HENRY SKINNER, M. D.

EDITOR: EDWARD J. NOLAN, M. D.

PHILADELPHIA:
ACADEMY OF NATURAL SCIENCES,
LOGAN SQUARE.
1897.

ACADEMY OF NATURAL SCIENCES OF PHILADELPHIA,
February 4, 1897.

I hereby certify that printed copies of the Proceedings of the Academy for 1896 have been presented to the meetings of the Academy as follows:—

Pages	9 to 24	February 25, 1896.
"	25 to 104	March 17, 1896.
"	105 to 168	April 14, 1896.
"	169 to 200	April 21, 1896.
"	201 to 216	May 12, 1896.
"	217 to 264	May 26, 1896.
"	265 to 280	June 16, 1896.
"	281 to 312	July 21, 1896.
"	313 to 376	August 4, 1896.
"	377 to 392	August 11, 1896.
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"	467 to 482	October 27, 1896.
"	483 to 546	December 8, 1896.
"	547 to 562	December 15, 1896.
"	563 to 594	February 2, 1897.

EDWARD J. NOLAN,
Recording Secretary.

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LIST OF CONTRIBUTORS.

With reference to the several articles contributed by each.

For Verbal Communications see General Index.

PROCEEDINGS

OF THE

ACADEMY OF NATURAL SCIENCES

OF

PHILADELPHIA.

1896.

January 7.

The President, Samuel G. Dixon, M. D., in the Chair.

One hundred and forty-three persons present.

The deaths of R. B. Haines and A. C. Gorgas, M. D., members, were announced.

The Council reported that the following Standing Committees have been appointed to serve during the current year:—

On Library.—Arthur Erwin Brown, Harrison Allen, M. D., Henry C. Chapman, M. D., Chas. P. Perot and Henry A. Pilsbry.

On Publications.—Thomas Meehan, Charles E. Smith, George H. Horn, M. D., Edward J. Nolan, M. D. and Henry Skinner, M. D.

On Instruction and Lectures.—Harrison Allen, M. D., Benjamin Sharp, M. D., George Vaux, Jr., C. Newlin Peirce, D. D. S. and Uselma C. Smith.

Standing Committee of Council on By-Laws.—Isaac J. Wistar, Theodore D. Rand, William Sellers and Benjamin Tilghman.

The following minute was unanimously adopted:

In view of the fact that General Isaac J. Wistar has served four consecutive years, the limit defined by the By-Laws, as President of the Academy of Natural Sciences of Philadelphia, his fellow members desire to indicate their esteem and affection by a cordial endorsement of the minute of recognition adopted by the Council and to express the hope that the Academy may long profit by the clearness of judgment, the knowledge of affairs and the courtesy of personal intercourse which have been the characteristics of his administration.

Dr. Benjamin Sharp made a second communication on his ethnological studies in Alaska and Siberia. (No abstract).

January 14.

The President, Samuel G. Dixon, M. D., in the Chair.

Thirty-four persons present.

The death of Samuel G. Lewis, a member, was announced.

A paper entitled "New Species of the Helicoid Genus Polygyra," by H. A. Pilsbry, was presented for publication.

Pleurotomaria crotaloides Morton in the New Jersey Cretaceous.—Mr. H. A. Pilsbry exhibited a fossil *Pleurotomaria* from Mullica Hill, New Jersey, found by Henry L. Balderston when on a excursion of the geological class of Westtown School, and submitted to the speaker by Lewis Woolman.

The specimen is an internal cast and has lost the earlier whorls. Enough remains, however, to distinguish it as a strongly marked species, apparently identical with *Cirrus crotaloides* Morton[1], described from Erie, Alabama.

The species has not been noticed since its original publication in 1834, and as Morton's description is very brief (less than three lines long) and involves a grave inaccuracy, and his figure is decidedly uncharacteristic, a more detailed description of the specimen discovered by Mr. Balderston is here given, followed by notes on Morton's type specimen. It may be described as follows:

Pleurotomaria crotaloides Morton. (Plate I).

Shell (cast) rather discoidal, the spire low-conic, base flattened and very broadly umbilicated. Whorls slowly increasing, very convex, separated by deep sutures; the last whorl strongly convex on the upper surface, thence sloping outward to the periphery, which is quite convex again, and near the base of the whorl. Base dis-

[1] Synopsis of the Organic Remains of the Cretaceous Group of the U. S. p. 49, pl. 19, fig. 5.

tinctly flattened, though convex. Umbilicus somewhat exceeding one-third the total diameter, broad, deep and perspective, the sutures within it strongly impressed.

Diameter 7 cm.; width of last whorl at aperture (measured below) 26 mm.; alt. of same about 19 mm.

The surface of the cast is smooth, not showing the impression of the anal fasciole. The sinus was probably short, at least in comparison with the large recent species; but as the latter third of the specimen is largely concealed by a hard arenaceous matrix, no impression of the anal sinus can be made out. The unremoved matrix shows clear impressions (external moulds) of the characteristic Lower and Middle Marl bed species *Plicatula urticosa* Mort. and *Ostræa larva* Lam.

In *Pleurotomaria perlata* Conr., the periphery is more strongly keeled and the umbilicus narrower than in this species. In *Pleurotrema solariformis* Whitf. the whorls are flatter both outside and within the umbilicus, and the slit is said to be bridged at intervals, though this last feature is excessively obscure if present in the type specimen.

The specimen described above is the property of Henry L. Balderston and has for the present been deposited in the museum of the Academy.

The type of *Cirrus crotaloides* Morton is a much smaller shell, alt. 18, diam. 39 mm. It is an internal cast of whitish calcareous material ("rotten limestone"). The last whorl has been broken above near the aperture, and the whorls of spire are slightly distorted on one side by pressure, and have lost considerable material by erosion. The umbilicus is filled to its verge with a calcareo-arenaceous matrix, harder than the cast itself, and a narrowly conic protuberance of the same material projects over the apex. This has been mistaken by Morton for the true spire, which accounts for his words "the two first whorls [sic] suddenly produced." In reality the true apex of the shell is concealed by this bit of hard matrix, about three whorls being visible. The contour of the last whorl is practically identical with that shown in the middle figure of the plate illustrating the Mullica Hill specimen. No impression of the anal sinus or fasciole is visible on the cast.

Erie, the locality where Conrad collected the type of *crotaloides*, is on the Black Warrior River, in the Selma Chalk or "Rotten Limestone" member of the Alabama Cretaceous.

JANUARY 21.

The President, SAMUEL G. DIXON, M. D., in the Chair.

Fifty-two persons present.

Papers under the following titles were presented for publication :—

"Descriptions of New Species of Mollusks," by H. A. Pilsbry.

"The Molting of Birds with special reference to the Plumage of the Smaller Birds of Eastern North America," by Witmer Stone.

The deaths of George Edward Dobson and Don Antonio del Castillo, correspondents, were announced.

JANUARY 28.

The President, SAMUEL G. DIXON, M. D., in the Chair.

Thirteen persons present.

A paper entitled "Contributions to the Zoology of Tennessee, No. 3, Mammals," by Samuel N. Rhoads, was presented for publication.

A resolution having been adopted at the preceding meeting providing for an inquiry as to the best method of exterminating the Tussock Moth, *Orgyia leucostigma*, with which the city squares and trees are infested, the subject was referred to the Entomological Section, a committee of which reported as follows:—

We would recommend for the destruction and extermination of the Tussock Moth, *Orgyia leucostigma*, that as soon as possible all the egg masses be hand-picked from the trees and destroyed. To be effective, this must be done before the first day of April. The trunk of each tree should be encircled about five feet from the ground by a band of "Raupenleim" or Dendroline, four inches wide and a quarter of an inch thick; this band should be renewed once a month during the summer season. All eggs, cocoons and caterpillars segregated below the band should be gathered and burned; or they may be killed by steam or by the flame apparatus used by house painters.

The committee is confident that the above method, if properly carried out, will exterminate the species in a given locality in two or three seasons, and put them under control the first summer. The committee has never seen this method properly carried out. Failure in the past has been due to the integrity of the band not being maintained and to the fact that a few segregated insects and eggs were simply brushed to the ground where the eggs hatched and the caterpillars reascended the trees. The life-history of the species will show why the methods described must prove successful, and we append an account of the transformations of this defoliator of our shade trees:—

"These caterpillars are first noticed on the trees in May, quite small, feeding on the leaves, and somewhat indifferently on either the upper or under side. When suddenly disturbed they drop from their perch, suspending themselves by a silken thread, which is attached to the leaf from which they started. They retain this habit until they are nearly full-grown, which occurs about the middle or toward the end of June. They then begin to wander, leaving the trees on which they have fed, often crawling to others, and sometimes travelling several hundred feet from the starting point before deciding to pupate. When they are ready for the change they spin their whitish cocoon in any convenient place; in the angles of wooden tree boxes, under the rails of fences, in the interstices of bark of the trees themselves, and in fact in any likely or unlikely place except a perfectly flat, smooth surface. The caterpillar has a very small supply of silk only, and to eke this out uses its own hair which it breaks off close to the body and forms the cocoon by a sort of felting process, the silk serving to give form and holding together the hair. In the cocoon the larvæ change to dirty yellowish or gray pupæ, the male much smaller than the female and showing rudiments of the future wings, while the female is nearly double the size and is grub or slug-like in form. Less than two weeks thereafter the final change takes place and the adults emerge—the sexes strikingly dissimilar in appearance. The male has two pairs of broad dusty gray wings, the anteriors crossed by narrow black lines, and with a more or less prominent white spot toward the lower outer angle. The feelers or antennæ are broadly feathered and prominent, while the fore-legs are plumed and tufted, stretched straight forward when the moth is at rest, so as to be the most conspicuous feature of the insect. The female, on the other hand, is entirely without wings, and somewhat slug-like, consisting principally of an abdomen, which is enormously distended with eggs. When she emerges from the pupa, she crawls upon the cocoon to which she clings, almost motionless for the balance of her life. Egg-laying begins soon after impregnation, the eggs being laid upon the old cocoon and covered with a frothy mass, which soon becomes hard and brittle and is snowy-white. As the eggs are laid, the female diminishes in size, eventually shrinking almost into nothingness and finally drops off dead. Neither male nor female takes food in this stage, their adult existence is devoted merely to reproduction. From the egg-masses above described, a second brood of larvæ hatches in July and the same life cycle is repeated, the adults of this brood appearing in September. The eggs laid at this time of life remain unhatched during the winter."[1]

It will be readily seen from this life history that the females being wingless the species can only be distributed by the crawling propensity of the caterpillar; this, together with the fact that the eggs are all laid in a mass, gives the key to the method of destroying them. Each egg-mass destroyed means the death of about three

[1] Rept. Ent. Dep., N. J. Agric. Col. Exp. Station, 1894.

hundred and fifty caterpillars. It takes a little experience to find the egg-masses in the winter, and very few would escape, to hatch out, if they were intelligently sought for. It must be remembered that they go through their metamorphoses almost in an automatic way and human endeavor to check them must proceed after the same plan, an old Latin phrase not being forgotten: 'Nihil sine labore.' Generally no attention is paid to pests of this kind until they become so bad as to attract the attention of the general public.

Respectfully submitted by

HENRY SKINNER, } *Committee of the Entomological Section.*
WM. J. FOX, }

The following were elected members: Henry Trimble, Charles E. Hite, C. Howard Colket, George de Schweinitz, M. D., James C. Corry, D. Calvin Mensch, Edward Gideon, I. Norris de Haven, Ruth Clement, M. D., and Sarah Y. Stevenson.

The following were ordered to be printed:—

NEW SPECIES OF THE HELICOID GENUS POLYGYRA.

BY HENRY A. PILSBRY.

At the request of Mr. John Ponsonby of London, the determination of a series of Polygyras of unknown or doubtful specific identity, from his collection, was undertaken by the writer. In the course of this work, the Mexican species of the genus were reviewed, the identification of the Academy's material verified, and several specific forms, hitherto nameless or under incorrect names, were studied.

The following communication relates to species of that characteristic " Lower Sonoran " group of Polygyra, of which *P. plagioglossa* and *P. ventrosula* represent approximately the extremes in the cycle of form changes.

The types of *P. latispira*, *matermontana* and *euglypta* are in the collection of the Academy. The types of *P. Ponsonbyi* are in the same collection and that of Mr. Ponsonby; and the type of *P. albicostulata* is in Ponsonby's collection.

These five species, with *P. Mearnsii* and *P. chiricahuana* Dall (Proc. U. S. Nat. Mus., 1895), and *P. solidens* and *P. triangularis* Mabille (Bull. Soc. Philomath. de Paris, 1895) complete the list of Polygyras given in the Guide to the Study of Helices, pp. 73, 74.

P. latispira n. sp. Pl. III, figs. 13, 14, 15, 16.

Shell depressed, with convex spire, rounded but noticeably shouldered periphery and convex base; umbilicated, the umbilicus within deep and cylindrical, about ·8 mm. diam., at the last whorl rapidly enlarging, 2·3 mm. diam., or contained about five times in the diameter of the shell, conspicuously grooved inside. Surface very closely and regularly rib-striate, moderately shining. Light yellow or buff in color. Whorls $5\frac{1}{2}$, closely coiled, slowly widening, rather convex, having an oblique impression behind the outer, and an excavation behind the basal lip. Suture well impressed, descending only a trifle at the aperture.

Aperture quite oblique, roundly lunate, the lip forming two-thirds of a circle, rather narrowly reflexed ; outer lip bearing an inwardly projecting pointed tooth ; basal lip with a slightly keeled face along its outer half, the inner part bearing a rather long, low, callous tooth with the summit a trifle flanged outwardly. Deep within the aperture a lobe-like tooth may be seen on the columella. Parietal tooth small, V-shaped, the outer ridge of the V extremely short.

Alt. 6, greater diam. 11⅔, lesser 10½ mm.

The specimens serving as types were collected some years ago (about 1880) by Dr. Horatio C. Wood in western Texas, either in the "Great Bend" of the Rio Grande or near El Paso, exact locality not noted.

The species is somewhat allied to *P. plagioglossa*, having about the same general contour and agreeing in the proportions of the parietal lamella; but the armature of the basal lip is conspicuously different, and there is a deep-seated lamella on the columella, such as well developed examples of *P. Mooreana* show, but apparently united by a low ridge with the inner end of the basal tooth. This lamella corresponds to the groove within the umbilicus, and is not visible in the drawings.

P. matermontana n. sp. Pl. III, figs. 10, 11, 12.

Shell depressed, with low, convex spire, rounded periphery and convex base; umbilicated, the axial perforation small and deep, at the last whorl rapidly enlarging to about one-fifth the diameter of shell. Surface shining, faintly wrinkled by growth-lines and showing under the lens superficial close spirals in some places; light horn colored. Whorls 5½, quite convex, the inner slowly increasing, narrow, the last decidedly wider, notably convex above, with the periphery above the middle; deeply and narrowly constricted behind the lip. Suture well impressed, abruptly deflexed in front.

Aperture quite oblique, rounded oval, the lip forming over two-thirds of the circumference; outer lip broadly expanded, flaring, bearing a concave lamella with a denticle at the lower end on its inner edge; basal lip reflexed, with a compressed, slightly entering tooth. Parietal callus a translucent film, bearing a V-shaped lamella not connected with the peristome, the outer branch of the V very short.

Alt. 5·2, greater diam. 9·5, lesser 8 mm.

Colima, Sierra Madre Mts., Mexico.

Besides the types from above locality, there is one specimen in the collection of the Academy labelled "Mexico" differing in size, alt. 6·1, greater diam. 11 mm., and having 6 whorls. It agrees in all other characters and is doubtless the same specifically. Two other specimens labelled "Texas" are altogether like the types.

P. matermontana is like *texasiana* in the notch between the two lip-teeth, but the outer tooth is a more pronounced and shorter lamella, the parietal " V " is less developed, and the upper surface is not costulate. The parietal lamella is much alike in *matermontana* and *latispira*, the outer branch being much less developed than in *Richardsoni*, *ventrosula* or *bicruris*. The umbilicus is like that of *latispira*, being slightly more ample than in *texasiana*, and with the central well, or perforation decidedly larger.

This species and the three following have nearly the same form of aperture teeth and are very similar to other species grouping immediately around *P. ventrosula* in this respect. The comparative width of umbilicus, the sculpture, and to a less extent, the contour, differ in the several forms. The inverted T shaped tooth upon the outer lip, formed by a lamella parallel to the lip-edge with a shorter one at its lower end, transverse to it, is characteristic of the group.

P. Ponsonbyi n. sp. Pl. II, figs. 1, 2, 3.

Shell globose-depressed, with low conoid-convex spire, rounded periphery and convex base. Umbilicus one-sixth the diameter of shell, with flattened, nearly vertical walls, narrowing to a perforation beyond the last whorl. Surface shining, smooth except for extremely faint growth-wrinkles; corneous-brown, with a chestnut-brown super-peripheral band on the body-whorl, appearing on the spire as a narrow sutural margination. Whorls 5½, convex, slowly widening, the last decidedly wider, tumid on the latter half of the base, deeply and narrowly constricted behind the outer and basal lips. Suture well and evenly impressed, abruptly and deeply deflexed in front.

Aperture very oblique, rounded-oval, the lip forming three-fourths of the circumference. Outer lip broadly flaring, its inner edge bearing a short concave lamella, with a projecting compressed tooth at its lower end; basal lip reflexed, with a similar compressed tooth. Parietal wall bearing a short, erect, straight lamina parallel with the basal lip, and having a very short V-branch at the outer end; the inner termination not extending to the columella insertion.

Alt. 5, greatest diam. 8·2, lesser 7·2 mm.

Types from Mexico, exact locality not known, in the collections of John Ponsonby and the Academy of Natural Sciences of Philad.

Like *ventrosula* and *Richardsoni* in the teeth of the lip, but more globose than either, parietal tooth with only a trace of the outer branch of the V, base more tumid, and umbilicus of last whorl more well-like.

P. euglypta n. sp. Pl. II, figs. 7, 8, 9.

Shell obese, with low conic spire, rounded-angular periphery near the top of last whorl, sloping outer wall and convex, tumid base. Umbilicated, a central perforation expanding at last whorl to form an umbilicus about one-sixth the diam. of shell, and with the wall rising almost vertically from its suture. Surface of outer 1½ whorls sculptured with sharp, strong and regular thread-like sigmoid riblets, subobsolete and more numerous by intercalation in the immediate vicinity of the umbilicus; the inner whorls of spire smooth. Whorls 4⅓–4¾, the inner slowly increasing, last whorl much wider, very deeply constricted and excavated behind the outer and basal lips. Suture impressed, deeply descending in front.

Aperture extremely oblique, transversely oval, the lip forming three-fourths of the circumference, upper and basal margins subparallel. Outer lip broadly flaring, with a short lamella on its inner edge, formed of a compressed, slightly entering portion joined T-like to a short lamella parallel to the inner lip-edge; basal lip reflexed, bearing a compressed, entering tooth similar to the lower portion of the T on outer lip. Parietal tooth like a narrow, slanting V, the two branches united with the ends of the lip.

Alt. 5·3, greater diam. 9·5, lesser 8·2 mill.

Alt. 4·3, greater diam. 7·5, lesser 6·4 mill.

Cinaloa (larger form) and Mazatlan (smaller form).

A member of the *P. ventrosula* group, distinguished from *ventrosula, Hindsi, Richardsoni* and *bicruris* by the very strong, sharp rib-striation of the last 1½ whorls.

P. albicostulata n. sp. Pl. II, figs. 4, 5, 6.

Shell obese, with convex spire, periphery much above middle of body-whorl, and tumid base. Umbilicated, the umbilicus narrow and deep, with vertical walls, not much enlarging at last whorl, where it measures about one-ninth the diameter of the shell; within the umbilicus the last whorl has a deep spiral furrow, obliquely passing into the groove behind the basal lip. Surface shining, the latter two whorls sculptured with coarse whitish riblets with corneous brown spaces; inner whorls nearly smooth, corneous brown. Whorls 5¼, weakly convex, the last very obtusely angular at its origin, becoming rounded and tumid on the latter half, deeply and narrowly constricted behind the outer and basal lips. Suture slightly impressed, rather abruptly and deeply deflexed in front.

Aperture oblique, oblong, the upper and basal margins subparallel; outer lip reflexed, its inner edge bearing a concave lamina ending below in a denticle; basal lip reflexed, impinging on the umbilicus, with a compressed tooth separated from the lamella on outer lip by a deep squarish sinus, a gentle swelling to the left of it. Parietal wall glazed with a translucent film, and bearing a long V-shaped tooth, the outer branch of which is short and not connected with the upper insertion of outer lip.

Alt. 5·5, greatest diam. 8·5, lesser 7·5 mm.

Type in collection of Mr. John Ponsonby of London. It is said to be from Mexico, and has the appearance of a northern Mexican shell.

The strong, whitish rib-striæ, narrow and nearly regular umbilicus with spiral groove within on the last whorl, and the aperture much as in *euglypta*, *Richardsoni* and *ventrosula*, are a combination of characters amply sufficient to distinguish this species from other forms now known; and while I am opposed on principle to the description of species without exact locality record, it seems best in some cases to depart from this salutary rule. I do not think any one will have difficulty in recognizing the species, as no other *Polygyra* having the apertural characters of this one, presents a similar umbilicus or sculpture.

EXPLANATION OF PLATES II and III.

Fig. 1. Polygyra Ponsonbyi n. sp., seen from below.
Fig. 2. Polygyra Ponsonbyi n. sp., anterior view.
Fig. 3. Polygyra Ponsonbyi n. sp., aperture, the plane of peristome at a right angle to line of vision.
Fig. 4. Polygyra albicostulata n. sp., from below.
Fig. 5. Polygyra albicostulata n. sp., anterior view.
Fig. 6. Polygyra albicostulata n. sp., aperture, the plane of peristome at a right angle to line of vision.
Fig. 7. Polygyra euglypta n. sp., aperture, the plane of peristome at right angle to line of vision.
Fig. 8. Polygyra euglypta n. sp., seen from below.
Fig. 9. Polygyra euglypta n. sp., anterior view.
Fig. 10. Polygyra matermontana n. sp., anterior view.
Fig. 11. Polygyra matermontana n. sp., seen from above.

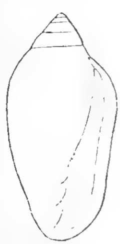
Fig. 12. Polygyra matermontana n. sp., seen from below.
Fig. 13. Polygyra latispira n. sp., anterior view.
Fig. 14. Polygyra latispira n. sp., seen from below.
Fig. 15. Polygyra latispira n. sp., seen from above.
Fig. 16. Polygyra latispira n. sp., aperture, the plane of peristome at a right angle to line of vision.

DESCRIPTIONS OF NEW SPECIES OF MOLLUSKS.

BY HENRY A. PILSBRY.

Marginella Veliei n. sp.

Shell oblong, the body-whorl tapering (somewhat Conus-like) from the rounded shoulder to the base, spire conic. Surface brilliant, enamelled over the sutures and throughout, pale olivaceous-buff, slightly bluish around the middle of body-whorl, the outer lip white. Whorls about 5, nearly flat, the last convex above, rather flattened in the middle. Aperture about four-fifths the length of shell, its upper half narrow, lower half about twice as wide; pale buff inside; outer lip slightly retracted at the two ends, smooth within, thickened by a moderate white callus outside, which is not produced upward to the preceding suture. Columella bearing four plaits, the lower three subequal, upper one slightly smaller and more deeply inserted.



M. Veliei×2.

Alt. 15, diam. 7·1; alt. of aperture 12 mm.

Alt. 14·6, diam. 7·5; alt. of aperture 11·8 mm.

Boca Ciega Bay, Florida (Dr. J. W. Velie!).

This species resembles *M. Hindsi* Petit in outline, but the callous rib of the outer lip is not continued upward as in that species. It is notable for the rather slender and tapering form of the body-whorl and slight inward bend of the outer lip. It is somewhat remarkable that so large a *Marginella* as this has until now escaped notice on our Florida coast.

Siphonalia semiplicata n. sp.

Shell fusiform, tapering about an equal distance above and below, solid and strong, gray with some indistinct brownish patches. Whorls about 8, nucleus smooth (partly lacking by erosion); 5½ later whorls sculptured with cord-like spirals about equal to their intervals in width, about 11 in number on penultimate and three preceding whorls; last 1½ whorls having short, sometimes indistinct, subvertical waves at the shoulder, the preceding whorls merely convex, with no vertical folds. Last whorl contracted and produced at base as usual, the siphon nearly straight, a little recurved. Aperture livid brown within, contained 1·8 times in length of shell; outer lip regularly arched, multilirate within, the liræ extending to within about 1½ mm. of lip-edge; columella concave above, straight, vertical and more heavily calloused in the middle, slanting to the left below. Alt. 47, diam. 24 mm.

Yokohama, Japan.

Allied to *S. fusoides*, *fuscolineata*, etc., but in this species the vertical waves of the shoulder are entirely absent on the spire; the canal is nearly straight.

In this connection it may be well to call attention to the fact, kindly communicated to me by Mr. J. Cosmo Melvill, that *Siphonalia Stearnsii* Pilsbry is identical with *S. pseudobuccinum* Melv. and *S. hyperodon* Pils. is the same as *S. Mikado* Melv. Mr. Melvill's names were proposed in the Journal of Conchology (Leeds), V, p. 348.

Ischnochiton aspidaulax n. sp.

Shell oblong, slightly narrower in front, moderately elevated, *carinated*, the side slopes nearly straight. Surface somewhat shining, and (*a*) dark olive at the sides, a light olive band dappled with darker spots along the ridge, or (*b*) light dull bluish dappled with brown, and with some snow-white patches on valves ii, iii, v and vi; yellowish at the apices of valves.

Median valves not beaked, the sutures concave. Lateral areas well defined, but only a trifle raised, sculptured with *numerous distinct, unequal radial grooves, not extending to the apex*, and parted by unequal spaces, densely sculptured with *oblique or V-shaped scale-like granules, the apices of the V's directed toward the beaks.* Central areas very densely and minutely sculptured with longitudinal irregular wrinkles, somewhat converging, becoming finer toward the ridge, coarser in front of the diagonal line. Posterior valve with the mucro slightly projecting, somewhat in front of the middle, posterior slope somewhat concave.

Interior bluish, with olive stains behind the valve-callus. Sinus rather narrow, straight and smooth, angular at the sides. Valve i with 10, valves ii to vii with 1–1, valve viii with 10 slits. Teeth rather long, sharp and smooth. Eaves narrow, deeply grooved above the teeth.

Girdle covered with compactly, irregularly imbricated glossy scales, very weakly striated, and measuring ·3 to ·25 mm. in width; *each scale olive-blackish with a broad outer border of white.* In a general view, the girdle appears light olive with an ill-defined dusky bar opposite each valve.

Length 18, breadth 9 mm. (exclusive of girdle). Angle of divergence 119°.

Panamic region, exact locality not known.

Specimens of this elaborately sculptured *Ischnochiton* were received from Mr. W. J. Raymond some years ago. Mr. E. R. Sykes, of London, has kindly compared it with the type of *I. dispar* Sowb., and informs me that it is quite distinct, confirming the opinion I had already formed from a study of the description and figures of that species. From other West American species it is readily distinguished by the peculiar sculpture, dorsal keel and the coloration of the girdle scales.

Sagda (?) Gabbi n. sp.

Shell depressed, with low, conoid-convex spire, round periphery and somewhat flattened, convex base, rather deeply indented around the minute umbilical perforation; *solid* though rather thin; whitish corneous or faintly buff; the surface rather dull though shining, smooth except for irregular, *very faint* growth-marks. Whorls about 5½, convex, slowly widening, the last decidedly wider, not descending in front. Suture impressed and narrowly translucent-margined below. Aperture subvertical, a little oblique, lunate; peristome evenly curved, sharp-edged, the *columellar margin lined with white callus inside,* and reflexed in the vicinity of the umbilical perforation, nearly concealing it.

Alt. 7, greater diam. 11, lesser diam. 10 mm. (Type).

Alt. 8, greater diam. 12, lesser diam. 10·8 mm. (specimen in Ponsonby Coll.).

San Domingo (W. M. Gabb!).

Compared with *Helix effusa* Pfr. (Monographia, V, p. 105, Tryon, Manual II, p. 163), of which part of the original lot collected by Smith are before me, this species is more solid, with smaller perforation, smoother surface and fewer, more rapidly widening whorls; but it is especially distinguished by the different form of the peristome. In *effusa* the basal lip (in a ventral view of the shell) is seen to bend forward in a broad convex lobe, the outer point of the curve extending as far forward as the insertion of the outer lip; and upon the base the usual direction of the arcuate growth-lines is reversed. In the new species, while there is a slight bend, no such effuse condition of the basal lip is developed.

This species is described from four specimens collected by Gabb (the types), and one in the collection of Mr. John Ponsonby, of London. The latter is slightly larger, and, at first glance, seems to have the aperture more vertical, but this is caused by the breaking away of the upper portion of the lip-edge.

The columellar callus becomes a little heavier, slightly convex, toward the lower end of columella. Upon breaking a specimen a minute embryonic shell was found. The species is therefore probably viviparous, as I have shown some other species of *Thysanophora* and *Sagda* to be. The callous lining of the interior in the columellar region is conspicuous in this species but absent in *H. effusa* Pfr. Both species seem to me referable to *Sagda* rather than to *Thysanophora;* but the two genera are intimately allied.

THE BEES OF THE GENUS PERDITA F. Smith.

BY T. D. A. COCKERELL.

In attempting to teach entomology to the students of the New Mexico Agricultural College, the difficulty was early felt, that there existed no work treating in an adequate manner of any group of insects obtainable in the vicinity. While it was possible to indicate the outlines of the subject without any very profound knowledge of the insects which were collected and studied, it appeared to the writer that this superficial method of work could not lead to the best results. It is quite true that an ordinary student has not time to master even the families of insects; but the writer has long felt persuaded that the plan of teaching the elements without entering into detail is essentially a vicious one, calculated in extreme cases, even to convey a totally false impression of the true lessons of biology.

In the first place, the main purpose of biological study in education is not so much to load the mind with information, as to prompt a habit of observation and deduction. Owing to the unfortunate trend of the present educational system, the students almost invariably come to the entomology class prepared to learn by heart any lessons that may be assigned to them, but very ill-prepared to notice what has not been actually pointed out. It is, perhaps, not an exaggeration to say that the average junior or senior student in a college possesses less inclination and ability to notice and compare than a child of from five to ten years of age.

The entomological studies, if successful, should tend to break down this acquired mental habit, and restore in some measure the inquisitiveness of childhood. Therefore, nothing can be worse than limiting the student's knowledge by what may be written in a text-book, and checking his budding interest in every direction by "I don't know," with the implication that it is no use trying to find out. The idea that *some* facts are to be regarded by the student, and all others ignored, is an entire perversion of the proper spirit of biological inquiry.

Another consideration is, that after all the cell, the individual and the species are the three natural units in biology, without a just conception of which, all reasoning must be futile. The orders, families, genera and other higher groups do not stand at all on the same plane, being essentially artificial arrangements for convenience in classification. Consequently a student who might be thoroughly acquainted with the higher groups and ignorant of species, would be very little prepared to form just conceptions of the phenomena of life.

When these ideas dawned upon the writer, he was somewhat disconcerted to reflect that in the whole range of zoology he possessed an intimate acquaintance with only two series, the slugs in Mollusca and the Coccidæ in Insecta. Of the former, which might have been used in zoological studies, there is but one species in New Mexico, and that not found in the neighborhood of the college; of the latter, the species are more numerous, but very unsuited for the purpose required, since they are exceptions to almost every ordinary entomological rule.

It is perfectly true, that there already exist many very admirable monographs of North American insects of different groups; but there are two reasons why even the best of these do not entirely serve our purpose. The first is, that comparatively little collecting has been done in southern New Mexico, so that many of our very common species are even unknown to science, and, therefore, not to be found in the monographs; the second, that very few of the published writings contain anything like a careful account of the habits of the species. One of the very first lessons that the student has to learn is that structure is as intimately related to environment, as lock to key, and a work which practically ignores one side of this question cannot be entirely satisfactory.

The nearest approximation to what is wanted is found among the higher lepidoptera, which are illustrated by such admirable works as those of Scudder and W. H. Edwards. Yet these insects are not very easily studied by a beginner, except in a superficial way, nor is their classification yet upon a perfectly sound basis. So finally, it was concluded to take up the bees and endeavor to work them up in such a manner that they might be used as desired. They are good typical insects, their principal structural characters are easily observed, their habits are most interesting, and they abound in New Mexico. Moreover, the bee-studies go very nicely hand-in-hand with flower-studies undertaken in botany, the relations between bees and flowers being among the most fascinating phenomena in natural history.

The present essay on *Perdita* is the first step toward the realization of the above mentioned ideal. Imperfect as it undoubtedly is, it has grown like a mushroom under the hands of the writer; so that the probability of finishing the whole series of bee-genera seems remote indeed, if each is to increase in a similar fashion. Seventeen North American species of *Perdita* were known before the writer began to study them; of these, two are not considered valid, but 55 have been added, bringing the list up to seventy! Thus, in number of species described, *Perdita* becomes at a bound the largest of North American bee genera.

MATERIAL EXAMINED.

By far the greater part of the material studied has been collected by the writer in New Mexico. With great kindness, Mr. W. J. Fox loaned a series of specimens containing his Lower Californian types, and all the species of Cresson except *cephalotes*, as well as several herein described as new. In various other ways, such as comparing types, Mr. Fox has throughout the whole investigation given invaluable assistance. Mr. C. F. Baker was so good as to send me the specimens he and his wife had collected in Colorado, which included some new forms. Mr. C. Robertson has given some very valuable information regarding the habits of the two eastern species. Some interesting species have been found by students of the college, Miss Mae Gilmore, Miss J. E. Casad, Mr. Alfred Holt and Mr. C. Rhodes, as duly indicated below. My botanical colleague, Professor Wooton, found one new species.

The writer has seen all the species treated of, except *cephalotes*, *halictulus* and *bicolor*. Of the 70 species, 26 are known in both sexes, 26 only in the ♂, 18 only in the ♀. 23 are at present only known from uniques. The flower-visiting habits of 50 species are known. The nesting habits are as yet unknown.

CHARACTERS USED.

It is hoped that those who may have occasion hereafter to describe species of *Perdita* will read this section, as a study of the published descriptions shows that some important characters are almost always omitted.

The coloration of the head and thorax is black, green or blue; frequently the parts are not colored alike, the metathorax especially being usually bluer than the mesothorax and scutellum. The metallic color does not extend on to the abdomen, except to a slight extent in *interrupta*. The sculpture of the metallic portions differs, and a good character is found in the smoothness or otherwise of the mesothorax; in some it is very smooth and shining, in others granular or striatulate and comparatively dull. The dulness or otherwise of the front, and the punctation of the area close to the ocelli, may also be used.

The pale markings may be absent; when developed they are from pure white to deep yellow, never red, though the yellow of many males may be reddened by cyanide. The reddest color observed is in the bright orange-rufous of the latter end of the abdomen in *crotonis*, and the orange-rufous legs of *foxi*. The abdomen, as in *latior*, may be bright ferruginous. These colors are entirely different from the scarlet induced by cyanide. In some species which live on yellow flowers (*luteola, beata, larreæ*) the whole body-color is deep yellow, the dark markings being reduced to a minimum. No species is known similarly white, nor is any species all rufous like some forms of *Nomada*.

The head may be comparatively small, round, or broader than long or longer than broad; in some species it is very large and subquadrate. The males may or may not have a conspicuous tooth or spire on the cheeks beneath; this character appears to be a valid specific one, but appears in species which are not closely allied, (e. g., *larreæ* and *pulchrior*), while it distinguishes certain forms from their closest allies, as *pulchrior* from *pallidior*, the latter having unarmed cheeks. It is to be observed that in the Mutillid genus *Sphærophthalma* a similar state of affairs occurs, only it is the females that possess the armed cheeks. Thus *S. montivaga* is extremely like *S. megacantha*, but lacks the spine on the cheeks. *S. toumeyi* also differs from its allies by its spinose head. The character is, therefore, one of those which has been termed "kaleidoscopic."

The mandibles may be bifid at the tip (*latior, texana*), or may be notched within (*sphæralceæ* ♀) or even present a distinct tooth on the inner side (*æneifrons*). They are, however, usually simple, and more slender in the males. In the females of the *albipennis* group they are very stout and strongly elbowed, quite different from the males. There is also a marked sexual difference in the mandibles of *ventralis*. The tongue differs in length and in the degree of development of the hairs. As will be seen below, the tongue has on two or three occasions proved useful in distinguishing allied forms (as *affinis* and *senecionis*), but it has not been studied throughout the series. In one instance, a useful distinction was found in the relative lengths of the joints of the maxillary palpi.

The form of the clypeus differs very much both between the species and the sexes of the same species (e. g., *ventralis*). For convenience I have compared the shapes noted to the outlines of different kinds of hats.

The degrees of hairiness of the face and cheeks, as also of the thorax (especially of the mesothorax) offer useful characters. The hairs are usually white, but may in part be grayish or brownish, or even, in a yellow species (*beata*), yellow. They are very rarely (*albovittata*) dense enough on the face to obscure the markings.

The antennæ present different grades of color (usually paler beneath) from yellow and orange to black. In the *albipennis* group the color of the flagellum has served to distinguish the males of allied forms.

The face markings at first seem complicated and hard to describe, but are easily reduced to a simple system. The face may be wholly dark, but if the pale marks are much reduced they are generally seen to linger last upon the clypeus. An exception to this is found however in *semicærulea*, with its shining yellow mark on each side of a perfectly dark clypeus. The clypeus may be wholly light, usually retaining a black dot on each side near the margin. The clypeal dark markings appear frequently in the form of two longitudinal black bars, as in *numerata*.

The lateral light markings of the face are commonly triangular, the inner angle being about opposite the dot on the clypeus, and the upper angle usually on a level with the antennal socket on the orbital margin. Sometimes the lateral mark extends up along the margin of the orbit much further; and it may terminate variously, being either pointed or truncate. The shapes of the lateral face marks afford excellent specific characters.

Above the clypeus, between its upper border and the level of the antennæ, is the *supraclypeal mark*, which differs very much in its degree of development, and even in its shape in some allied species. It may be produced upward in the median line to an enlarged yellow mark on the front, the *frontal mark,* but this is not very common.

Finally, just below each antenna may be a small subtriangular mark, which I have called the *dog-ear mark,* because of its resemblance to the ear of a hound, first observed in the ♂ form described as *canina.*

In the males the face is frequently all yellow or white up to the level of the antennæ; and then good characters are found in the degree of its further upward extension, and in the form of its upper limit.

The face markings are nearly always conspicuously different in the sexes, but not so in *albovittata* and the *albipennis* group, nor in *luteola,* nor the *texana* group.

The pale markings of the thorax are confined to different degrees of yellow on the prothorax, often affording good characters, and occasional very characteristic yellow patches on the pleura, except in *mexicanorum,* which has a yellow postscutellum, and *luteiceps,* which has a little yellow on mesothorax and scutellum. Two species, *punctosignata* and *cephalotes,* have the thorax yellow with black markings; *marcialis* has it yellow with green markings, the mesothorax being green with yellow lateral margins.

The wings may be simply hyaline or milky-hyaline, or slightly smoky; never really dark and never spotted or banded. The nervures and stigma may be dark brown, light brown, yellowish or colorless; the stigma is usually hyaline centrally. In the *texana* group the stigma is hardly developed.

Very good characters are found in the venation. The marginal cell differs greatly in size and length, but I never saw one so long as to suggest the condition of *Calliopsis.* It may be obliquely or squarely truncate. It may have the portion below the stigma (*substigmatal*) longer than that beyond (*poststigmatal*), but usually they are about equal or the latter is longer. There are but two submarginal cells; and the shape of the second, whether triangular or how much narrowed to the marginal, should in each case be noted. The so-called second submarginal is morphologically the third, the true second of genera with three submarginals being absent. On one side of the type ♀ of *obscurata,* the true second submarginal actually appears, small, triangular and petiolate, much as in the Larrid genus *Plenoculus.*

The third discoidal cell may be very weak or even entirely wanting, according to the development of the second recurrent nervure.

The legs may be dark or yellow, or variously marked with these colors, and the proportions of dark and light, though variable, afford good characters within reasonable limits. The anterior tibiæ are usually yellow in front at least.

The abdomen differs somewhat in shape, and may be either wholly dark or variously banded or spotted. In every case it should be carefully described, and the color of the ventral surface should also be mentioned.

The ♂ genitalia differ in one or two species I have examined, but I have not studied them sufficiently to be able to introduce them into the classification.

In addition to the above structural and colorational characters, too much stress cannot be laid on the importance of noting the exact localities and the flowers visited. Without the assistance derived from such information, it would have been impossible to unravel the *mentzeliæ* series, or satisfactorily arrange the forms allied to *affinis.* Further, facts of this kind are invaluable in the difficult task of correctly associating the sexes.

The time of flight should also be carefully noted. Some species are vernal, others (the great majority) fly in late summer and autumn.

GEOGRAPHICAL AND VERTICAL DISTRIBUTION.

The species of *Perdita* are characteristic of the arid region of North America. Of the 70 species, 49 are found in New Mexico, and of these, no less than 34 are in the Mesilla Valley, in the Middle Sonoran (= lower part of Upper Sonoran) zone, at 3,800 feet. Ascending the Valley of the Rio Grande, four species were taken at San Marcial, one at Socorro and nine at Albuquerque, but at none of these places was more than a few day's collecting done. One species was found at San Augustine, on the east side of the Organ Mountains, but has since been observed in the Mesilla Valley. There can be no doubt that *Perdita* abounds throughout the Upper Sonoran zone in New Mexico.

At Santa Fé, 7,000 feet, in the transition zone of New Mexico, a good deal of collecting was done in two seasons, but the species of *Perdita* do not appear to be so numerous as in the Upper Sonoran. Only seven species were taken, although one or two were very numerous in individuals. In the mid-alpine zone no species were seen, either in New Mexico or in the three years residence in Colorado.

In Colorado, species of *Perdita* have been found at La Junta, Fort Collins, Estes Park and Glenwood Springs. On August 12, 1887, I found a species at Cottonwood Creek, Pleasant Valley, Fremont County, Colorado ; it was sent to Mr. Ashmead, but the species was not determined. In my note-book I recorded that it was 3½ mm. long, head black, thorax gray, abdomen red-brown ; surely it was a new species, different from any herein described. A few species of *Perdita* have been found in other parts of the west—three in Lower California, three in California, three in Nevada. Two are known from Texas, one from the State of Chihuahua, Mexico. Two vaguely from Mexico.

In the Eastern States, *Perdita* is represented by only two species, *octomaculata* of the northern region, from Illinois to New Hampshire ; and *obscurata* in the south, Georgia and Florida. One of the Rocky Mountain species, *albipennis*, extends northeastward to South Dakota.

As regards vertical distribution, one species, *sphæralceæ*, extends from the Mesilla Valley to Santa Fé, but the Santa Fé form is an easily distinguishable race. *P. lepachidis* extends unaltered from Socorro to Santa Fé ; and *zebrata* and *chamæsarachæ* extend from Albuquerque to Santa Fé. *P. austini* and *bigeloviæ* extend from the Mesilla Valley to Albuquerque.

THE FLOWERS VISITED.

It may be laid down as a general rule that each species of *Perdita* visits normally but one species of flower, but occasional specimens may be found on flowers to which they do not normally belong. The exceptions to this rule are found in *P. octomaculata* visiting *Solidago, Coreopsis* and *Aster; P. cladothricis* visiting various Compositæ as well as *Cladothrix; P. pectidis* visiting *Pectis, Tribulus* and *Wedelia; P. fallax* visiting *Bigelovia, Verbesina* and *Pectis; P. phymatæ* visiting *Bigelovia* and *Gutierrezia;* and *P. semicrocea* visiting *Solidago, Bigelovia* and *Gutierrezia.*

In the case of several uniques, it is not certain that they normally belong to the flowers on which they were found. Thus a single *P. pulchrior* was found on *Bigelovia* at Las Cruces, and it would have gone in as a *Bigelovia* species but for its previous discovery on *Mentzelia* at Albuquerque. In the Mesilla Valley, toward and at the base of the Organ Mountains, are many species of flowers which should by all analogy have their species of *Perdita.* But the opportunity has not offered to make excursions to determine this at the right season, and we can only surmise that some of the uniques taken on *Verbesina, Bigelovia*, etc., will be hereafter found abundantly attached to some other plant in the neighborhood.

The flowers visited are cited in their systematic order, following the arrangement of Engler and Prantl, as recently adopted in the A. A. A. S. list. The number of known *Perdita* flowers is 25, of which 13, more than half, are Compositæ. Twelve species of flowers have furnished more than one *Perdita* species, the greatest number (12) being from *Bigelovia wrightii.*

It is to be explained in reference to the names used for the flowers, that the writer is in favor of using the earliest generic name in every case, when not preoccupied by a valid homonym; and also the earliest specific name when not preoccupied by a valid homonym in the same genus. But he is entirely opposed to the practice of displacing names because antedated by synonyms, which are not and never were deserving of recognition; and he does not consider a varietal name invalid because previously used for a different species, or a variety of a different species, in the same genus. He thus objects to the substitution of *Chondrophora* for *Bigelovia* (or *Bigelowia*), or of *Covillea* for *Larrea.* Likewise of var. *pilosus* for var. *villosus* of *Aster ericoides.*

SALICACEÆ.

(1). SALIX. The willow-frequenting bees at Las Cruces in May are *Perdita salicis, P. numerata, Andrena salicinella* Ckll., *Andrena* n. sp., *Halictus* sp., and *Prosopis* sp. *P. salicis* abounds, but of *numerata* only one was taken.

AMARANTHACEÆ.

(2). CLADOTHRIX CRYPTANTHA S.Watson. *P. cladothricis* abounds on this; it was rather surprising to find so simple a flower so abundantly visited by a particular species of bee. The genus *Cladothrix* has cited in the Index Kewensis only two species, both from Western North America.

NYCTAGINACEÆ.

(3). WEDELIA INCARNATA (L.) Kuntze. Visited by *P. pectidis.* The *Boerhaavia*, common at Las Cruces, is not visited by *Perdita;* while the large purple *mirabilis* is, of course, a moth flower, and is visited by *Deilephila lineata.*

CAPPARIDACEÆ.

(4). CLEOME SERRULATA Pursh. This is not found growing wild at Las Cruces, but it abounds from Albuquerque to Santa Fé and northward into Colorado, being visited in great numbers by *Perdita zebrata*. There is a not uncommon white-flowered form (*C. albiflora*) which I observed at Watrous, N. M., and other places.

While *P. zebrata* is the only *Perdita* of the *Cleome*, it has to compete with numerous bees of other genera. At Santa Fé, on August 2d, I noted that *Nomia punctata* was in full force on the *Cleome*, its hind legs loaded with the green pollen. Other *Cleome* bees at Santa Fé are *Melecta miranda*, *Anthophora*, *Megachile*, *Melissodes* and *Bombus*. At Albuquerque a *Calliopsis* is common on the *Cleome;* and I saw at this locality on August 16th, a humming-bird visiting it.

LEGUMINOSÆ.

(5). PROSOPIS JULIFLORA var. GLANDULOSA (Torrey). The mesquite furnishes *Perdita exclamans* and *P. punctosignata*. Mr. Alfred Holt has also taken an *Anthidium* on mesquite at Las Cruces.

It will be noted that the generic name of this plant is the same as that of a genus of bees. This inconvenience might be avoided by spelling the bee-genus *Prosapis*, as has already been done by Mr. Ashmead (Hym. Colo., p. 31). The botanical genus has priority. The mesquite extends in modified form to sea-level in the neotropical region; it is, in fact, essentially a neotropical type.

ZYGOPHYLLACEÆ.

(6). TRIBULUS MAXIMUS L. Visited by *P. pectidis*. The plant cannot be other than *maximus*, but it does not agree in detail with published descriptions. I have found the plant (though not the bee) as far north as La Junta, Colorado.

(7). LARREA DIVARICATA var. TRIDENTATA (DC.). At San Marcial were found on this *P. marcialis*, *P. larreæ*, *P. larrearum* and *P. semicærulea*. The *P. larreæ* is colored yellow like the flowers of the plant. The genus *Larrea* consists of four or five species, confined to the Mexican region and the Argentine Republic. Our species is a variety of one of the Argentine ones.

EUPHORBIACEÆ.

(8). CROTON TEXENSIS (Klotzch) Muell. Arg. At Albuquerque I found numbers of *P. crotonis* on this. The same plant is common at Santa Fé, but yields no *Perdita*. The constancy of *Perdita* spp. to their proper flowers was well illustrated at Albuquerque, where on the *Croton* was only *P. crotonis*, while on the *Cleome* only 8 paces distant was only *P. zebrata*. At Las Cruces, *Croton neomexicanus* is common, but I found on it no *Perdita*, or even bees, only Larridæ and especially *Philanthidæ*, including *Aphilanthops taurulus*. This was on September 25th, and only staminate flowers were to be found. *Croton* is a very large genus, with many neotropical species, but also found in the tropics of the Old World.

MALVACEÆ.

(9). Sphæralcea angustifolia Spach. Abundant and variable from Las Cruces to Santa Fé, in the former locality furnishing *P. latior* and *P. sphæralceæ;* in the latter a distinct race of *sphæralceæ*. At Santa Fé the *Sphæralcea* is visited also by *Epeolus, Bombus, Colletes, Melissodes*, etc. At Las Cruces it is principally visited by *Diadasia*.

LOASACEÆ.

(10). Mentzelia nuda (Pursh) Torr. and Gray. Visited at Santa Fé by *P. mentzeliæ*, and at Albuquerque by *P. pallidior* and *pulchrior*. It is a favorite *Bombus* flower. The genus goes south to Chili.

UMBELLIFERÆ.

(11). Hydrocotyle umbellata L. Mr. Robertson reports *P. obscurata* from this. I have never myself found any *Perdita* on an Umbellifer.

SOLANACEÆ.

(12). Chamæsaracha coronopus (Dunal) A. Gray. *P. chamæsarachæ* abounds on this at Albuquerque, and was also taken on it at Santa Fé. The genus is a small one, the Index Kewensis cites 1 Texas, Mexico, 2 California (here including our *coronopus*), 1 Mexico, and 1 Japan. Thus it is not apparently of neotropical origin.

COMPOSITÆ.

(13). Gutierrezia sarothræ (Pursh) Britt. and Rusby. At Albuquerque were found on this, one each of *P. austini, gutierreziæ* and *pallidior*—the last doubtless accidental.

(14). Gutierrezia sarothræ var. microcephala (Gray) Coulter. This is common at Las Cruces, and has furnished *P. austini, semicrocea, luteola, phymatæ, tarda* and *cladothricis*. On September 25th, a single ♀ *verbesinæ* was also taken on it, but this was undoubtedly accidental, as *verbesinæ* was extremely numerous on *Verbesina* close by, and if it had anything to gain by visiting *Gutierrezia*, it would be seen there more than once.

The genus *Gutierrezia* goes south to the Magellan Strait region. It is moderately numerous in species in the Mexican (Sonoran) region and arid region of the U. S., and again in in the southern part of the neotropical region, as far north as Chili.

(15). Solidago canadensis L. Fig 1. This common Golden-rod has a wide range over the continent, and extends from Las Cruces to Santa Fé, being usually seen on or about the acequia banks. Mr. Robertson records it as one of the plants visited by *P. octomaculata* in Illinois; in Colorado Mr. Baker has taken from it *bakeræ, affinis, sexmaculata* var. and *rectangulata*. At Las Cruces it furnished fair numbers of *semicrocea*, and a single *grandiceps*. It is worthy of note that it is not at all visited by *luteola*, or indeed any of the *Bigelovia* species except *semicrocea*.

Fig. 1.

(16). Bigelovia wrightii Gray. Fig. 2. This is the very abundant *Bigelovia* of comparatively dry sandy ground between the river bottoms and the benches at Las Cruces and Albuquerque, N. M. Hitherto it had been confounded by us with *B. rusbyi*, owing to a specimen, apparently quite identical with our plant, having been so named at the California Academy of Sciences. As I was somewhat uneasy about this determination, Professor Wooton at my request sent a specimen to Columbia College, and word comes back that it is assuredly *wrightii* and not *rusbyi*. This explanation is needed, because I have sent out various insects labelled as from *B. rusbyi*.

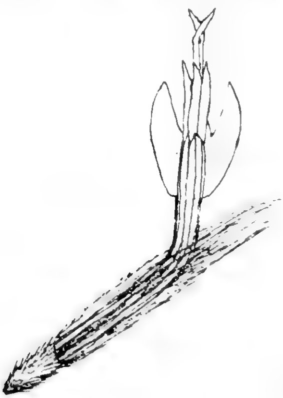


Fig. 2.

Besides being most prolific in *Perdita* species, this plant is wonderfully attractive to many kinds of insects. At Albuquerque I got from it *P. bigeloviæ*, and among other things the ant, *Tapinoma anale* André, and quantities of a pretty Chalcidid, *Orasema viridis* Ashmead (Det. Dep. Agric.). The latter is new to the U. S. Fauna, having been only lately described from a specimen found at Tepic, Mexico (Proc. Cal. Ac. Sci., 1895, p. 553).

At Las Cruces I found on *B. wrightii* plenty of *P. luteola* especially, accompanied by *semicrocea, æneifrons, phymatæ, fallax, bigeloviæ, nitidella, austini,* while *cladothricis, pulchrior, maculipes* and *pellucida* were occasional. Here the flowers are peopled by the same species of ant, *Tapinoma anale* André (det. Ernest André) as was found on them at Albuquerque; its color is such as to render it inconspicuous. Three species of beetles are particularly noticed on the flowers, *Chauliognathus scutellaris* Lec., *Crossidius pulchellus* Lec., and *Clerus abruptus* Lec. (det. Wickham), of which the first two are yellow like the flowers, with some black; and the last (appearing in October) is beautifully marked with red, resembling at a glance *Sphærophthalma heterochroa,* which is found in the same vicinity, though never on flowers. Sundry Coccinellidæ, Chrysomelidæ and Bruchidæ also frequent the flowers. Some Heteropterous insects found on the flowers are colored yellow to escape observation; one of these, *Phymata fasciata,* is predaceous, and a serious enemy of the bees. So there are also yellow or yellowish Thomisidæ, and certain Bombyliidæ and Trypetidæ among the Diptera which visit the *Bigelovia* flowers are more or less strongly yellow—more especially the beautiful little *Phthiria sulphurea* Loew (see Psyche, January, 1895, p. 188). Among Hymenoptera, besides various bees, are found several Philanthidæ, Scoliidæ, Eumenidæ, Chalcididæ, Chrysididæ, etc., some of the species being new or rare in collections, for example, *Aphilanthops taurulus* Ckll., *A. quadrinotatus* Ashm. (heretofore only known from a specimen found at Denver, Colo.), *Acanthochalcis nigricans* Cam., and *Chrysis mesillæ* Ckll. The genus *Bigelovia* belongs especially to the arid region, but there are two species in Ecuador.

(17). CHRYSOPSIS VILLOSA (Pursh) Nutt. This is properly a mountain plant (abundant, for example, in the mid-alpine of Colorado), but several vigorous plants are growing in a dry watercourse near the N. M. Agricultural College, the seeds having doubtless been washed from the Organ Mountains. On one of these I caught the unique of *P. vespertilio.* At Santa Fé I watched some *Chrysopsis villosa,* but only got one specimen of an *Anthophora.*

(18). ASTER ERICOIDES var. VILLOSUS (Michx.) Torr. and Gray. Mr. Robertson reports this as visited by *P. octomaculata.*

(19). ASTER CANESCENS var. VISCOSUS (Nutt.) Gray. Fig. 3. At Las Cruces this is freely visited by *P. asteris.* Two species of *Aster* which are common at Las Cruces, *A. spinosus* and *A. hesperius*, have produced no *Perdita.* The former is a weed of waste grounds, the latter occurs on the acequia banks, so they may not be natives of the immediate region. It has occurred to me that by watching the bees on a flower, some evidence might be obtained as to the length of time the flower has grown in the locality. Thus, to take an extreme class of cases, garden exotics are visited by comparatively few bees, and of course have none peculiar to them, as *P. asteris* to *Aster canescens* var.


FIG. 3.

(20). LEPACHYS TAGETES (James) Gray. Visited by *P. lepachidis;* also, at Santa Fé, by *Melissodes, Agapostemon, Halictus* and *Bembex.*

(21). HELIANTHUS ANNUUS L. Fig. 4. The sunflower is the flower of *P. albipennis;* very rarely a *verbesinæ* may also be found upon it. Other sunflower bees are *Panurgus, Melissodes* and *Andrena,* all at Las Cruces. *Phymata fasciata* also occurs on the sunflower heads. It is to be noted that the *Andrena* found on sunflowers at Las Cruces is not the same as Mr. Robertson's Illinois *A. helianthi.*

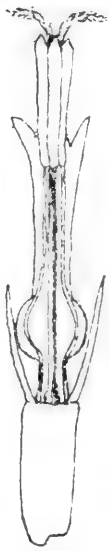


FIG. 4.

(22). VERBESINA ENCELIOIDES (Cav.) Gray. Fig. 5. At Las Cruces this produces commonly *P. verbesinæ,* rarely *beata, perpulchra* and *albovittata,* and occasionally or accidentally *albipennis,* var. *vagans, laticeps* and *fallax.* In October I noticed *Apis mellifica* visiting the flowers in numbers; the honey-bee flies longer and visits more species of flowers than any wild bee I know, and must surely prove rather a serious competitor of the wild species. The competition would be most severely felt, of course, in those years when, owing to unfavorable weather, the flowers were less numerous than ordinary.

The yellow bug *Phymata fasciata* Gray, abounds on the *Verbesina;* on September 28th, I found one which had caught a *P. verbesinæ.* This *Phymata* not only preys on bees, but the butterfly, *Lycæna exilis,* the house fly, *Musca domestica,* and doubtless many other insects. Another enemy of bees which is found on *Verbesina* is a Thomisid spider; on September 22d, I found one of these had caught a *P. verbesinæ.*

There are various other *Verbesina* bees, including the pretty *Agapostemon melliventris,* which also appears in the spring, then visiting *Sisymbrium* and *Streptanthus.*

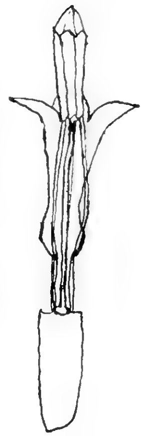


FIG. 5.

(23). BIDENS ARISTOSA (Michx) Britt., (= COREOPSIS ARISTOSA Michx). Mr. Robertson cites this as visited by *P. octomaculata.*

(24). SENECIO DOUGLASII DC. On this Professor Wooton found *P. senecionis,* as also an *Andrena* and other bees.

(25). PECTIS PAPPOSA Gray. This is visited by *P. pectidis,* but *cladothricis, fallax* and *biparticeps* have also been taken on it, while once only a *luteola* was seen in the net after sweeping *Pectis.* The flowers are frequented by an ant, *Dorymyrmex pyramicus* Rog. (det. André). One also finds upon them *Panurgus* (commonly) and *Epeolus* (rarely), as well as sundry Philanthidæ and Bombyliidæ, etc.
The genus *Pectis* has many neotropical species, extending even south to the Argentine Republic. It has also West Indian representatives in Cuba, San Domingo and Curaçoa.

In reviewing the above list of plants, it will be readily seen that *Perdita* does not usually frequent the boreal types of flowers, but rather those which extend northward from the neotropical region. This, taken with the known distribution of the genus, strongly suggests that in the main we have to do with an austral series of types, which have spread northward and become largely differentiated into species since the glacial epoch. *P. octomaculata,* however, must be looked upon as a survival from preglacial times; and here it is especially significant that *affinis* and *senecionis,* which more especially represent *octomaculata* in the west, are the very ones which visit boreal flowers, *Solidago* and *Senecio* to wit. Further, *bakeræ* which does indeed visit *Solidago* also, shows every indication of being a recent derivative from the *Cleome* type *zebrata;* an instance, in fact, of the neotropical immigrants adapting themselves through modification to subboreal conditions.

Another thing that deserves notice is the relationship between the size of the bees, the length of their tongues, and the kinds of flowers. It would appear that a longer tongue is not always developed independently to meet requirements, but that the total size of the bee may be increased, and with it the tongue. Or conversely, the size of the bee may be reduced. Speculations of this kind are, perhaps, not very profitable, but it will be advantageous to give the facts which suggest them.

Close to the N. M. Agricultural College *Verbesina encelioides* and *Bigelovia wrightii* grow in the utmost profusion. In September collections were made off both, the plants being but a few yards from one another, with the following results:—

VERBESINA:—*Perdita, Calliopsis, Panurgus, Melissodes, Cœlioxys, Andrena, Epeolus;* but on October 5th when the *Bigelovia* was getting over, *Halictus ligatus, H. pectoraloides* and *Agapostemon melliventris.*

BIGELOVIA:—*Perdita, Agapostemon, Anthophora* (small species), *Megachile* (one), *Colletes, Halictus* ♂, *Halictus stultus* ♀, *Prosopis, Nomia nevadensis.*

Thus it will be seen that the bees of these two plants were almost entirely of different genera in September, those on the *Verbesina* being Apidæ with few exceptions, those on the *Bigelovia* largely Andrenidæ. But as the *Bigelovia* began to be over, the large Andrenidæ visited the *Verbesina*, which had given a second crop of flowers. Now although *Perdita* appears equally in both lists, the species are different, and if we except unique specimens, as we justly may, those on the *Verbesina* are of larger size, those on the *Bigelovia* comparatively small. The abundant larger *verbesinæ* is never seen on *Bigelovia*, nor the not less abundant smaller *luteola* on *Verbesina.*

And when we come to look at the *Perdita* spp. of the *Gutierrezia*, they average still smaller than those of the *Bigelovia.*

I am fortunate in being able to present some figures of the flowers of some of the *Perdita* Compositæ, drawn by Miss Mae Gilmore under the supervision of Professor E. O. Wooton. As they are all on the same scale, (diam. x 5) the reader will be able to form his own conclusions by studying them in connection with the facts above cited. "The honey . . . in Compositæ is secreted by a ring surrounding the style at the base of a narrow tubular corolla, and as it accumulates it rises up into the wider part of the corolla where it is accessible to the most short-lipped insects, and where the anthers shelter it from rain."—(Hermann Müller). In the *Bigelovia*, *Aster* and *Solidago* the tube is seen to be narrow, permitting the rapid rise of the nectar, and probably preventing the insertion of the tongue of large bees. Hence, these flowers are visited only by the smaller species of *Perdita*, with other small Apidæ and Andrenidæ. In *Verbesina* and *Helianthus* the tube is wider, doubtless permitting the larger bees to readily insert their tongues; but it it is narrower at the neck than *Bigelovia* or *Solidago*, preventing small insects from so readily thrusting their heads inward to stretch for the nectar. The wider tube also may prevent the nectar from rising so far, while in *Helianthus* there is a large bulb to contain it.

Solidago canadensis is commonly cultivated in gardens in Europe and there H. Müller mentions only flies as visiting it (Fertilization of Flowers, p. 321), though he gives a further reference to a paper which I have not seen. With us, as has been shown, it is native and visited by several bees.

THE NATURE OF SPECIFIC DIFFERENCES.

It is a commonplace observation that specific characters are of all kinds, and may be either strongly marked or difficult to discern. A very small amount of study teaches us that there is no essential difference between those characters called specific and those called varietal; in fact, the very same kind of difference which marks species in one group, may only mark varieties or mutations in another. Thus we come to see that the essential distinctions between species are physiological, the morphological ones being only valid for diagnostic purposes just so far as they happen to coincide with the physiological.

There are even what I have termed "physiological species," i. e., species separated only by habit; not at all, so far as we can judge, by structure, or if at all, in only a very slight degree. I have elsewhere cited examples of this kind in Coccidæ, but in Hymenoptera we find many instances in which the tangible characters are reduced to a minimum. Thus, Schmiedeknecht cites the case of *Bombus silvarum* var. ♂ *nigrescens* Perez, a submelanic mountain form, which is only to be separated from *B. pratorum* by an examination of the genitalia. Among the European *Sphecodes* also, a study of microscopical characters has led to a remarkable increase in the number of recognized species. Only the other day, I received a new part of Marshall's Monograph of British Braconidæ, in which the following paragraph is sufficiently significant:—

"Nearly a dozen species [of *Aspilota*] have been indicated or described; their inconstant characters render precise definition extremely difficult, and tabulation almost impossible. . . . Accident has brought to light some facts relative to one species, *nervosa* Hal., from which it appears that the varieties mentioned by that author [Haliday] belong almost certainly to several distinct species. The *fuscicornis* Hal., requires to be elucidated in a similar way, for the capture and examination of isolated examples of unknown origin, lead to very uncertain results." (Tr. Ent. Soc. Lond., 1895, p. 375).

Now in *Perdita* precisely the same state of affairs occurs, and it will thus be found that while certain species (e. g., *crotonis*, *luteola*) are very easily recognized, some others (e. g., *bakeræ*, *verbesinæ*) are almost as well to be called races or varieties as species. In the opinion of the writer, we have indeed the process of evolution going on under our eyes, the puzzling forms being those which have only lately segregated themselves, and have not yet developed striking peculiarities.

Take for example *bakeræ*, the closest ally of the *Cleome* species *zebrata*. It does not appear to differ more from *zebrata* than the mutations of the latter do from one another, and in the female is practically identical with it so far as outward signs go. But the ♂ *bakeræ* has a slight but constant difference in its wider supraclypeal mark, and it also differs in its genitalia. These differences would never have been noticed, in all probability, had not *bakeræ* been observed to differ in its habits from *zebrata*, to frequent not the *Cleome*, but Golden-rod. In fact, the similarity is so great that Mr. Fox, after seeing specimens, expressed the opinion that *bakeræ* was a synonym of *zebrata*.

Another case, not less perplexing, is found in the *albipennis-verbesinæ-lepachidis* series. The males of this series, placed in a row, readily separate into those which have narrow yellow bands on the abdomen and those which have not. Those with the bands separate into a series with the flagellum orange, and one with it blackish, and it is seen that the former are from *Verbesina*, the latter from *Helianthus*.

Now the females of this series (that of *lepachidis* being unknown) separate at once into those with broad distinct yellow abdominal bands, and those with the abdomen only spotted. The former are from *Helianthus* (rarely from *Verbesina*), the latter very abundant on *Verbesina.* But now we find, to our surprise, that some of the males with yellow on the abdomen belong to the spotted females, and come from *Verbesina;* while others (with the dark flagellum) belong to the well banded *Helianthus* females. Further than this, other males without the yellow belong to other well banded *Helianthus* females from a different locality. Thus among the *Helianthus* forms (*albipennis*) the females from two localities (La Junta and Las Cruces) are hardly at all different, while their males are decidedly different; and the male of the Las Cruces form more resembles the ♂ of *verbesinæ,* which is common on *Verbesina* in the same locality. But the Las Cruces males differ from *verbesinæ* in the color of the flagellum; while the La Junta males, differing from *verbesinæ* in the abdomen, resemble it in the antennæ! The difficulty is still further increased by the occurrence of individual varieties presenting other combinations of the "specific" characters. In such a case as this we should be hopelessly adrift without biological observations. There is no apparent reason why the variations in clypeal markings should not be just as "specific" as those in the color of the flagellum, or (as in *lepachidis*) in the color of the head and thorax. Mr. Fox, after examining a series, concludes that we do not know the ♂ of *albipennis,* and that my *albipennis* ♂, *verbesinæ* and *lepachidis* are all varieties of *hyalina.* But all this is contradicted by actual observation of the insects on the flowers. The characters which I have used occur uniformly in series from the same flowers, except in the case of widely separated localities, where they are still uniform for a given flower in a given locality. There will be very rarely an individual proper to one flower found on another, as one or two *helianthi* on *Verbesina,* but such exceptions do not vitiate the general rule. Some characters, as the difference in clypeal markings, belong especially to no one of these series, and hence have no specific value.

If, as believed, evolution is in progress among the species of *Perdita,* we are naturally led to seek for evidence of natural selection. In some cases, as of the yellow *luteola, beata* and *marcialis,* all on yellow flowers, we note at once the utility of the peculiarity; and when we see the yellow predaceous bug *Phymata* also on the flowers, the whole matter seems clear. Yet it must be confessed that on *Verbesina* the yellow *beata* is extremely rare, while the dark *verbesinæ* abounds.

The face-markings, so distinctive of species, differ greatly as a rule in the sexes, and in most species are very constant. There is every probability that they serve as recognition marks; and it is here significant that when they are very variable, as in ♀ *zebrata*, there is no other species of *Perdita* on the same flowers that could be confused with the varying one.

The species appear to be all single brooded, but the great resemblance between the vernal *numerata* and the late summer *bigeloviæ*, suggested the possibility of double-brooded seasonally dimorphic species. The strongest fact, however, that militates against this idea is that there are so many more late summer and autumn species than vernal ones, while the eastern *octomaculata* is represented by no congener at all in the spring.

Another question arose as to the possibility of dimorphism in the males of some species; references to this matter, which deserves further study, will be found under the species concerned.

It will be observed that the grouping of the species is arbitary, those being associated which the student is likely to meet with on the same flowers, or in the same part of the country. This was done because it was felt that no natural arrangement could yet be arrived at, and a purely artificial one, based solely on considerations of convenience, was better than one which might give a false idea of relationships. The difficulty arises in many cases from the so-called "kaleidoscopic" characters, the possession of which by two species does not necessarily imply descent from an ancestor exhibiting them. Thus *luteola* and *beata* are colored alike in almost every detail (except the black on the pleura of *beata*), and are extremely different from any other *Perdita*. But *beata* in its size and hairy mesothorax approaches the *albipennis* group and departs widely from *luteola*. The character of armed cheeks has already been referred to, and several others might be cited. How strangely the several "specific" characters may appear or disappear, is shown well in the series of *albipennis* and *verbesinæ*.

There is, however, one natural group, that of *texana* and *latior*, which is very distinct and may ultimately be regarded as forming a distinct genus. F. Smith's generic name *Macrotera* has been used for *texana*, but perhaps incorrectly.

Summing up, the writer has to express the opinion that variations in *Perdita* certainly do not occur indefinitely in all directions, but that they do occur independently, so that the several species differ from one another hardly so much in absolute characters, as in the various combinations presented of similar or identical characters Furthermore, it is apparent that the earliest distinctions between species are at least often of a very subtle character, so that the workings of natural selection during the actual process of segregation are anything but easy to observe. And this need not surprise us when we reflect that among ourselves constitutional characters, not easily identified by any coincident structural features, play so large a part in determining our ability to reach manhood and beget offspring.

ARTIFICIAL KEY.

(*Note.*—The numbers *before* the specific names coincide with the numbers of the same in the descriptive portion.)

Entirely yellow, with no conspicuous markings 1
Yellow or orange, with dark markings 3
Head and thorax dark 5

1. 8 mm. long, mesothorax pubescent, pleura with a black patch . . . . 63 *beata* ♀
   About 4 mm. long, head very large, cheeks armed 15 *larreæ* ♂
   Over 5 mm. long, head ordinary, cheeks unarmed, mesothorax not pubescent 2
2. Antennæ dark above, a black line before the eyes, 55 *luteola* ♀
   Antennæ not dark, a black dot before the eyes . 55 *luteola* ♂
3. Extremely small, cheeks armed, mesothorax mostly green, 16 *marcialis* ♂
   Not so small, vertex with a black band from eye to eye, thorax with black markings 4
4. Size 6 mm., head very large, abdomen without distinct bands . . . . 34 *cephalotes* ♂
   Size 4½ mm., head not very large, abdomen with distinct bands . . . . 35 *punctosignata* ♂
5. Abdomen orange, or orange-brown, or ferruginous; not banded, unless at base 6
   Abdomen dark brown, or black, or spotted, or banded . . 13
6. Head large, abdomen short and broad, ferruginous, marginal cell obliquely truncate, mandibles bidentate . . . 7
   Not so 8

7. Head brown, thorax black . . . . 1 *texana* ♂
Head and thorax dark green . . . . 2 *latior* ♂
8. Cheeks toothed beneath, legs entirely yellow . 14 *pulchrior* ♂
Cheeks unarmed 9
9. Face all dark 10
Face partly pale 11
10. Nervures colorless, abdomen orange . . . . 54 *semicrocea* ♀
Nervures fuscous, abdomen dark testaceous, 32 *halictoides* ♀
Nervures ferruginous, abdomen ferruginous . . 33 *bicolor* ♂
11. The pale color confined to clypeus and triangular marks at side of face . . . . 20 *chamæsarachæ* ♀
Face all light below antennæ; length $3\frac{1}{2}$ mm 12
12. Area between eyes and ocelli smooth and shining like mesothorax, 2d segment of abdomen with a dark band, vertex and mesothorax not blue . . . . 54 *semicrocea* ♂
Area between eyes and ocelli distinctly granular, much duller than the shining mesothorax, 2d segment of abdomen without a band, vertex and mesothorax dark blue, 20 *chamæsarachæ* ♂
13. Clypeus entirely dark 14
Clypeus not entirely dark 24
14. Abdomen piceous with yellow spots or dots, legs with yellow markings 15
Abdomen not spotted 16
15. Length about 6 mm., abdomen with only 4 pale dots . . 26 var. *punctata* ♀
Length about 5 mm., abdomen with 6 pale yellow spots or blotches . . . . 26 *sexmaculata* ♀
16. Abdomen black with pale yellowish bands 17
Abdomen not banded 20
Abdomen dark brown, with a short white band on 2d segment; size very small, less than 4 mm. . 41 *cladothricis* ♀
Abdomen testaceous with suffused bands, mesothorax smooth, shiny . . . . 6 *ventralis* ♀
17. Stigma brownish, mesothorax hairy, size larger, 7 mm. or over 18
Stigma entirely pallid, mesothorax practically nude, size smaller, not over 6 mm. 19
18. Nervures almost colorless . . . . 22 *sphæralceæ* ♀
Nervures dark brown . . . . 22 v. *alticola* ♀

19. Anterior femora mostly black, abdomen with heavy dark bands . . . . 12 *mentzeliæ* ♀
Anterior femora entirely pale, abdomen with evanescent bands . . . . 13 *pallidior* ♀
20. Head and thorax piceous, marginal cell obliquely truncate, abdomen ovate, size rather large . . . . . . 1 *texana* ♀
Thorax black except the green metathorax; head green, front æneous . . . . 53 *æneifrons* ♀
Thorax black except the blue metathorax; head blue; a yellow spot on each side of clypeus . . . 18 *semicærulea* ♀
Head and thorax green 21
21. Females 22
Males, size small, nervures and stigma testaceous, fore tibiæ yellow in front . . . . 4 *arcuata* ♂
22. Abdomen broad, mandibles bidentate, marginal cell obliquely truncate . . . . 2 *latior* ♀
Not so 23
23. Small, about $4\frac{1}{2}$ mm. long, nervures brown . . 52 *phymatæ* ♀
Larger, nervures nearly colorless . . . . . 68 v. *nigrior* ♀
24. Face below level of antennæ all yellow or white, except clypeal dots in some. Males 25
Face below level of antennæ not all pale 43
25. Face below antennæ white 26
Face below antennæ yellow 28
26. Last three segments of abdomen rufous, the other banded 19 *crotonis*.
Abdomen yellowish-white, banded, face below antennæ pellucid white, first 4 legs all dull white except a dark streak on middle tibiæ . . . . 50 *pellucida*.
Abdomen dark brown with white markings 27
27. Abdomen with about 6 white marks, or fewer yellowish spots . . . . 42 *pectidis*.
Abdomen with two more or less developed white bands, 41 *cladothricis*.
28. Legs black with a little yellowish . . . . . . 25 *affinis*.
Anterior and middle femora marked with black, cheeks unarmed 29
Anterior femora all yellow, the 4 anterior tibiæ not all yellow 33
First 4 legs all yellow, or at least not marked with black or brown 34

29. Nervures pallid . . . . 22 *sphæralceæ.*
Nervures dark 30
30. Face and disc of mesothorax nearly bare, face below antennæ bright yellow 31
Face and disc of mesothorax hairy 32
31. Very small, abdomen yellow with pale suffused brown bands . . . . 43 *biparticeps.*
Larger, abdomen dark with clean-cut interrupted light bands . . . . 27 *rectangulata.*
32. Head broader than long, distal band on 2d abdominal segment broadly continued to lateral margin, dog-ear marks with more or less of a dark border below . 22 v. *alticola.*
Head round, distal band of 2d abdominal segment failing some distance before lateral margin . . . . 38 *hirsuta.*
33. Face all yellow (except the anteorbital spots) up to middle ocellus . . . . 29 *luteiceps.*
Face not all yellow up to middle ocellus . . 49 *maculipes.*
34. Legs entirely orange-rufous, abdomen black, nervures brown . . . . 21 *foxi.*
Legs not orange-rufous, abdomen banded 35
35. The yellow extending above antennæ in median line . . . 36
The yellow not extending above antennæ in median line . 41
36. The yellow extending above across the face 37
The yellow extending above only at sides and middle line . 39
37. Larger, about 5 mm. long, face-markings resembling *gutierreziæ* . . . . 48 *bigeloviæ.*
Smaller, about 4 mm. long 38
38. Face yellow up to anterior ocellus . . . . . 37 *martini.*
Face not yellow up to anterior ocellus . . . 45 *gutierreziæ.*
39. Upward extension of yellow in median line narrow, shaped like a spear-head, abdomen above with only 3 or 4 bands, 40 *salicis.*
Upward extension of yellow in median line broader . . . 40
40. Incursion of blue downward terminating at a right angle; pleura dark . . . . 47 *nitidella.*
Incursion of blue terminating at an acute angle; pleura largely yellow . . . . 36 *exclamans.*
41. Cheeks armed, abdomen heavily banded . . 12 *mentzeliæ.*
Cheeks unarmed 42

42. Abdomen not heavily marked . . . . 13 *pallidior.*
Abdomen piceous with ill-defined yellowish bands . . . . 10 *obscurata.*
43. The pale color confined to clypeus and sides of face . . . 44
The pale color not confined to clypeus and sides of face . . 72
44. Abdomen dark, not banded, or the bands discontinuous . 45
Abdomen with continuous bands 63
45. Larger species, length over 6 mm. 46
Smaller species, 6 mm. or less 51
46. Mesothorax practically nude 47
Mesothorax hairy 49
47. Abdomen dark brown without pale marks . . . 56 *nuda* ♀
Abdomen with pale marks, clypeus pale with two black bars, 48
48. Abdominal markings yellow . . . . 11 *octomaculata* ♀
Abdominal markings creamy white . . . . 58 *senecionis.* ♀
49. Female; abdomen more or less spotted . . 68 *verbesinæ.*
Males 50
50. Head and thorax brassy-green . . . . . . 70 *lepachidis.*
Head and thorax rather bluish-green . . . 69 *albipennis.*
51. Abdomen without distinct light markings 51a
Abdomen with yellow or white markings 58
51a Pale face-marks reduced to a spot on clypeus; nervures brown . . . . 52 *phymatæ* var. ♀
Pale face-marks not so reduced, lateral marks present . . 52
52. Nervures brown, Californian species 53
Nervures pallid 54
53. Lateral face-marks with their upper angle a right angle. 3 *californica* ♂ var.
Lateral face-marks with their upper angle a very acute angle . . . . 31 *trisignata* ♀
54. Clypeus with two large dark patches on hind margin, upper angle of lateral face-marks a very acute angle, mesothorax very hairy . . . . 57 *asteris* ♀
Clypeus pale except the usual dots 55
55. Anterior tibiæ black in front; face extremely hairy . . . 65 *albovittata* ♂
Anterior tibiæ yellow or rufotestaceous in front 56
56. Marginal cell with the substigmatal portion very much longer than the poststigmatal, size very small . . . . . 17 *larrearum* ♀
Marginal cell ordinary 57

57. Larger ($4\frac{1}{2}$ mm.), face less hairy, lateral face-marks shaped like the main-sail of a schooner . . . . . . 66 *vagans* ♂
Smaller (4 mm.), face more hairy, lateral face-marks triangular . . . . 59 *vespertilio* ♂
58. Abdomen with 6 or 8 white marks 59
Abdomen with yellowish markings 60
59. Mesothorax shiny; clypeus dark with a light spot; face-markings white . . . . 42 *pectidis* ♀
Mesothorax dull; clypeus light with dark spots or bars; face-markings yellowish . . . . 51 *fallax* ♀
60. Face-markings white, 1st segment of abdomen largely blue, 5 *interrupta* ♂
Face-markings yellowish or yellow 61
61. Postscutellum yellow . . . . 7 *mexicanorum* ♂
Postscutellum not yellow 62
62. Nervures dark brown, lateral face-marks truncate above, clypeus light marked with dark, mesothorax dullish, abdominal marks very pale . . . . 25 *affinis* ♀
Nervures colorless, lateral face-marks pointed above, clypeus dark marked with light, mesothorax shining, abdominal marks yellower . . . . 10 *obscurata* ♀
63. Larger species, length over 6 mm. 64
Smaller species, 6 mm. or less 68
64. Males, abdominal bands narrow, inconspicuous, dull yellow, emarginate at sides 65
Females, bands conspicuous 66
65. Front comparatively shining, flagellum blackish . . . . . 69 var. *helianthi* ♂
Front dull, flagellum orange . . . . 68 *verbesinæ* ♂
66. Abdomen white with black bands, clypeus white with two black dots . . . . 64 *perpulchra* ♀
Abdomen dark with yellow bands 67
67. Nervures dark . . . . 67 *sparsa* ♀
Nervures colorless . . . . 69 *albipennis* ♀
68. Clypeus hairy, legs black, face-markings and abdominal bands white . . . . 65 *albovittata* ♀
Not so 69
69. Yellow at sides of face extending above level of insertion of antennæ: size very small . . . . 44 *austini* ♂
Yellow or whitish at sides of face only extending to level of insertion of antennæ; size not so small 70

70. Abdomen dark with light bands . . . . . . 48 *bigeloviæ* ♀
Abdomen light with dark bands 71
71. Mesothorax very shiny, dark blue-green . . . 47 *nitidella* ♀
Mesothorax dull, hairy, brassy-green . . . . . 28 *snowii* ♀
72. Dog-ear marks absent 73
Dog-ear marks present, or at least represented by dots . . 83
73. Abdomen with the last two segments bright rufous, the others white with black bands . . . . 19 *crotonis* ♀
Not so 74
74. Bands of abdomen at least mostly entire 75
Bands of abdomen all interrupted 80
Abdomen dark without bands 82
75. Stigma solid dark brown or black, clypeus with two broad black bars, lateral pale areas of face pinkish, 39 *numerata* ♀
Stigma hyaline, at least centrally 76
76. Anterior legs entirely yellow, mesothorax dull, sides of face broadly yellow up to level of antennæ, then for a short way suddenly very narrowly . . . . . 27 *rectangulata* ♀
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The black bands of abdomen more or less united on lateral margin, anterior tibiæ with a black mark behind 78
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Lateral triangle of face coming to a point above, but narrower than in *zonalis*, face-markings pallid; a greener species 79
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Supraclypeal mark narrower, or reduced to two spots . . 23 *zebrata* ♀
80. Female, flagellum only pale testaceous beneath . . . . . 25 *affinis* ♀ var.
Males 81
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Flagellum mostly yellow; species of Lower California . . . 67 *sparsa*.
82. Head large, quadrate, face very hairy . . . . 62 *laticeps* ♂

Head ordinary, face not so hairy . . . 57 *asteris* ♀ var.

83. Abdomen black or dark brown, without pale marks . . . 84
Abdomen not banded, but with yellow marks 86
Abdomen distinctly banded 87

84. Cheeks armed, head large, clypeus with a narrow median line and broad anterior border yellow, two yellow spots above clypeus . . . . 60 *grandiceps* ♂
Cheeks unarmed, clypeus all pale except the usual dots . . 85

85. Lateral corners of clypeus reaching base of mandibles, marginal cell shorter . . . . 3 *californica* ♂
Lateral corners of clypeus not reaching base of mandibles, marginal cell longer . . . . 61 *crassiceps* ♂

86. The yellow abdominal marks oblique, dog-ear marks represented by dots only . . . . 9 *nevadensis* ♀
The yellow abdominal marks small and straight . 46 *tarda* ♂

87. Males 88
Females 92

88. Cheeks armed . . . . 6 *ventralis*.
Cheeks unarmed 89

89. Mesothorax granular, abdominal bands without lateral bulgings on proximal margin, face-markings deep yellow, 22 *sphæralceæ* var.
Mesothorax smooth and shining 90

90. Middle and posterior femora yellow, without black patches, abdominal bands regular, though with sublateral bulgings on proximal margins, marginal cell longer, 30 *dubia* ♂
Middle and posterior femora with black spots or patches, marginal cell shorter 91

91. Supraclypeal mark very little broader than long, 23 *zebrata* ♂
Supraclypeal mark nearly twice as broad as long . . . . 24 *bakeræ* ♂

92. Nervures colorless; pale stripe along anterior orbits not extending to level of middle ocellus . . . . 40 *salicis*.
Nervures dark; pale stripe along anterior orbits extending to level of middle ocellus . . . . 36 *exclamans*.

Species of Texas and Mexico, with the mandibles bifid at tips, the head large, the stigma subobsolete, the abdomen broad, rufous in the ♂, black or piceous in the ♀.

1. Perdita texana (Cr.) Cr., Cat. Hym., 1887, p. 296.

♀ *Macrotera texana* Cr., Tr. Am. Ent. Soc., 1878, p. 70. (Hab., Texas).
♂ *Macrotera megacephala* Cr., l. c., p. 71. (Hab., Texas).

This species was discovered by Mr. L. Heiligbrodt, who took three of each sex. I know of no other specimens, and nothing is known of the exact locality or habits. The dark chocolate-brown head and black thorax at once separate this species from *P. latior.* In both species the marginal cell is obliquely truncate.

2. **Perdita latior** n. sp. Fig. 6, (part of wing).

♂ ♀, length 5½–6 mm., broad, head large, broader than long; head, thorax, legs and tip of abdomen with pubescence consisting of dull white erect hairs; punctuation of vertex, mesothorax and scutellum very fine and close; upper surface of metathorax bare, shining, minutely granular; dorsum of abdomen very minutely punctured, the punctures on first segment very sparse. Tegulæ pale testaceous; wings hyaline, nervures pale brown, stigma little developed, 3d discoidal present, marginal about as long as 1st submarginal, 2d submarginal narrowed more than half to marginal.

FIG. 6.

♂.—Clypeus prominent, with a minute tooth on each side. Head and thorax dark green, metathorax strongly tinged bluish. Mandibles except their dark tips, clypeus, lower corner of face, and a broad transverse band between antennæ, dull testaceous. The punctuation, which is close before the ocelli, becomes sparse behind them. Antennæ dull testaceous, more or less suffused with blackish. Legs dark piceous, the front of the anterior tibiæ and all the tibial spurs, dull testaceous. Abdomen shining, ferruginous; first segment more or less suffused with blackish.

♀.—Head and thorax dark green, face almost black, dorsum of mesothorax and scutellum purplish, dorsum of metathorax bluish.

Antennæ dark brown, the last 7 joints of flagellum beneath becoming dull testaceous or ferruginous. Mandibles yellowish-ferruginous, dark at tips. Legs colored as in ♂. Abdomen brown-black, the margins of the segments subtestaceous.

Hab.—Las Cruces, N. M., middle of August, 1895, on flowers of *Sphæralcea angustifolia,* 3 ♂, 3 ♀. (Ckll., 4,806, 4,809, 4,814, etc.) It was associated with *Diadasia* and *Halictus.*

Obs.. P. arcuata Fox, the description of which reads rather like *latior,* is of a different group, viz. that of *californica,* etc.

Species of California and Mexico, with the clypeus in the ♂ narrowly produced at the sides to the bases of the mandibles, resembling in shape a panama hat.

3. **Perdita californica** (Cr.) Cr., Cat. Hym., 1887, p. 296.

♂ *Macrotera californica* Cr., Tr. Am. Ent. Soc., 1878, p. 71. (Hab., California).

Three specimens are known, collected by Edwards and Crotch.

Nothing is known of exact locality or habits. The following notes were made from one of the types.

Clypeus panama-hat-shaped, as in *interrupta*. Cheeks unarmed. Dog-ear marks distinct, but supraclypeal mark wanting. Head quite large. Mandibles simple.

The lateral face-marks have their upper angle a right angle, and are so placed as to be exactly level with top of clypeus, the dog-ear marks projecting a little above the same level.

The mesothorax is tolerably shiny, but quite closely and strongly punctured. The stigma and veins are brown, not very dark; marginal long, obliquely truncate, appendiculate, poststigmatal portion considerably longer than substigmatal. Stigma small. 2d submarginal large, narrowed fully one-half to marginal. 3d discoidal distinct but rather weak.

The following tables separate *californica* from two species presenting a certain superficial resemblance to it.

A. (1). Upper margin of face-marks forming nearly a straight line. Head larger. Marginal cell appendiculate. Margins of abdominal segments very distinctly reddish-testaceous, =*californica* ♂.

(2). Upper margin of face-marks forming a broad W. Head smaller. Marginal cell not appendiculate. Margins of abdominal segments not reddish-testaceous, =*asteris* ♀.

B. (1). Larger. Supraclypeal mark absent. Lateral face-marks not reaching level of insertion of antennæ. Clypeus shaped like a panama hat, ... =*californica* ♂.

(2). Smaller. Supraclypeal mark present. Lateral face-marks going above level of insertion of antennæ. Clypeus shaped like a rather low cork helmet, . . =*tarda* ♂.

4. **Perdita arcuata** Fox, Proc. Cala. Acad., 1893, p. 18. ♂ (Hab., Calmalli Mines, L. Cala., in April).

Two specimens known, found by Mr. Haines. From one of these I noted as follows: Mandibles simple; cheeks unarmed. Differs from *semicærulea*, *phymatæ* and *latior* in having margins of abdominal segments broadly rufotestaceous, exactly as in *californica*. In the shape of the head, and general structure, it precisely agrees with *californica*; but differs from that by its entirely dark face, the labrum and the base of the mandibles only being yellowish. The vertex is well punctate, and it and the mesthorax are quite dull.

5. Perdita interrupta Cr., Tr. Am. Ent. Soc., 1878, p. 70. ♂ (Hab.. California).

Three specimens were found by Crotch; we have no information as to exact locality or habits. From one of the types I noted the following:

Cheeks unarmed, quite densely (for a *Perdita*) white pubescent. Face more hairy than usual. Clypeus with two black dots. Lateral pale patches of face forming nearly right-angled triangles, the upper angle being the right angle. Mesothorax granular, dull. Wings distinctly smoky, nervures dark brown. Marginal rather long, substigmatal portion equal to poststigmatal. Second submarginal narrowed about or hardly one-half to marginal. Third discoidal distinct. First segment of abdomen, except its distal margin, blue, granular, in strong contrast with the piceous remaining segments. *P. fallax,* which presents a certain superficial resemblance to *interrupta,* differs as follows:

(1). Its clypeus is shaped like a felt hat, not like a panama hat as in *interrupta.*

(2). The upper angle of lateral face-marks is a very acute angle.

(3). The poststigmatal portion of marginal cell is distinctly longer than the substigmatal.

(4). The head and thorax are green, whereas they are blue in *interrupta.*

6. Perdita ventralis Fox, Proc. Cala. Acad., 1893, p. 17. ♂ (as ♀ ex. err.): Proc. Cala. Acad., 1894, p. 116 ♀.

The original types, three specimens, were found by Mr. Haines on Margarita Island, L. Cala., in March. Later, the same collector obtained numerous examples including females, on Magdalena Island, also in March. These islands are close together, a little south of the 25th parallel of latitude.

The ♂ has the cheeks armed, and the clypeus panama-hat shaped. In the ♀ the cheeks are unarmed, and the clypeus differently shaped. In the ♂ the mandibles are very slender, pointed; in the ♀ stout, notched within. In view of these differences, it is at first hard to believe that they are sexes of one species, for all that they agree in the abdomen with its suffused banding, in the mesothorax, etc.

P. ventralis is smaller than *mentzeliæ* and *pallidior,* and differs by the suffused banding of abdomen. *P. mentzeliæ* and *pallidior* have the mesothorax microscopically tessellate, with distinct sparse punctures; *ventralis* has it very shiny, smooth, hairless except the anterior third, which is sparsely hairy and punctured. The thorax shines distinctly blue in *ventralis* ♂, but in the ♀ it hardly goes off a pure black. The ♂ resembles *californica* in its face-markings, but is so much smaller, and the dog-ear marks are much more prominent. The vertex is minutely roughened in the same way in ♂ and ♀.

The face in the ♀ is all dark, not so in the ♂. The ♂ has the lateral face-marks much broader than long, the dog-ear marks well-developed, but the supraclypeal mark represented only by a dot adjacent to each dog-ear mark.

It is to be regretted that *ventralis* is the only undoubted member of the *californica* group of which we know the ♀. The sexual differences in *Perdita* are very unequal in the different species, whether occurring as face-markings or as structural characters. In the undoubted sexes of *P. verbesinæ*, the clypeal differences are not so great as in *ventralis*, but the difference in the mandibles is actually much greater.

7. **Perdita mexicanorum** n. sp.

♂.—Length about 5½ mm. Head and thorax dark blue. Head rather large, cheeks unarmed, clypeus panama-hat shaped, glossa very long and unusually hairy. Cheeks and face very sparsely hairy with short hairs. Vertex strongly granular, and with rather close but shallow punctures. Antennæ entirely sepia-brown, the same color above as below. Mandibles yellowish, subtestaceous, dark at tips, simple, not particularly slender. Face-markings sulphur-yellow; clypeus yellow with the usual two black dots very small and near the edge, and its proximal margin (the crown of the panama-hat) broadly dark, the edge of the yellow somewhat irregular and medially emarginate. Supraclypeal and dog-ear marks absent. Sides of face with large squarish yellowish patches, their upper margins truncate and rather irregular, about level with the top of the clypeus. Inwardly, these patches do not join the clypeal margin, but leave a thin wedge of dark color between.

Thorax dark blue, the mesothorax slightly inclined to greenish. Prothorax and tubercles entirely dark; postscutellum sulphur-yellow. Mesothorax moderately shining, but distinctly granular and punctuate, median groove distinct. Metathorax shining but very distinctly granular.

Tegulæ testaceous; wings slightly smoky, nervures and stigma dull brownish-ochreous, stigma not centrally hyaline. Marginal cell rather long, very distinctly appendiculate, poststigmatal portion a little longer than substigmatal. Second submarginal rather large, narrowed hardly one-half to marginal, the narrowing more proximal than distal. Third discoidal distinct. Cubital and subdiscoidal nervures produced almost to wing-margin.

Legs sepia-brown; anterior tibiæ in front, and a stripe on middle tibiæ, yellow.

Abdomen shining, sepia-brown, darker toward the apex; venter nearly the same. There are well-defined yellow marks at sides of segments 2–5, partly passing over to the venter.

Hab.—Mexico, one example sent by Mr. Fox. Unhappily we know nothing of the exact locality or habits of this interesting species. It is the only *Perdita* I know with a yellow postscutellum.

Two species from Nevada, known only in the ♀; exact locality and habits unknown.

8. **Perdita zonalis** Cr., Tr. Am. Ent. Soc., 1879, p. 202. ♀ (Hab., Nevada).

Ten specimens were collected by Morrison. From one of these I have noted as follows:

Clypeus low cork-helmet type, reaching base of mandibles. Mesothorax excessively shiny, dark brassy-green, very sparsely but distinctly punctured. Face markings pale yellow. Upper margin of clypeus medially truncate, not rounded. Clypeus all yellow except two dark dots. Supraclypeal patch well-developed, broad, but not twice as broad as long. No dog-ear marks. Sockets of antennæ narrowly ringed with yellow. Lateral face marks triangular, rather broad, coming to a point at level of insertion of antennæ. Upper margin of face marks not forming a W but V V. Stigma and nervures pale testaceous, stigma large, marginal cell with poststigmatal portion longer than substigmatal. Second submarginal large, narrowed one-half to marginal. Third discoidal distinct.

Abdomen above yellow with four black bands, and a black mark on each side of first segment. The abdomen is peculiar for the black bands being very distinct, neither notched nor interrupted in the middle, and narrower than the yellow between them.

From *zebrata* and *bakeræ* it may be known by the black bands of abdomen not being united on lateral margin, the anterior tibiæ all yellow, the lateral triangle of face broader and the face markings lemon-yellow. From *salicis* ♀ it is distinguished at once by the very much broader lateral face-marks.

9. Perdita nevadensis n. sp.

♀.—Length almost 6 mm. Head so dark green as to seem black; thorax pitch black, with the metathorax green. In certain lights the prothorax and anterior part of the mesothorax present a greenish lustre. Head moderately large, broader than long, depressed on vertex; clypeus shaped like a rather low cocked-hat, flattened at the top, the teeth of anterior margin dark and rather long. Vertex dull, rugulose. Face and cheeks with sparse inconspicuous hairs. Antennæ dark brown; the flagellum paler, inclining to yellow beneath. Face-markings pale dull yellowish; clypeus pale with two broad divergent black bars and a black dot distad of each, supraclypeal mark represented by two round or suboval spots; dog-ear marks represented by obscure small spots, not alike on both sides; lateral pale patches triangular, the upper angle an acute one and level with the insertion of the antennæ, the shortest side of the triangle at least two-thirds the length of the longest. Mesothorax shiny, hardly granular, sparsely hairy and punctate. Thorax all dark, except the tubercles, which are pale yellow. Metathorax granular.

Tegulæ pale testaceous. Wings hyaline, faintly smoky, nervures and stigma pale brown, stigma centrally subhyaline. Marginal cell moderately long, obliquely truncate, poststigmatal portion a very little longer than substigmatal. Second submarginal large, narrowed on its distal side one-half to marginal. Third discoidal distinct. Legs dark brown, anterior knees, anterior tibiæ in front and stripe on middle tibiæ, yellow.

Abdomen rather broad, above and below piceous, segments 2–4 above with distinct oblique lateral yellow marks. The mark on the 2d segment is on one side broken into two.

Hab.—Nevada, one specimen sent by Mr. Fox.

The following tables will separate *nevadensis* from some species which it superficially resembles.

A. (1). Lateral marks of face triangular, terminating in a point, =*nevadensis* ♀.

(2). Lateral marks of face truncate at end and notched within, =*affinis* ♀.

B. (1). Face-markings whitish, lateral marks narrower, abdominal marks white, ... =*fallax* ♀.

(2). Face-markings yellow, lateral marks broader, abdominal marks yellow, ... =*nevadensis* ♀.

C. (1). Larger, clypeus higher, supraclypeal mark absent, lateral marks notched within, . . . *octomaculata* ♀.

(2). Smaller, clypeus lower, supraclypeal mark present, lateral marks not notched within, . . =*nevadensis* ♀.

Species found east of the 95th meridian.

10. Perdita obscurata Cr., Tr. Am. Ent. Soc., 1878, p. 70. ♂ ♀ (Hab., Georgia).

One male and one female were found by Morrison. I have made the following description from the female; the student will observe that in some points it disagrees with that of Cresson, notwithstanding that it is from the same specimen.

♀.—Head and thorax dark bluish-green. Clypeus broad, not much attenuate at sides, reaching base of mandibles. Face-markings pale yellow, lateral marks very narrow, inversely club-shaped, reaching as far as level of insertion of antennæ. Clypeus without marks, except a very distinct central one, shaped like an inverted egg-cup with the egg in it, the base at posterior clypeal border, the apex not reaching anterior border of clypeus. Mandibles except tips pale yellow. Mesothorax shiny. Tubercles rather pale brownish. Hind margin of prothorax with two small yellow spots. Wings hyaline, stigma very large, pale yellowish, veins colorless. Marginal cell with the substigmatal portion a little longer than the post-stigmatal. First submarginal very long, longer than marginal. Second submarginal short, suboval and high, narrowed about one-half to marginal. On one side there is a small petiolate submarginal cell between normal 1st and 2d submarginals, it receives the first recurrent nervure, and is approximately an equilateral triangle. Third discoidal distinct. The broadly interrupted narrow fasciæ on abdomen are not obscure or suffused, but clean-cut and distinct. It differs from the ♀ of *affinis* by the lateral face-marks being pointed above, the clypeus dark marked with light, the mesothorax shiny, the nervures colorless, and the abdominal marks yellowish.

The ♂ I have not seen; Mr. Fox has kindly sent me a sketch of the face-markings, showing the face entirely yellow below the level of the antennæ, the yellow not extending upward at all in the median line, but obliquely extending upward at the sides from the antennal socket to the orbital margin, where it ends at an angle of about 50°. The cheeks, Mr. Fox informs me, are not armed.

Mr. Charles Robertson tells me that at Orlando, Florida, on March 16th, he captured a ♂ *obscurata* on flowers of *Hydrocotyle umbellata.*

11. Perdita octomaculata (Say). Cr., Cat. Apidæ, 1879, p. 216.

Panurgus 8-maculatus Say, Long's 2d. Exped., ii, p. 350, 1824. ♂ ♀ (Hab., U. S.).

I have a ♀ from New York State, sent by Dr. Skinner, and a ♂ from southern Illinois, sent by Mr. Roberston. Mr. Fox informs me that he has seen specimens from the White Mts., N. H., collected by Mrs. Slosson, New York, New Jersey and Virginia. He has taken it in southern New Jersey, but sparingly. Prof. J. B. Smith reports it from Westville, N. J., on Cresson's authority. Of its habits, nothing has been recorded, but Mr. C. Robertson informs me that he has taken it from Aug. 13th to Sept. 20th, on flowers of *Solidago canadensis, Coreopsis aristosa* and *Aster ericoides* var. *villosus*.

Three allied species found on Mentzelia in New Mexico.

12. Perdita mentzeliæ n. sp.

♂.—About 5½ mm. long. Head rather large, quadrate, broader than thorax, mandibles simple, cheeks beneath with a prominent tooth, lower margin of clypeus nearly straight; vertex finely rugulose, with sparse feeble punctures between the ocelli and the antennæ; eyes narrow. Color very dark blue-green, with the whole of the face beneath the antennæ, and the lower half of the cheeks, including the spines, orange-yellow. On each side of the face the yellow extends upward, narrowing to a point on the orbital margin about two-thirds the length of the scape above the level of the insertion of the antennæ. Mandibles yellow with ferruginous tips. Antennæ yellow, becoming deep orange toward their tips; the flagellum slightly marked with blackish above.

Thorax shiny, very dark blue-green, becoming black on the scutellum and hind part of mesothorax, metathorax tinged with blue. Collar, tubercles, under side and part of hind border of prothorax orange-yellow. Mesothorax with only a few scattered indistinct punctures. Metathorax minutely granular. Pleura, anterior border of mesothorax and sides of metathorax with scattered white hairs.

Tegulæ hyaline; wings hyaline, nervures very pale yellowish. Marginal cell about or hardly as long as stigma. Second submarginal not narrowed one-half to marginal. Third discoidal hardly perceptible.

Legs orange; posterior femora with a brown patch behind; posterior tibiæ and tarsi mostly brown. Abdomen orange-yellow, first segment almost all black, segments 2, 3 and 4 with broad suffused black bands. Venter orange, immaculate. Quite as often, perhaps more frequently, the abdomen is shining black above, except the terminal segment which is testaceous, and the more or less obviously testaceous distal margins of the other segments.

♀.—Somewhat larger; head rounder, not broader than thorax. Punctures of mesothorax distinct but scattered. The pale markings all yellowish-white instead of yellow. Face dark, clypeus black contrasting with the green upper part of face. An irregularly triangular yellowish-white patch on each lower corner of face between clypeus and orbit. Coxæ black, their ends whitish. Femora black, their tips whitish. Tibiæ whitish, middle and hind tibiæ largely suffused with black. Dorsum of abdomen with the black nearly covering the segments, leaving transverse white areas or bands, not continued to lateral margin, on segments 2–4. Venter whitish, not banded.

Hab.—Santa Fé, N. M., close to the Denver & Rio Grande depot, at flowers of *Menzelia nuda*, Aug. 3, 1895, many specimens. They were associated with *Bombus* (abundant) and *Andrena* (rare).

13. Perdita pallidior n. sp.

♂.—Resembles the ♂ of *mentzeliæ*, but differs in the cheeks being unarmed beneath, in the smaller head, the second submarginal cell more narrowed above, the legs entirely yellow, the abdomen above orange-yellow, with the first segment nearly all dark brown or black, and a dark brown band on segments 2 and 3, that on 3d failing some distance before the lateral margin.

♀.—Resembles the ♀ of *mentzeliæ*, but differs in the legs being all yellowish-white, except a dusky shade on inside of anterior femora, and outside of middle and posterior tibiæ. The white subtriangular marks on sides of face are rather more produced upward along the orbital margin. The abdomen above is yellowish-white, the first segment with a broad brown-black ring, the second and third segments with dark bands, the fourth segment with a pair of dark spots, suffused in outline.

Hab.—Albuquerque, N. M., close to Prof. Hadley's house, abundant on flowers of *Mentzelia nuda*, Aug. 15, 1895. A single ♀ was also swept from *Gutierrezia sarothræ* (det. E. O. Wooton) at the same time and place. No other bees were then found upon the *Mentzelia*, except *Perdita pulchrior*. On the *Gutierrezia* were found also *Perdita gutierreziæ* and *P. austini*, one each.

14. Perdita pulchrior n. sp. Fig. 7, (part of wing).

♂.—Resembles the ♂ of *pallidior*, but rather larger and stoutly built, with the cheeks armed below with a prominent spine. Head large and subquadrate. Second submarginal not so much narrowed above. Legs entirely yellow. Abdomen above shiny pale orange-yellow, the first segment mostly black, second with a pair of dark spots; no dark bands. The second segment may have its lateral margins also dark, and the third segment may show spots.

FIG. 7.

Hab.—Albuquerque, N. M., on *Mentzelia nuda*, same time and place as *pallidior*, two males (Ckll., 4,537, 4,538). On Sept. 12th, I was surprised to take another example, also a male, on *Bigelovia wrightii* close to the Agricultural College, Las Cruces, N. M. This species may possibly represent a dimorphic ♂ of *pallidior*; the ♀ is either unknown, or not to be separated from those presumably referable to *pallidior*.

Four species found on Larrea in New Mexico.

15. Perdita larreæ n. sp. Fig. 8. (stigma etc).

♂.—Hardly 4 mm. long, bright orange-yellow, smooth and shiny; pubescence consisting of sparse white hairs on vertex, cheeks beneath, mesothorax, pleura, tibiæ, tarsi, apex and venter of abdomen. Head very large, considerably larger than the small thorax, subquadrate; clypeus produced into a spine at each lower corner, cheeks with a stout spine beneath, eyes rather small and narrow.

FIG. 8.

Wings small, hyaline, nervures white, stigma hyaline in middle.

Marginal cell narrow but hardly produced beyond stigma, not quite as long as first submarginal, appendiculate. Second submarginal very small, triangular, coming to a point at its junction with marginal. First recurrent joining, first transverse cubital. Third discoidal cell wanting.

The mandibles are elongate, simple, dark at tips. The ocelli are more or less dark, with some dark marbling about them. Tongue about as long as head.

Hab.—San Marcial, N. M., close to Mr. Shope's house, at flowers of *Larrea divaricata* var. *tridentata*, June 28, 1895. Five specimens.

16. Perdita marcialis n. sp.

♂.—Size and form of *P. larreæ*. Anterior margin of clypeus not so broad, with the spines longer and parallel; whereas in *larreæ* they are divergent. Wings as in *larreæ*, but the marginal cell rather more produced beyond stigma. A keel between antennæ, giving place to a groove running upward to middle ocellus. Color deep orange, with dark markings. A black spot before the upper part of each anterior orbital margin; a large green-metallic patch on vertex, enclosing the two posterior ocelli, but just escaping the anterior one or only partly enclosing it; mesothorax shiny metallic olive-green, except rather broad yellow lateral margins; dorsum of metathorax dark green; a large round dark patch on sides of thorax beneath. Abdomen above more or less suffused with brown, which is dark at base of first and apex of second segments, and becomes reddish on last two segments. Hind legs tinged with brown. Mandibles simple as in *larreæ*.

Hab.—San Marcial, N. M., on *Larrea* at the same time and place as *P. larreæ*. One specimen.

17. Perdita larrearum n. sp.

♀.—4 mm. long. Head dark brassy-green, thorax black, pleura and metathorax bluish, abdomen dark sepia-brown. Head rounded, rather large, vertex conspicuously roughened, cheeks and occiput with a rather dense fringe of white hairs, clypeus and sides of face very narrowly pale yellowish-ferruginous, the pale color continuing along orbital margin some distance above level of antennæ, but so thin that its termination is diffiult to trace.

Antennæ blackish above, yellowish beneath.

Tubercles and hind border of prothorax narrowly, yellowish. Anterior portion of mesothorax curiously ornamented with appressed pure white hairs. Mesothorax appearing granular, microscopically reticulate, with very sparse shallow punctures.

Legs brown, anterior tibiæ and tarsi dull yellow. Tegulæ yellowish-hyaline. Wings hyaline, nervures white or colorless. Marginal cell with its substigmatal portion fully twice as long as the post-stigmatal. Second submarginal triangular, bulging without, narrowing to a point at marginal. Third discoidal distinct.

Abdomen above sepia-brown, the proximal ends of the first two segments slightly yellowish. Venter dull brownish-yellow.

Hab.—San Marcial, N. M., on *Larrea* at the same time and place as *P. larreæ*. Three specimens.

There are three possibilities regarding the last three species:

(1). That they are three distinct species.

(2). That the males represent two valid species, and *larrearum* the ♀ of one of them.

(3). That there is only one species, *larreæ*, *marcialis* being the dimorphic ♂ and *larrearum* the normal ♀ of the same.

While I incline to one of the latter suppositions, the difference between the three forms is very great, so that in the absence of further evidence they must be provisionally regarded as species.

18. Perdita semicærulea n. sp.

♀.—Length 6 mm. Unusually hairy, the pubescence erect and white. Head of ordinary size, dark greenish-blue, bluer at sides of face, more brassy-green between antennæ. Vertex finely rugulose, punctured. Clypeus high, pitch-black, smooth with large moderately close punctures. The only face-markings consist of a shining, hairless, bright sulphur-yellow oval patch on each side of the clypeus, separated from the eye margin by a distance at least equal to its own diameter.

Antennæ dark-brown, scape black, last joint of flagellum becoming pale. The antennæ are rather conspicuously enlarged toward their ends.

Mesothorax and scutellum smooth and shining, but with deep, large and rather close punctures. Thorax all black, except the metathorax which is blue. Pleura with quite long white hairs.

Tegulæ hyaline. Wings milky-hyaline, stigma very pale yellow, hyaline in middle, nervures colorless, costal nervure black. Marginal cell rather short, appendiculate, poststigmatal portion hardly longer than substigmatal. Second submarginal large, narrowed about one-half to marginal. Third discoidal distinct.

Legs brown-black, a little yellow on anterior tibiæ and knees.

Abdomen shining, brown-black above and beneath. Sides of first segment, and in a less degree those of the others, with tufts of white hairs. Dorsum of last three segments more or less hairy, that of the last one considerably so.

Hab.—San Marcial, N. M., on *Larrea*, at the same time and place as *P. larreæ*. One specimen. (Ckll., 3,077). This species is easily recognized by the dark clypeus, with a shining, smooth, yellow spot on each side of it. It is not nearly related to *P. larreæ*, but rather to *P. phymatæ*, which, however, has not the yellow spots.

A species with the end of the abdomen rufous, found on Croton.

19. Perdita crotonis n. sp.

♀.—About 5 mm. long. Head rather broad, shining, dark blue or greenish-blue; clypeus except two black dots, a transversely elongate mark adjacent to hind border of clypeus, narrowing medially, and a triangular patch on each side of face, not quite reaching to level of insertion of antennæ, white. Mandibles white with rufous tips. Cheeks rather densely white-hairy. Antennæ with the scape black above, white beneath; funicle and flagellum black or very dark brown, last joint of latter pale at tip. Thorax shiny, rather densely pubescent for a *Perdita*, mesothorax very dark bottle-green, median groove very distinct. Tubercles and posterior median border of prothorax white. Tegulæ brownish, with a white spot on anterior half. Scutellum quite brassy-green. Metathorax dark blue, distinctly rugulose. Pleura smooth, dark blue.

Legs white; with the femora except ends, most of hind coxæ, a patch behind each of the four anterior tibiæ, the hind tibiæ except basal third, and the hind tarsi, black. Wings hyaline, nervures fuscous, stigma margined with fuscous. Marginal cell with the post-stigmatal portion about or hardly as long as the substigmatal; second submarginal narrowed about one-half to marginal; third discoidal distinct.

Abdomen above and below with the last two segments entirely rufous, without markings. Segments 1–3 above white, with black bands at proximal and distal margins of segments, those on proximal margins of segments 2 and 3 very narrow, and that on distal margin of 3d represented only by a line of mottling. (Ckll., 3,262, etc.)

Mut. ♀.—Clypeus with two longitudinal black lines or bands in addition to the marks above described. (Ckll., 3,259).

♂.—The whole of the face beneath the level of the antennæ white, except the two black dots on clypeus. Along the orbits the white is further produced a short distance, rapidly narrowing to a point. Second submarginal narrowed distinctly more than half to marginal. Last three segments of abdomen rufous. Cheeks unarmed. (Ckll., 3,261).

Hab.—Albuquerque, N. M., June 30, 1895, in numbers at flowers of *Croton texensis*. In August, Miss Myrtle Boyle found a single specimen at La Tenaja, near Santa Fé. I looked for it at Santa Fé, but failed to find it, though the *Croton* is abundant.

A small species with orange or orange-rufous abdomen found on Chamæsaracha.

20. Perdita chamæsarachæ n. sp.

♂.—$3\frac{1}{2}$ mm. long. Head and thorax shining dark blue, abdomen brownish-orange. Vertex granular. Head rounded. Face below antennæ yellowish-white, the upper border of the pale color coincident with the lower level of the insertion of the antennæ, except that on each side of the dog-ear plate there is a notch formed by an incursion of the dark color. Clypeus with a small black spot on each side. Mandibles rufous at tips. Antennæ dark above, below dirty yellowish, the scape whiter. Sides of face with appressed white hairs. Cheeks unarmed, rather densely clothed beneath with erect white hairs. Sides of metathorax, and postscutellum, with similar hairs. Tubercles yellowish-white, tegulæ hyaline. Wings hyaline, nervures very pale straw-yellow, third discoidal very weak, second submarginal narrowing about one-half to marginal. Legs pale yellow, a dark patch on anterior femora, and middle and posterior femora and tibiæ largely dark. Abdomen above bandless, first segment dark at base. Venter entirely orange. (Ckll., 4,568, etc.).

♀.—Closely similar, but the dog-ear marks and pale mark above clypeus wanting, i. e., the pale color on face is confined to the clypeus and triangular marks at sides of face. (Ckll., 4,573).

Hab.—Albuquerque, N. M., in the old town at flowers of *Chamæsaracha coronopus*, Aug. 16, 1895, abundant. Also at Santa Fé, in the capitol grounds, on flowers of *C. coronopus*, Aug. 2, 1895, two specimens. At Santa Fé it was associated on the flowers with *Halictus* ♂ and *Colletes*. This species resembles *P. semicrocea*, but that has the face dark in the ♀.

A species from the transition zone in New Mexico, habits unknown.

21. Perdita foxi Ckll. Proc. Phila. Acad., 1895, p. 18. ♂ (Hab., Santa Fé, N. M.)

The unique type, taken on June 25th, is only known. The species may be known by its orange-rufous legs, and black unbanded abdomen.

A species found on Sphæralcea, very different in the sexes, ranging in modified form over 3,200 feet altitude.

22. Perdita sphæralceæ n. sp.

♀.—Length 7½ mm. Head and thorax dark greenish, abdomen black with three light bands. Head rather small, rounded, somewhat broader than long, vertex and occiput dark olive-green, granular; a shining brassy prominence between the antennæ; clypeus black, shining, sparsely punctured toward the sides. No pale marks on face, except a small yellow spot on extreme lower corner. Mandibles brownish, ferruginous at apex, sharply and squarely notched on inner side near end, but not actually bifid. Cheeks quite densely hairy. Antennæ dark brown, almost black above.

Tubercles, and hind border of prothorax more or less, very pale yellowish. Mesothorax bulging in front, not very shiny, dark brassy, hardly green, quite pubescent with erect whitish hairs. Sides of metathorax with tufts of hairs, but postscutellum not conspicuously hairy.

Tegulæ hyaline. Wings hyaline, nervures very pale yellowish, almost colorless, stigma margined with brown. Marginal cell rather long, poststigmatal portion distinctly longer than substigmatal. First submarginal not nearly so large as first discoidal. Second submarginal large, narrowing hardly one-half to marginal. Third discoidal quite distinct.

Legs black ; anterior knees, anterior tibiæ in front, middle tibiæ at tip behind, dull yellow. Abdomen rather narrow, black ; second, third and fourth segments at base with a broad pale yellowish band, slightly notched in middle behind. Venter dark brown. The abdominal bands have a slightly greenish tint, so that when the insect is alive on the flowers it rather suggests a miniature *Nomia* similar to *N. punctata*.

♂.—Length 6 mm. Cheeks unarmed. Light markings all deep saffron-yellow, instead of pale greenish-yellow. Mandibles simple, yellow with ferruginous tips. Face beneath antennæ all yellow, except two black dots on clypeus, the yellow moreover extending upward at sides of face, coming to a point at an angle of about 50°, not quite so far up as the length of the scape above level of insertion of antennæ. Antennæ yellow ; funicle, flagellum and end of scape above, dark brown.

Yellow hind margin of prothorax connecting with yellow tubercles. Legs yellow ; part of middle coxæ, posterior coxæ except ends and a spot behind, a large patch on anterior and middle femora behind, a patch on both sides of hind femora, a large patch on middle tibiæ, and outer side of hind tibiæ and tarsi, black. Pleura with a round yellow patch, not very conspicuous, in front.

Abdomen above shining, dark brown, with rather broad yellow bands at proximal margins of segments 2–5, that on 4 narrowest, that on 5 broadest, and notched behind medially. Sixth segment dull rufous with a brown rather suffused band. Venter dull orange.

Hab.—Las Cruces, N. M., common at flowers of *Sphæralcea angustifolia*, middle of August to middle of September, 1895.

P. sphæralceæ, race **alticola.**

♀.—Nervures dark brown. A light spot on each side of 5th abdominal segment. (Ckll., 3,850). The spots on 5th segment may be absent as in the type.

♂.—Nervures dark, as in the ♀. The dog-ear marks have more or less of a dark border below.

Mut. SUFFUSA. ♂.—Abdomen above suffused with brown, only the yellow bands on segments 2 and 3 remaining. Dog-ear marks reduced, their lower half often wanting.

Mut. ♀.—Only 6 mm. long. Abdominal bands narrow, that on segment 5th present though interrupted in the middle. (Ckll., 3,849). This may be the proper ♀ of mut. *suffusa.*

Hab.—Santa Fé, N. M., common at flowers of *Sphæralcea angustifolia;* the males much more frequent than the females. The species was first taken in Mr. Boyle's garden on July 25, 1895; 2 normal ♂ *alticola*, 2 ♂ *suffusa.* On July 27th were taken several males, about equally divided between *alticola* proper and *suffusa*, and also two females. The latest date I have is Aug. 8th, a ♀ taken by Miss Myrtle Boyle. The ♂ differs from *zebrata* ♂ by its very dark (not bluish) thorax, much yellower light markings, darker stigma, and rather differently shaped face-markings.

A species found on Cleome serrulata (C. integrifolia).

23. Perdita zebrata Cr., Tr. Am. Ent. Soc., 1878, p. 69. ♀ (Hab., Colorado).

♂ *Perdita canina* Ckll., Proc. Phila. Acad., 1895, p. 17. (Hab., Santa Fé, N. M.). Figs. 9, 10, (face-marks and ♂ genitalia).

Originally described from seven specimens taken by Ridings and Morrison. The ♂ was not known until described by me as *canina.* My No. 1,270 (l. c., p. 18) proves to have been the true ♀, and is identical with at least some of Cresson's types of *zebrata*, though it is possible that under this name more than one species was included. The matter is complicated from the variability of ♀ *zebrata* on the one hand, and the discovery of *P. bakeræ* on the other, the latter species being easily distinguished in the ♂, but only with extreme difficulty in the ♀.

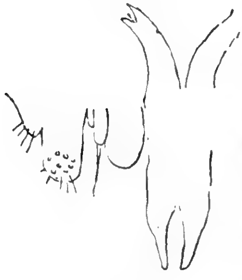

FIG. 10.

FIG. 9.

Mr. Fox has sent me a ♀ of *zebrata* from the Magdalena Mts., N. M., Aug., 1894, collected by Snow. Mr. C. F. Baker sends it from Fort Collins, Colorado, where it was collected in August; this is the most northern locality known for it. The most southern locality is Alma, Socorro Co., N. M., where it was found by Mr. Alfred Holt. I have myself collected it as follows:

(1). Albuquerque, June 30th and Aug. 16, 1895. (2). Lamy, N. M., July 2d and July 13th. (3). Santa Fé, N. M., July 5th to Aug. 3d. (4). Watrous, N. M., July 13th. (5). Las Vegas, N. M., July. (6). La Junta, Colo., July.

Everywhere it is found in great abundance on flowers of *Cleome serrulata,* and on nothing else; whereas the closely allied *P. bakeræ* is found on *Solidago.* On July 12th, at Santa Fé, I saw them settle on the stamens of the *Cleome,* climb to the top, and collect the pollen. At Watrous I saw one inserting its tongue in the base of the flower, running down the inner surface of the petals.

In the ♂s the face-markings are very constant, but frequently the light bands of the abdomen will be interrupted on segments 3 and 4. The ♀s vary much in the clypeal marks, from no marks on the clypeus but the usual pair of dots, to two black bars or even an almost wholly black clypeus. These variations do not seem to have any reference to the environment.

Mr. Fox has examined for me all Cresson's type specimens of *zebrata* (♀) and reports that they have the supraclypeal spot notched above, except one, which has it divided in two. This last was the one Cresson actually had in hand when describing, as may be seen from his description. The clypeus in four specimens is bi-spotted with black, in one entirely yellow.

A species very like P. zebrata, found on Solidago in Colorado.

24. Perdita bakeræ n. sp. or race. Figs. 11, 12, (head and ♂ genitalia).

♂.—Like the ♂ of *P. zebrata,* but seems to average smaller, the pale bands of the abdomen are small and interrupted, at least on the third and fourth segments, and the supraclypeal mark is nearly twice as broad as long. Sometimes the abdominal bands are entire, but the supraclypeal mark still affords a distinguishing character.

♀.—Seems to differ only from ♀ *zebrata* in its broader supra-clypeal mark, notched in the middle.

Hab.—Fort Collins, Colorado, 12 ♂, 3 ♀, sent by Mr. C. F. Baker. They were collected as follows: (1). On *Solidago canadensis,* Aug. 8, 1895, both sexes. (2). On *Solidago canadensis,* Aug. 15, 1895, a ♂. (3). On sticky flower-buds of *Helianthus annuus,* Aug. 20, 1895, two ♂s.

When Mr. Baker sent me this species, with the statement that it was found on *Solidago*, I could hardly believe there had not been some mistake, as it so nearly resembled *P. zebrata*, which I have

FIG. 12.

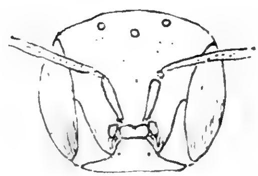

FIG. 11.

found always on *Cleome*, never on *Solidago*. Mr. Baker, however, assures me that there has been no mistake; and on re-examining the series I find that it differs from *zebrata*, in the males at least, by the average greater reduction of the pale bands of the abdomen, and constantly in the broader supraclypeal mark. We thus appear to have a species in the early stages of differentiation, perhaps hardly to be regarded as more than a race of *zebrata*. I have taken the liberty of naming it after Mrs. Baker, who has collected part of the material received from Fort Collins.

Since the above was written, I have examined the ♂ genitalia of *canina* (*zebrata*) and *bakeræ*, and find apparently good distinctions. See fig. 12.

Three species found on Solidago in Colorado, one being also found at Santa Fe, N. M.

25. Perdita affinis Cr., Tr. Am. Ent. Soc., 1878, p. 69. ♂ ♀ (Hab., Colorado).

Five specimens were collected by Ridings; I have examined one of the types. Mr. Baker sends me two ♀ s taken at Fort Collins, Colo., one on Aug. 8th, the other on Aug. 15, 1895. The latter was on *Solidago canadensis*.

Cresson's description is not entirely satisfactory. The nervures and stigma (except the hyaline centre) are dark. The clypeus in Mr. Baker's examples has two black bars; in the type specimen examined these bars are present, though not so much developed.

The vertex and mesothorax are dark green, granular, dull. The clypeus is not hairy. The wings are slightly smoky; the marginal cell has the poststigmatal portion appreciably longer than the substigmatal, the third discoidal is distinct.

From *P. pectidis*, it differs thus:

(1). Larger, mesothorax dull, granulated, markings of face and abdomen yellowish, ... =*affinis* ♀.

(2). Smaller, mesothorax smooth, very shiny, markings of face and abdomen white, ... =*pectidis* ♀.

In its face-markings, dull mesothorax and dark nervures *P. affinis* ♀ agrees precisely with *octomaculata* ♀, but it differs thus:

(1). Larger, markings of abdomen chrome-yellow, wings tinged smoky or yellowish, ... =*octomaculata* ♀.

(2). Smaller, markings of abdomen creamy or yellowish-white, wings clear or nearly so, ... =*affinis* ♀.

I have not seen the ♂ of *affinis*. Mr. Fox kindly sends me a sketch of the face-markings, showing the face all yellow below the level of the antennæ, the yellow extending above in the median line as a small rounded projection, and at the sides obliquely from the antennal sockets to the orbital margin, where it ends at an angle of about 50°. Thus the face-markings of *affinis* ♂ differ at once from those of *octomaculata* ♂, which has the yellow confined to clypeus and sides of face, except a couple of small spots or streaks in the place of the supraclypeal mark.

26. Perdita sexmaculata Ckll., Proc. Phila. Acad., 1895, p. 12. ♀ (Hab., Santa Fé, N. M.).

The unique type was taken on July 25th; it could hardly have been on *Solidago*, which would not, I think, be in flower at Santa Fé at that time. I have a note in my diary that on Aug. 2, 1895, *Solidago canadensis* was only beginning to flower, and was visited by a few *Halictus*. The form found on *Solidago* in Colorado represents a variety, as follows:

Var. **punctata** ♀.

Length about 6 mm.; abdomen with only 4 pale dots, on segments 3 and 4. As it is possible that this will prove to be a distinct species when a good series is collected, the following additional particulars are offered:

Head and thorax greenish-black, metathorax blue-black. Mandibles yellowish with rufous tips. Face and mesothorax very little hairy. Vertex and mesothorax granular, quite distinctly dark greenish. Clypeus black, minutely granular, sparsely and irregularly punctate. Scutellum with the granulations becoming obsolete on the shining disc. Wings slightly smoky, nervures and stigma dark brown, stigma not hyaline in middle. Marginal cell short, distinctly appendiculate, the poststigmatal portion shorter than the substigmatal. Recurrent and transverse cubital nervures broken by hyaline dots. Third discoidal distinct. Cubital and subdiscoidal nervures produced far beyond the cells, the latter to the margin of the wing. Four middle tarsi rufotestaceous, as also the anterior knees, and anterior tibiæ before. The light dots on abdomen are inconspicuous, so that it appears at first sight immaculate brown-black.

Hab.—Fort Collins, Colorado, Aug. 8, 1895, on *Solidago canadensis;* one example, sent by Mr. Baker. The head is shorter than in *affinis*, and the pale face-marks are wanting; the marginal cell is also shorter.

27. Perdita rectangulata n. sp. Fig. 13, (face-marks).

♀.—About $5\frac{1}{3}$ mm. long. Head and thorax dark brassy-green, granular, dull; metathorax bluish. Head of ordinary shape and size. Clypeus, supraclypeal mark, lateral face-marks, and spot midway between antennæ and middle ocellus, lemon-yellow. Between the supraclypeal mark and the frontal spot, the usual facial keel is well-developed, slightly intruding into the spot. The supraclypeal mark is approximately rectangular, clear cut, about twice as broad as long. The dots on the clypeus are obscure. The lateral face-marks are broad at base, reaching the point on the clypeus next to the dot, gradually narrowing upward, until at a point about level with the upper edge of the antennal sockets they are squarely truncate nearly to the orbital margin, but still are continued upward along the latter as a narrow stripe a little longer than the width at the truncation. The clypeus is rather of the Panama-hat type, with the lateral narrow prolongation to the base of the mandibles, but the central portion (crown of the hat) is higher. The face is nearly hairless. Mandibles stout, simple, curved, pale yellow with dark tips.

Fig. 13.

Antennæ with the scape entirely yellow; funicle and flagellum dark brown above, yellow below.

Mesothorax moderately hairy for a *Perdita.* Collar, hind border of prothorax and tubercles connecting with it, yellow. Tegulæ yellowish-hyaline. Wings hyaline, nervures and stigma pale yellow; marginal cell with the poststigmatal portion longest; 3d submarginal large, narrowed more than half to the marginal; 3d discoidal distinct. Legs yellow, tarsi pale testaceous; spot on middle femora and tibiæ, a large blotch on hind femora, and hind tibiæ except basal third, black.

Abdomen above lemon-yellow, the last segment slightly orange. First segment with two black spots; rather broad black bands at hind margins of segments 1–4, intruding a little, especially at sides, on the base of the segment following, not at all notched, nor joined together. Venter yellow without bands.

♂.—Differs as follows: Scape with a small black stripe above. Face below antennæ all yellow, owing to the space beneath the antennæ being filled in by well-developed dog-ear marks, and to the supraclypeal mark being higher. The lateral face-marks are rather obliquely (not squarely) truncate, and are scarcely at all produced along the orbital margin above the truncation. The frontal pale spot is wanting. The collar is not yellow, and the yellow border of prothorax is reduced to two marks, the tubercles also remaining yellow. The nervures and stigma are dark brown, the marginal cell is longer, and the second submarginal less narrowed above. Legs black, with the knees and anterior femora and tibiæ in front, yellow. The abdomen is black, with orange or yellow clean-cut interrupted bands on segments 1–4. Venter dark. The cheeks are unarmed.

Hab.—Fort Collins, Colorado, Aug. 15, 1895, on *Solidago canadensis;* one ♀, one ♂, sent by Mr. Baker. The ♂ is so different from the ♀, that it may be a distinct species; but the face-markings are exactly such as might belong to the sexes of a species, and there are several points of similarity in structure. In a case of this sort, one decides partly by the circumstances of the capture, the two sexes having been taken from the same flowers on the same day.

Three other species from Colorado, habits unknown.

28. Perdita snowii n. sp.

♀.—Length 5½ mm. Head and thorax dark brassy-green, dull and granular, metathorax bluish and more shining. Head fairly large, approximately round; face very little hairy, although the mesothorax and other parts of thorax are quite hairy, the hairs being of a pale brownish color, dirty white on the under parts. Mandibles stout, simple, yellowish with rufous ends. Antennæ dark brown, scape pale beneath. Clypeus, and sides of face rather narrowly up to level of antennæ, dull pale yellowish. The face-marks at sides are abruptly truncate at their upper end, the truncation a little oblique. Supraclypeal and dog-ear marks wanting. Tubercles and two spots on hind border of prothorax, pale yellowish or subtestaceous. Wings dull hyaline, iridescent, nervures and stigma rather dark yellowish-brown, stigma centrally subhyaline. Marginal cell large, appendiculate, poststigmatal portion longest. Second submarginal large, narrowed more than one-half to marginal; 3d discoidal distinct. Tegulæ hyaline.

Legs brown-black, hairy; anterior femora at ends, and anterior tibiæ, except a patch behind, yellow; anterior tarsi, middle and hind knees, and much of middle tibiæ, yellowish testaceous. Hind tibiæ in the type specimen with a mass of dull orange pollen.

Abdomen above dull brownish-white; first segment black at base; segments 1–4 with broad brown-black bands on their hind halves, these bands not at all interrupted, those on segments 2–3 conspicuously thickest in the middle, those on 1–2 joined laterally by a longitudinal line; 5th segment hairy, with a rudimentary band. Venter brown.

Hab.—Estes Park, Colorado, August, 1892 (F. H. Snow, No. 210). One specimen, sent by Mr. Fox. The abdomen may have been more brightly colored in life. *P. snowii* differs from *nitidella* ♀ at once by its dull hairy mesothorax; from *bigeloviæ* ♀ it differs in shape of lateral marks of face, as well as in abdomen.

29. Perdita luteiceps n. sp.

♂.—Length about 5 mm. Cheeks unarmed. Head moderately large, rounded, somewhat broader than long, deep yellow with dark green markings. There is a spot close to each anterior orbital margin above the level of the antennæ (as in *punctosignata*), the ocelli are situated on an irregular transverse dark patch, and the occiput is dark, from it also coming a narrow dark stripe toward, but not reaching, the upper end of the eye. Labrum and mandibles yellow.

Antennæ yellow, funicle with a black patch above, joints of flagellum slightly darkened above.

Thorax dark bronzy-green, very granular, moderately dull, metathorax a bluer green. Prothorax yellow except a transverse dark stripe. A transverse yellow patch near hind border of mesothorax, and a little yellow along hind border of scutellum. Pleura hairy, dark with a moderately small yellow patch. Mesothorax hairy in front, nearly hairless behind.

Tegulæ yellowish hyaline. Wings hyaline, nervures and stigma (except its hyaline centre) very pale yellow. Marginal cell rather long, substigmatal portion about as long as poststigmatal; a linear appendiculate nervure longer than the marginal itself; 2d submarginal rather large, narrowed a little more than half to marginal; 3d discoidal distinct.

Legs yellow; a blackish patch on middle femora and tibiæ bebehind, hind legs blackish except knees.

Abdomen above yellow; first segment narrowly dark at base; at the sutures of all the segments is a narrow black band, which takes the form of two transversely elongate spots on the hind margin of each segment, adjacent to a narrow entire band on anterior margin of the next. None of the bands are united laterally. The yellow is much more developed in proportion to the black than in *martini*. Venter yellow, immaculate.

Hab.—Glenwood Springs, Colorado, Aug. 24, 1894. Collected by Prof. Gillette; sent to me by Mr. Fox. The unique specimen is unfortunately reddened by cyanide. *P. luteiceps* is very near *martini*, but differs by the brassy-green (not blue) thorax, the vertex with a transverse yellow band above the ocelli, and in the greater development of yellow on the abdomen. It is to be added that *martini* is a spring species, while *luteiceps* was caught in late summer. It is curious that among the numerous late summer species of *Perdita* at Las Cruces, the locality of *martini*, none resemble it so closely as *luteiceps*.

30. **Perdita dubia** n. sp.

♂.—About or slightly over 5 mm. long, Very like the ♂ of *bakeræ* or *zebrata*, resembling them in the shining mesothorax, color of head and thorax, face-markings, etc. The mesothorax is a rather yellower-green. The supraclypeal mark is heart-shaped with the apex cut off, thus differently shaped from that of *bakeræ* or *zebrata*, but nearest to *zebrata*. The dog-ear marks are a little reduced, leaving a perceptible amount of dark color between them and the clypeus. The lateral face-mark, formed as in *zebrata*, presents an obscure dark streak on its upper portion. The sides of the face are more hairy than in *zebrata* or *bakeræ*. The cheeks are very hairy. The labrum presents a conspicuous pit. The thorax is rather more hairy than in *bakeræ* or *zebrata*. The posterior and middle femora are entirely yellow, except for the slightest indication of black on the posterior ones; otherwise the legs resemble those of *bakeræ*.

Wings hyaline, nervures sepia-brown, stigma hyaline in middle. The marginal cell is distinctly longer than in *bakeræ* or *zebrata*, and has the poststigmatal portion longest. Second submarginal large, narrowed one-half to marginal; 3d discoidal absent.

Abdomen above with nearly equally broad bands of yellow and black. First segment all black; then follow four black bands at the junction of the segments, none interrupted, nor joined at the middle or the sides. Tip blackish. Venter yellow, with a little black along the sutures.

Hab.—Glenwood Springs, Colorado, Aug. 24, 1894. Collected by Prof. Gillette, sent by Mr. Fox. Like the last, taken at the same time, it is reddened by cyanide. It is unfortunate that we know nothing about the habits of this species, and have only a single specimen. It will be recognized by the regular entire abdominal bands, the coloration of the legs, etc.

A species from California, habitat unknown, ♂ unknown.

31. Perdita trisignata n. sp. Fig. 14, (face-marks).

♀.—Length about 5½ mm. Head and thorax blue-black or greenish-black, the tint difficult to define. Head of ordinary size, nearly round, somewhat depressed on vertex; face very sparsely hairy, cheeks not so hairy as in many species. Vertex dull and very distinctly granulose. Middle ocellus in a distinct depression. Mandibles stout, yellowish, with rufous tips and bases. Clypeus brown-black, contrasting with the distinctly green face above it; in shape high, something like a cocked-hat. Face-markings pale lemon-yellow, consisting of a longitudinal median stripe on clypeus, starting from its hind-border but not reaching its anterior border; and the lateral marks, elongate-pyriform, with the upper end pointed and level with the sockets of the antennæ. The clypeal mark suggests that of *obscurata*. Antennæ dark brown. Mesothorax only sparsely hairy, distinctly granular and punctured, the punctures sparse but distinct. Metathorax granular, very dull, duller than scutellum and postscutellum. Pleura hairy, with white hairs. Tubercles and two spots on hind margin of prothorax yellow. Tegulæ testaceous, subhyaline.

Fig. 14.

Wings rather small, yellowish-hyaline, nervures and stigma testaceous. Stigma small and narrow; marginal cell very large, poststigmatal portion noticeably longest. Second submarginal large, narrowed more than one-half to marginal; 3d discoidal distinct.

Legs dark brown with the tarsi testaceous; anterior and middle tibiæ in front, and corresponding knees, dull yellow. Abdomen above and below dark reddish-brown, without markings.

Hab.—California, collector and exact locality unknown; sent by Mr. Fox. One specimen, known by the yellowish wings, abdomen without markings, etc.

Two species described by F. Smith, exact locality and habits unknown.

32. Perdita halictoides Sm., Br. Mus. Cat., Vol. I, p. 128, (1853). ♀ (Hab. North America).

The description indicates that this species is similar to *P. semicrocea,* but differs in having the nervures fuscous (in *semicrocea* they are colorless), the abdomen dark testaceous, and the legs rufotestaceous with the tarsi pale.

33. Perdita bicolor (Sm.).
Macrotera bicolor Sm., Br. Mus. Cat., Vol. I, p. 130, (1853). "♀" (Hab. Mexico).

The description shows that this species is twice as large as the last, the head and thorax black and the abdomen ferruginous, more or less fuscous at base. It might, perhaps, be confused with *M. texana,* but the abdomen is elongate-ovate and the mandibles are rounded at their apex, simple. The wing-nervures are ferruginous. *P. texana* has a ferruginous abdomen only in the ♂.

As the description of this insect did not enable me to ascertain definitely whether it belonged to the group (or genus) of *P. texana* = *megacephala* and *P. latior,* I applied to Mr. E. A. Smith, of the British Museum, asking him to kindly examine his father's type, and report on certain points specified. He handed my letter to Lt. Col. Bingham, who very kindly examined the typical specimen, and reported as follows:

"1. The type is a ♂, not a ♀. It has the two basal segments fuscous, the 3d and following segments ferruginous, with the apical one, which is very small and somewhat hidden by the fimbria of pale hairs on the posterior margin of the 6th segment, black.

"2. The mandibles are deeply grooved on the outside from near the base to the apex, which, however, does not appear to be bifid.

"3. The figure of the marginal cell given in Part 1, pl. V, f. 22, of Smith's Catalogue, is fairly good, the cell may be a little more obliquely truncate at apex, perhaps.

"4. From Cresson's description of *M. megacephala* ♂, Smith's type of *bicolor* differs as noted above in the basal segments of the abdomen being fuscous, and in the posterior tibiæ being clothed with a 'a thin scopa' of pale yellow pubescence, as Smith described, which has now faded to a dirty white."

While I am not yet certain, I am decidedly inclined to suppose that we may after all recognize *Macrotera* as a valid genus, with these species, *M. bicolor* Sm., *M. texana* Cr., and *M. latior* (Ckll.).

A species from Nevada, yellow with black markings, habits unknown, ♀ unknown.

34. Perdita cephalotes (Cr.) Cr., Cat. Hym., 1887, p. 296.
Macrotera cephalotes Cr., Tr. Am. Ent. Soc., 1878, p. 71. ♂ (Hab. Nevada).

Described from a single specimen, collected by Mr. Hy. Edwards. It has a very large head, after the manner of *grandiceps* and *crassiceps*, but the markings are very like those of *punctosignata.*

Two specimens were obtained by the Death Valley Expedition in the Panamint Mountains. (N. Amer. Fauna, No. 7, 1893, p. 246).

Two species found on mesquite in New Mexico.

35. Perdita punctosignata Ckll., Suppt. to Psyche, Sept., 1895, p. 6. ♂. (Hab. Las Cruces, N. M.).

Two specimens are known, both from mesquite; one taken by Miss J. Casad, the other by Mr. Alfred M. Holt. The latter specimen has a large yellow patch on dorsum of metathorax, instead of two spots. The eyes are pale coffee-color with a purplish tint.

36. Perdita exclamans (Ckll.).
Perdita nitidella var. *exclamans* Ckll., Suppl. to Psyche, Sept., 1895, p. 5. ♂. (Hab. Las Cruces, N. M.).

This and the last are spring species, found in May. *P. nitidella*, which frequents *Bigelovia* in the late summer and early autumn, is unquestionably distinct from *exclamans.* Of the latter we know four specimens, 3 ♂, 1 ♀. Prof. Townsend took a ♂ some years ago; this is the specimen formerly reported in error as *nitidella.* Miss Casad found the type specimen, and the other two were obtained at the same locality by Mr. A. M. Holt in 1895, a ♂ on a young cottonwood tree, not in flower, and near some mesquite bushes, May 9th, and a ♀ on mesquite, May 13th.

The ♀ may be described as follows:

♀.—Larger, about 6 mm. long. Antennæ dark brown above, yellow beneath. Clypeus cocked-hat shape, flattened above, very pale yellowish with the usual two dark dots. Supraclypeal yellow mark well-developed, produced above into a narrow stripe widening into a large frontal patch, so that the whole has the shape of an hour-glass. The frontal patch is separated by a moderately wide interval from the anterior ocellus. Dog-ear marks present but small, their tips about level with the top of the clypeus. Lateral face-marks receding from the clypeus close to the dark dots, leaving a wide band of dark color between them and the upper part of the clypeus, etc.; at the level of the antennal sockets they are suddenly narrowed, ascending the orbital margin as a thin band, rather suddenly widening opposite the middle of the frontal patch, and terminating roundly and abruptly at the level of the hind margin of the anterior ocellus. Lower part of cheeks pale yellow.

Prothorax and narrow lateral borders of mesothorax yellow. Pleura entirely dark. Metathorax blue, rugulose, contrasting with the scutellum, postscutellum and mesothorax, which are brassy-greenish, very smooth, shining, polished, the scutellum with distinct sparse punctures. The vertex is green, but rugulose and punctured. Legs as in ♂, but hind tibia and tarsus all brown. Wings with 3d discoidal cell distinct; 2d submarginal narrowed less than half to marginal.

Abdomen above yellow; markings dark sepia, first segment dark at base, connecting with a blotch on each side, hind margins of segments 1–4 with dark bands, connecting laterally with a spot on proximal margins of 3 and 4, but these spots lacking on fifth segment, while the bands on 1 and 2 are broadly confluent along lateral margin. Vertex yellow, immaculate.

This is very different from the ♀ of *nitidella.*

Two species found in spring in the Mesilla Valley, N. M., habits unknown, ♀ unknown.

37. **Perdita martini** Ckll., Proc. Phila. Acad., 1895, p. 14. ♂. (Hab. Las Cruces, N. M.).

The unique specimen was taken on April 26th.

38. **Perdita hirsuta** n. sp.

♂.—Length about 5 mm. Head and thorax blue, granular, unusually hairy with white hairs, but the disc of metathorax, and yellow face below antennæ, bare. Head of ordinary size, rounded, a little broader than long; cheeks unarmed. Face just above the level of the antennæ conspicuously hairy, the hairs arranged so as to appear to radiate from the antennæ. Antennæ black above, yellow beneath, the scape with only a black blotch above. Mandibles very straight, very pale yellowish with rufescent tips. Clypeus rather cocked-hat shape, flattened above, with the sides very rapidly descending and the prolongation to the base of mandibles very narrow. Face below antennæ all lemon-yellow, except the usual clypeal dots. Above the antennæ the yellow extends only as a small projection in the median line, and a little along the orbits, so that the upper angle of the yellow with the orbital margin is about 50° instead of a right angle. Lower half of the cheeks with a yellow band along orbital margin.

Collar and hind margin of prothorax connecting with tubercles but failing in the middle line, yellow. Tegulæ hyaline. Wings hyaline, nervures sepia-brown, stigma margined with brown. Marginal cell moderately long, appendiculate, the poststigmatal portion about as long as substigmatal. Second submarginal not narrowing quite one-half to marginal; 3d discoidal fairly distinct. Legs yellow, anterior and middle femora and tibiæ with a black patch behind, hind femora and tibiæ black with a yellow stripe in front, hind tarsi blackish.

Abdomen above with about equally broad bands of black and yellow. First segment basally black. The five dark bands are not interrupted, nor joined medially or laterally. Sixth segment with three dark spots. Venter yellow, immaculate.

Hab.—Las Cruces, N. M., on the College Farm, May 2d, 1895. One specimen collected by A. M. Holt.

Two species found on willow in the Mesilla Valley, N. M.

39. Perdita numerata Ckll., Tr. Am. Ent. Soc., 1895, p. 296. ♀. (Hab. Las Cruces, N. M.).

One specimen is known, taken on May 2d, associated with *P. salicis.* It resembles most the ♀ of *bigeloviæ,* but the stigma is entirely dark and the clypeus has two broad black bars. The marginal cell is short, appendiculate; the 2d submarginal is large, very broad below, narrowed considerably more than half to marginal.

40. Perdita salicis n. sp.

♀.—Length 5 mm. Head and thorax shining dark green; head bluish-green, mesothorax and scutellum brassy-green, metathorax dark blue. Head rounded, of ordinary size; vertex minutely roughened, cheeks only sparsely hairy; clypeus except two black dots, the area between clypeus and antennæ, and sides of face narrowly terminating in an acute point about half the length of the scape above the level of insertion of antennæ, dull pale yellow. In the median line the pale color is sometimes carried upward as a narrow stripe about two-thirds of the distance between insertion of antennæ and middle ocellus. Mandibles simple, unusually stout, blunt at tips, dull pale yellowish with rufous ends. Mouth parts only moderately elongated. Antennæ black above, yellow beneath, the yellow predominating on scape, the black on flagellum.

Mesothorax very shiny, sparsely punctured. Prothorax including tubercles either entirely yellow, or the anterior and posterior borders broadly yellow, leaving a narrow transverse dark band. Legs entirely yellow, except hind tibiæ and tarsi, which are brownish. The middle tibiæ sometimes show a brown patch.

Tegulæ yellowish hyaline. Wings hyaline, costal nervure and margin of stigma dark brown, the other nervures practically colorless. Marginal cell rather obliquely truncate, the substigmatal portion about as long as poststigmatal; 2d submarginal not or hardly narrowed one-half to marginal, the degree of narrowing variable; 3d discoidal distinct. Abdomen above black, with five very regular yellow bands, the first slightly interrupted. The black and yellow are nearly of equal width, so that the abdomen might be said to be alternately black and yellow-banded. Venter entirely yellow with an orange tinge.

♂.—Length 4 mm. Cheeks unarmed. More pubescent, antennæ more yellow. Mandibles pointed but not slender, the shining rufous tips very distinctly separated from the yellowish portion.

Face all pale yellow up to level of antennæ, the yellow extending further upward, in the median line as a narrow mark of the shape of a spear-head, scarcely the length of the scape, and at the sides about the length of the scape along orbital margin, but very obliquely truncate, and notched on its inner side below the truncation. Prothorax with more black. Mesothorax and scutellum bluer. Hind femora with a dark brown patch near the end. Nervures brown; 3d discoidal very indistinct.

Abdomen above with only four bands; these narrower, and divided or deeply notched in middle. Sometimes the abdomen has only three bands.

Hab.—Las Cruces, N. M., in the town, numerous at flowers of narrow-leaved willow and another species of willow, May 2, May 3, May 5, 1895. They are associated on the willows with *Halictus*, *Andrena* and *Prosopis*.

The small species of the Pectis and Cladothrix.

41. Perdita cladothricis n. sp.

♀.—Length $3\frac{1}{3}$–$3\frac{2}{3}$ mm. Head and thorax shining, very dark æneous, face entirely dark, clypeus and metathorax black. Abdomen dark sepia-brown, with a transversely elongate mark or band of white at base of second segment. Legs dark brown, the anterior knees and the tarsi, pale or whitish. Antennæ dark brown. Vertex very minutely sculptured. The usual pale hairs are very little developed anywhere, except at sides of end of abdomen; the post-scutellum and the sides of the metathorax are bare and shining. Wings hyaline, beautifully iridescent, nervures fuscous, stigma pale brown, 3d discoidal cell distinct, marginal with the substigmatal portion longer than the poststigmatal, 1st submarginal broad, 2d submarginal small and triangular, narrowing to a point at junction with marginal.

♂.—Length $2\frac{1}{2}$–3 mm. Cheeks unarmed. Differs from the female at once by the face, which (with the mandibles except their reddish tips) is entirely ivory-white below level of antennæ, the white moreover extending a short distance above the antennæ, in the form of a narrow line between them, and a broad prolongation on each side between the antennæ and the orbits, not quite as long as the scape, and ending in an abrupt truncation. The antennæ are mainly white beneath. The tubercles, and the border of prothorax adjacent and in front, and a portion of the anterior part of the pleura, are white. The coxæ, a considerable portion of the anterior and middle femora, and part of the anterior tarsi, are white.

The abdomen, in addition to the white band of the ♀, usually shows a longer and narrower white band at base of 3d segment. Venter dirty whitish, becoming brown at base and apex.

Hab.—Las Cruces, N. M., very abundant on *Cladothrix cryptantha* (det. E. O. Wooton), Sept. 15, 1895. On this occasion I took 6 ♂, 12 ♀; I do not think the males were really less numerous, but owing to their small size and incessant activity they were less easily caught than the females. The earliest date I have for this species is a ♂ taken on *Cladothrix*, associated with a new *Oxybelus*, in the beginning of September. Stray examples will be found at times on other plants. On September 17th, four ♀ were obtained by sweeping from *Pectis papposa*, but *Cladothrix* was growing within a few feet of the *Pectis*. On September 23d, a ♀ was obtained from *Bigelovia* *wrightii.* On September 25th, a few ♀ were caught on *Gutierrezia sarothræ* v. *microcephala.*

42. Perdita pectidis n. sp.

♀.—Head and thorax black, vertex greenish. Head of moderate size, rounded, somewhat depressed on vertex. Sides of clypeus and sides of face adjacent to orbital margin with sparse but large and deep punctures. Vertex minutely rugulose, with sparse small punctures. Cheeks less hairy than usual. Mandibles rufescent, whitish at base, with dark tips. Clypeus with three rather large white marks, the central one longitudinally oval. Sides of face with an irregularly subtriangular white patch, narrowing to a point above, about the upper level of the sockets of the antennæ. Antennæ with the scape black, the flagellum sepia-brown.

Mesothorax smooth, sparsely punctured, very shiny. Metathorax blue-black. Collar, tubercles, and a couple of small spots on hind border of prothorax, white. Tegulæ hyaline subtestaceous. Femora black, knees whitish. Tibiæ and tarsi brown; anterior tibiæ in front, and a stripe on middle tibiæ pale yellow.

Wings smoky, nervures and stigma sepia-brown. Poststigmatal portion of marginal cell hardly as long as substigmatal; 2d submarginal narrowed more than half to marginal; 3d discoidal distinct.

Abdomen above very dark brown, segments 1–4 each with an oblique white stripe on each side. Pygidial area dark subrufescent. Venter dark brown.

♂.—Wings clear. Metathorax quite blue. Mandibles white with rufescent tips. White markings of face as in *cladothricis* ♂. Pale marks of abdomen reduced, sometimes to 4 or 5 small spots, which are then pale yellowish.

Hab.—Las Cruces, N. M., in numbers on *Pectis papposa*, Sept. 17, 1895. It is closely allied to *cladothricis*, but differs at once by the face of the ♀ not being all dark, and the different abdominal markings.

On September 20th, I took four ♀ *P. pectidis* from flowers of *Tribulus maximus*, and two, also ♀, from flowers of *Wedelia incarnata.*

With the *P. pectidis* on *Pectis papposa* were a few *P. fallax*, ♀ which I at first supposed to be a variety of it. *P. fallax* is, however, distinguished by its greenish head and thorax (or at least the mesothorax more or less greenish), scape pale yellowish below or with a yellow stripe, face-markings tinged distinctly yellowish, clypeus pale, sometimes with two black bars, diverging below, and the usual black dots, wings clear, abdominal markings inclined to be smaller, or wanting on 4th segment.

43. Perdita biparticeps n. sp.

♂.—Length $3\frac{1}{2}$ mm. Head and thorax very dark blue; thorax practically black, except the metathorax. Head large in comparison with the small thorax, rounded, somewhat broader than long, cheeks unarmed. Face below antennæ, labrum and mandibles except their slightly rufescent tips, lemon-yellow. The yellow extends above the antennæ a short distance (and equally) in the median line and at the sides, almost exactly as in the ♂ of *affinis*, the limit of the lateral extension marked by a small pit close to the ocular margin, where the yellow forms an angle of about 55°. Cheeks yellow below, the yellow extending furthest upward along the orbital margin. Antennæ sepia above, yellow below, the scape all yellow except end above. Vertex granular. Mandibles simple. Mesothorax shining but noticeably sculptured, the surface lineolate rather than granular. The mesothorax, as also the face, is very free from hairs; and even on the pleura and sides of metathorax there are comparatively few. The upper part of the cheeks, however, exhibits conspicuous white hairs.

Tegulæ hyaline; wings slightly smoky, nervures and stigma sepia-brown, the latter pallid in middle. Marginal cell rather large, appendiculate, substigmatal portion about as long as poststigmatal; 2d submarginal rather large, narrowed one-half to marginal; 3d discoidal distinct.

Legs yellow, anterior and middle femora and tibiæ with a dark brown patch behind; posterior femora brown with yellow ends and an obscure yellow stripe in front, posterior tibiæ brown with the proximal fourth pallid, tarsi whitish.

Abdomen above pale sepia-brown, shining, with rather obscure and suffused yellow markings, namely a patch on disc of 1st segment, and bands at bases of segments 2–4, the last two of these shorter and emarginate posteriorly. Venter dull yellow, brownish toward tip.

Hab.—Las Cruces, N. M., on *Pectis papposa*, Sept. 17, 1895, one example.

Differs from *rectangulata* by its small size and shiny mesothorax, as well as the markings of the abdomen. The pleura has not the yellow patch seen in *maculipes*.

Small species found on Gutierrezia, ♀ unknown.

44. Perdita austini Ckll., Proc. Phila. Acad., 1895, p. 13. ♂. (Hab., Las Cruces, N. M.).

The type was taken in September. The cheeks are unarmed, the mandibles simple, the clypeus of the Panama-hat type, with the crown higher, more like a Puritan's hat. The mesothorax is shiny, it and the face nearly bare; but the cheeks and pleura, as well as the thorax beneath generally, with conspicuous white hairs. The marginal cell is rather long, but the substigmatal portion is noticeably longer than the poststigmatal; the second submarginal is narrowed nearly to a point above.

I took one specimen at Albuquerque, N. M., on *Gutierrezia sarothræ,* Aug. 15, 1895. At Las Cruces it is quite rare so far as observed. Mr. C. Rhodes took one on *Bigelovia wrightii,* toward the end of September. I took it on *Gutierrezia sarothræ* var. *microcephala* on Sept. 25th. The ♀ is unknown.

45. Perdita gutierreziæ n. sp. or variety.

♂.—About 4 mm. long, size and appearance of *nitidella* ♂. Cheeks unarmed, but projecting at base of mandibles so as to simulate a small tooth. Face entirely yellow up to nearly the length of scape above level of insertion of antennæ, the yellow enclosing a black spot on each side at its extreme upper border close to margin of eye. On each side, midway between the eye and the median line, the yellow is depressed by a slight invasion of the blue, which forms thereat an angle considerably greater than a right angle. Lower half of cheeks broadly yellow, pleura with a yellow patch, which is wanting in *nitidella;* 2d submarginal cell more narrowed above than in *nitidella;* 3d discoidal distinct. Veins dark brown. The rest much as in *nitidella.*

Hab.—Albuquerque, N. M., one specimen on *Gutierrezia sarothræ,* August 15th. This is certainly distinct from *nitidella,* but it may be only a variety of *bigeloviæ;* see below under *maculipes.*

46. Perdita tarda n. sp.

♂.—Length 4½ mm. Head and thorax dark blue. Head moderately large, distinctly broader than long, cheeks unarmed, vertex rugulose and punctured. Face very free from hairs, except sides near antennæ, where they are rather conspicuous; cheeks thickly clothed with long white hairs. Antennæ dark brown above, yellowish beneath, the scape all yellow beneath and at base above.

Mandibles very little curved, yellow, rufescent at ends. Clypeus approximately cocked-hat shaped, the lateral prolongations broad. Face below antennæ all lemon-yellow except a notch of the dark color distad of each dog-ear mark, and not quite so large as it. The supraclypeal mark is roundly emarginate above. The clypeus has the usual two dark dots. Along the orbital margins the yellow ascends about half the length of the scape above the level of the antennæ, and ends in an oblique truncation; this upward band of yellow is a little wider than the scape. The cheeks are entirely dark. Mesothorax smooth and shining, though minutely lineolately sculptured, nearly black; mesothorax finely sculptured, very distinctly blue. Pleura all dark. Tubercles yellowish.

Tegulæ pale brown; wings slightly smoky, nervures and stigma sepia-brown, the latter pale in middle. Marginal cell large, appendiculate, poststigmatal portion longest; 2d submarginal narrowed less than half to marginal; 3d discoidal distinct. Transverse cubital nervures more or less broken by hyaline dots. Legs black, all the knees, anterior and middle tibiæ in front, and base of hind tibiæ, yellow; tarsi pale brownish, the anterior ones yellowish.

Abdomen above piceous, with narrow whitish bands, interrupted in the middle, rather obscurely indicated on disc of 1st segment, and at base of segments 2 and 3. The markings are in the form of narrow straight stripes, not oblique ones as in some species. Venter dark brown.

Hab.—Las Cruces, N. M., one specimen on *Gutierrezia sarothræ* var. *microcephala*, Sept. 23, 1895. Allied to *P. biparticeps*, from which it differs at once in the face-markings, the abdomen, etc. From *austini* it differs radically in the face-markings.

Small species found on Bigelovia wrightii, having the abdomen banded.

47. **Perdita nitidella** Ckll., Proc. Phila. Acad., 1895, p. 16. ♂. (Hab., Las Cruces, N. M.).

On *Bigelovia wrightii* at Las Cruces, several males on September 2d, one ♀ on September 11, 1895. The latter is herewith described:

♀.—Length 5 mm. Face-markings creamy-white. Clypeus white with two black dots, the anterior margin narrowly brown, and traces of the two longitudinal bars in brown. Sides of face with an irregularly subtriangular white mark, the upper obliquely truncate end of which is level with the insertion of the antennæ. Cheeks quite densely white-hairy. Prothorax with less pale marking, the tubercles not connected with yellow of margin of prothorax. Nervures dark brown; 3d discoidal distinct. Legs about as in *austini*, but anterior femora partly black in front, and middle femora with less black. Abdomen banded as in ♂, but the banding yellowish-white.

48. Perdita bigeloviæ n. sp.

♂.—About 5 mm. long. Resembles *nitidella* ♂, but larger; face-markings as in *gutierreziæ* ♂, but the black spots close to eyes above are not enclosed, but only produce a notch in the yellow; and the yellow is in the middle-line rather more produced upward, not reaching the ocellus, but terminating some distance before it in an emarginate truncation. Venation as in *nitidella*, with 3d discoidal cell very indistinct. Pleura largely yellow, the amount of yellow on it variable. Legs and abdomen as in *nitidella*. Cheeks unarmed. (7 ♂s examined.)

♀.—Length 6mm. Similar to *nitidella* ♀, the pale marks of face rather inclining to pinkish-brown; and the marks of sides of face distinctly notched on inner side, and sometimes also at end. Sometimes there are two pale spots above the clypeus; 3d discoidal cell distinct. Abdomen brown-black, with creamy-white bands on segments 1–4, that on 1 interrupted; 5 with a rudimentary linear broken band, or frequently with a distinct broad band.

Hab.—Albuquerque, N. M., several of both sexes between the old and new towns, on *Bigelovia wrightii*, Aug. 16, 1895. The males of this lot were unfortunately reddened by the cyanide; but the females, collected in the same bottle at the same time, were not so affected. On September 11th, a specimen of each sex was taken on *Bigelovia wrightii* close to the Agricultural College at Las Cruces. The ♀ is very similar to that of *P. numerata.*

49. Perdita maculipes n. sp., or variety.

♂.—A small form, 4 mm. long, similar to *nitidella*, anterior and middle femora all yellow, anterior and middle tibiæ each with a black patch.

From *nitidella* it is readily separated, thus:

(1). Median and lateral upward extensions of yellow on face irregularly truncate; anterior and middle tibiæ with a black patch; pleura with a large yellow patch; bands of abdomen united at sides; lower part of cheeks broadly yellow, = *maculipes* ♂.

(2). Median and lateral upward extensions of yellow on face not truncate, or lateral ones notched and subtruncate; anterior and middle tibiæ all yellow; pleura without a large yellow patch; bands of abdomen not united (or only the first two or three united) at sides; lower part of cheeks very narrowly yellow . . . . =*nitidella* ♂.

From *biparticeps* it is thus distinguished:

(1). Size smaller, abdomen suffused; pleura without yellow patch, = *biparticeps* ♂.

(2). Size larger, abdomen not suffused; pleura with a large yellow patch; median face-marks more developed above antennæ, = *maculipes* ♂.

It is very much like *gutierreziæ*, but differs from that in its longer marginal cell, the abdominal bands joined laterally, and the upper margin of the yellow of face much more distinctly trifid, besides the marks on the tibiæ. It resembles *gutierreziæ* in the broadly yellow lower part of cheeks, and the yellow blotch on pleura.

From small examples of ♂ *bigeloviæ* it is distinguished by the abdominal bands being united at the sides, the face-markings as already mentioned, and the tibiæ with dark marks—though the middle tibiæ of *bigeloviæ* sometimes show a small spot. The marginal cell is as in *bigeloviæ*.

Hab.—Las Cruces, N. M., one example on *Bigloria wrightii*, Sept. 5, 1895. (A. M. Holt.) The above form allies itself very closely with *bigeloviæ* and *gutierreziæ*, which have the cheeks more or less broadly yellow and the yellow patch on the pleura. The more one studies these forms the more apparent does it become that *nitidella*, with its dark pleura and narrow yellow line only on the cheeks, is distinct; while *bigeloviæ*, *gutierreziæ* and *maculipes* run each other so close that they seem to be varieties of one species. Yet I leave them as they stand, not because I think that they are what would be called good species, but rather to draw attention to the divergence which may represent an early stage in species-formation. It will be noted that *maculipes*, while retaining the essential characters of *bigeloviæ*, departs in its face-markings toward the condition of *nitidella*.

50. Perdita pellucida n. sp.

♂.—Length about 5 mm. Head very dark blue, thorax black except the dark blue metathorax. Head of ordinary size, rounded, broader than long; cheeks unarmed, mandibles moderately stout, simple. Vertex granular. Face with rather conspicuous but very scattered hairs, a tuft of erect hairs behind the ocelli being most noticeable. Cheeks with long white hairs. Face below antennæ semitransparent dull white, the clypeus prominent and shining. The upper margin of the white is not very clearly defined, but it ends abruptly in the median line at the lower level of the antennal sockets, while at the sides of the face it ascends rather broadly not quite the length of the scape above the level of the antennæ. Thus the pale color of the face is distributed as in *obscurata* ♂, except that it perhaps ascends a little higher at the sides. (In *bigeloviæ* and *nitidella* it ascends above the level of the antennæ in the median line). Clypeus narrowly produced at sides to bases of mandibles, but higher than in the Panama-hat type. Mandibles white with rufous tips. Antennæ pale testaceous; flagellum, funicle and end of scape becoming dark brown above. Lower half of cheeks narrowly white along orbital margin, thus recalling the cheek-marking of *nitidella*.

Thorax with sparse but rather conspicuous hairs. Mesothorax shining, appearing slightly bluish in some lights, very finely lineolately sculptured, median groove distinct. Metathorax microscopically reticulate. Part of collar, and whole hind margin of prothorax, connecting with tubercles, but very narrowly interrupted in median line, white. The margin of the prothorax below the tubercles is broadly white. Pleura hairy, dark except a white spot about as big as a tubercle, anteriorly. Tegulæ hyaline. Wings hyaline; costal nervure, margin of stigma, and marginal nervure, sepia-brown, the other nervures colorless. Marginal cell unusually long, poststigmatal portion considerably the longest, minutely appendiculate. (In *nitidella* and *bigeloviæ* the marginal is conspicuously shorter.) Second submarginal narrowed more than one-half to marginal; 3d discoidal very weak.

Four anterior legs yellowish-white, tarsi becoming testaceous, middle tibiæ with a dark brown line behind. Hind legs with the basal two-thirds of coxæ above, most of distal half of femora above and behind, and tibiæ except anterior margin, dark brown; the tarsi brownish.

Abdomen above with nearly equally broad bands of dull white (becoming pale brownish toward tip) and dark sepia-brown; these bands not interrupted, nor united at sides or in the middle, nor notched. First segment all brown-black except the hind margin narrowly. The dark bands are four in number, the sixth segment having no band. Venter pale yellowish, slightly orange toward the tip.

Hab.—Las Cruces, N. M., one specimen on *Bigelovia wrightii*, close to the Agricultural College, Sept. 12, 1895. (Ckll. 5,100). The type specimen may be a little immature, but it is clearly distinct.

Small species found on Bigelovia wrightii, the abdomen not banded.

51. Perdita fallax n. sp., or race.

♀.—5 mm. long. Head and thorax dark green, dullish, rather hairy but the hairs short, face below antennæ bare and shining. Head of ordinary size, rounded, not broader than long, occiput and cheeks well fringed with short hairs, vertex granular. Clypeus moderately high, flat above, with the sides very narrowly produced. Face-markings yellowish-white; clypeus all pale except the two usual dots, and two dots near the upper margin, representing the ends of the bars seen in some species, or the bars may be even fairly well-developed. Supraclypeal mark absent, though there may be a pair of scarcely perceptible pale specks close to upper border of clypeus. Dog-ear marks absent. Pale lateral marks at first rapidly narrowing, and then gradually, ending in a narrow truncation at the level of the antennæ. Cheeks dark, mandibles rufous at tips. Antennæ dark brown, yellow beneath, the sutures of the flagellar joints dark.

Mesothorax minutely lineolately sculptured. Pleura all dark. Tubercles and two spots on hind border of prothorax white. Tegulæ hyaline subtestaceous. Wings hyaline, nervures and margin of stigma sepia-brown. Marginal cell appendiculate, poststigmatal portion a little the longest. Second submarginal large, narrowed a little more than one-half to marginal; 3d discoidal distinct. Legs brown-black; anterior knees and anterior tibiæ in front pale primrose-yellow. Middle and hind knees whitish.

Abdomen rather broad and flat; above piceous, with an oblique white mark on each side of segments 1–3, those on 1 very narrow and closely approximating in the median line. Tip orange, or to be more precise, the pygidium is orange with the border colorless and hyaline, the tip emarginate, as is also the case in *affinis*. Venter piceous.

Hab.—Las Cruces, N. M., on *Bigelovia wrightii*, Sept. 23, 1895, two specimens (Ckll.). This is, in all respects, very closely allied to *P. affinis*, but it is smaller, the abdominal markings are white and the abdomen is not so conspicuously marked. Yet in all essential particulars it agrees so nearly with *affinis* that it might well be deemed a southern race of it. The clypeal markings vary as in *affinis*. On Sept. 20th, I took one example of *P. fallax* on flowers of *Verbesina encelioides*, and on Sept. 17th, three on *Pectis papposa*.

52. **Perdita phymatæ** Ckll., Proc. Phila. Acad., 1895, p. 12. ♀. (Hab., Las Cruces N. M.).

In the original description the legs are described as dark brown without markings, but in the normal form of the species the knees are all pallid and the anterior tibiæ are yellow in front, as in *fallax*. The original type specimen, now in Coll. Am. Ent. Soc., was examined for me by Mr. Fox, who reports that the yellow is represented by pale testaceous.

The mesothorax is minutely sculptured, though shining. The second submarginal cell is large, and narrows more than half to marginal; 3d discoidal distinct. The clypeus is strongly punctured, and frequently presents a small yellow median spot. Glossa not hairy.

This species was common on *Bigelovia wrightii* at Las Cruces, Sept. 23, 1895, but the ♂ has not been observed. It was also taken on *B. wrightii* on Sept. 2d, together with *P. nitidella*, *P. luteola*, *Halictus stultus* and *Prosopis*. On Sept. 25th, it was taken on *Gutierrezia sarothræ* var. *microcephala*, together with *P. semicrocea*, etc.

53. **Perdita æneifrons** n. sp.

♀.—Length 5 mm. Head dark green with the front very distinctly brassy, and the clypeus black; thorax pitch black, with the metathorax dark green. Abdomen black, shiny, without bands or spots, venter dark subolivaceous brown.

Head rounded, of ordinary size, not broader than long, vertex minutely rugulose and very sparsely punctured. Clypeus shining, prominent, high, but not produced laterally to bases of mandibles, very sparsely punctured on its lower portion. Mandibles pale yellow at base, rufescent otherwise, with a distinct tooth on inner side. Face all dark, medially free from hairs, laterally with short hairs. Cheeks moderately hairy. Antennæ dark brown.

Mesothorax shining, perfectly smooth, bare; except its anterior border, which presents short hairs and is very feebly sculptured, and even presents in some lights a vague greenish tinge. Scutellum bare, postscutellum with a thin fringe of white hairs.

Metathorax granular. Prothorax, even including tubercules, wholly dark. (In *phymatæ* the tubercles are more or less pallid.) Tegulæ hyaline. Wings milky hyaline, nervures and stigma almost colorless, the latter yellowish. (In its pallid wings it resembles *semicrocea.*) Stigma large; marginal cell short, substigmatal portion longest, 2d submarginal narrowed about one-half to marginal; 3d discoidal distinct.

Legs black, knees pallid, anterior tibiæ in front, anterior tarsi and an obscure stripe on middle tibiæ, yellow. Tip of abdomen rounded or subtruncate, not emarginate. (It is emarginate in *fallax.*)

Hab.—Las Cruces, N. M., on *Bigelovia wrightii*, Sept. 23, 1895, in some numbers with *P. phymatæ.* Its superficial resemblance to *phymatæ* is such that when catching the specimens I thought I had only one species, but a careful examination shows striking differences in the head, thorax and wings. The ♂ was not found.

54. Perdita semicrocea Ckll., Proc. Phila. Acad., 1895, p. 13. ♀. (Hab., Las Cruces, N. M.).

In 1895 this species has been taken commonly at Las Cruces; on *Bigelovia wrightii*, Sept. 2d and Sept. 12th; on *Solidago canadensis*, Sept. 3d; on *Gutierrezia sarothræ* var *microcephala*, Sept. 25th. The original specimen was taken in October. *P. semicrocea* is less strictly limited to one flower than most of the genus, being taken rather freely on all the plants mentioned—perhaps most freely on the *Solidago.* The ♂ differs in having the face below the level of the antennæ entirely yellowish-white, except the clypeal dots. The pale color does not extend further upward, but is slightly notched on each side of the antennæ, the outer margin of the notch being a little higher than the termination of the pale color on the orbital margin. The cheeks are unarmed. The narrow tip of the abdomen is very narrowly truncate, not emarginate. The anterior and middle legs are yellow, except a dark patch on the femora behind.

55. Perdita luteola Ckll., Ent. News, 1894, p. 328. ♂. (Hab., Las Cruces, N. M.).

Very abundant on *Bigelovia wrightii*, Sept. 2d, etc. On Sept. 23d, I caught several on *Gutierrezia sarothræ* var. *microcephala.* I have found them on no other flowers, except that once I saw one in the net after sweeping over *Pectis papposa.*

The ♀ differs in having a black line in place of a black spot before the eyes, being really the groove usually seen in that situation, wholly black; a similar black line placed longitudinally on each side of the anterior half of the second segment of the abdomen; and the antennæ brown-black or dark brown above. The ♂ has the cheeks unarmed.

When left too long in a damp cyanide bottle the ♂ turns a brilliant crimson all over.

A species found in New Mexico, habits and exact locality unknown.

56. Perdita nuda n. sp.

♀.—Length 7½ mm. Head and thorax green, legs and abdomen dark chocolate-brown. The body in general is remarkably free from hairs; the face is bare but the occiput and cheeks present scattered short hairs; the thorax is practically bare, even including the pleura and sides of metathorax; the tip of the abdomen has a fairly dense fringe of hairs; the tibiæ and tarsi are quite hairy, the hairs of a dull whitish color.

Head of ordinary size, a little broader than long, dark green, the face very flat, vertex granular, clypeus punctured. There are no face-markings except an oblong dull yellow spot on the clypeus. Basal portion of mandibles yellow with a large dark spot. Glossa not hairy. Antennæ brown-black; flagellum whitish, scape and funicle testaceous beneath.

Thorax dark olive-green, metathorax bluish; the whole rather dull and finely sculptured. The pleura is quite shiny, but still sculptured. There are no pale marks on the thorax, but the tubercles, quite prominent, are dark brown.

Tegulæ hyaline with an opaque spot in front. Wings milky-hyaline, nervures and stigma dark brown, the latter pallid in middle. Marginal cell with the poststigmatal portion as long or a little longer than the substigmatal. Second submarginal large, narrowed more than one-half to marginal. Third discoidal distinct. Anterior knees, and anterior tibiæ in front, pale yellow. Abdomen above and below dark brown, without any pale markings. Tip emarginate.

Hab.—New Mexico, one specimen sent by Mr. Fox. Locality, etc., unknown. It resembles *P. phymatæ*, but is much larger than that or *asteris*. *P. asteris* has a hairy mesothorax; *phymatæ* has a nude mesothorax, but is much more shiny as well as being so much smaller. *P. semicærulea* has a hairy mesothorax.

A species found on Aster canescens.

57. Perdita asteris n. sp.

♀.—Length about or hardly 6 mm. Head very dark blue, thorax very dark green, metathorax dark blue. Both head and thorax are very hairy, with short hairs; the disc of metathorax bare, and the disc of clypeus seeming bare, but seen, when sideways, to have a fine down. Head rather large, rounded, about as broad as long. Vertex very finely granular, punctate; sides of clypeus punctate. Mandibles with the basal two-thirds very broad, whitish, becoming rufescent; the terminal third black, comparatively slender, coming to a point. Antennæ dark brown above, yellowish beneath. Pale markings of face yellowish-white, restricted to clypeus and sides of face. Clypeus high, pale with the usual dots, but with a dark blotch on each side above, so that the yellowish-white color rapidly narrows, but instead of coming to a point, broadens a little to an abrupt truncation on the upper clypeal margin. Lateral marks of face broadly triangular, the inner angle of the triangle being opposite to the point on the clypeus where the pale color suddenly narrows, and the upper angle (of about 30°) on a level with the antennal sockets.

Thorax with a very narrow yellow line on hind border of prothorax, and a very small yellow stripe on tubercles. Mesothorax dullish, granular.

Tegulæ pale, testaceous; wings milky-hyaline, nervures and stigma very pale yellow, nearly colorless, the latter centrally hyaline. Marginal cell moderately long and narrow, with its poststigmatal portion a little the longer. Second submarginal rather large, narrowed more than half to marginal, being not far from an equilateral triangle. Third discoidal distinct.

Legs pubescent, black; the tarsi all white with a testaceous or yellowish tinge; hind margin of first joint of hind tarsi blackish, anterior knees and anterior tibiæ in front pale yellow. Abdomen above shining piceous without markings, the hind margins of the segments a little rufescent. Venter dark brown.

Mut. ♀.—Clypeus all yellowish-white except the usual dots and two ill-defined brown spots above. A semilunar dull yellowish supraclypeal mark. One specimen.

Hab.—Las Cruces, N. M., Sept. 19, 1895, four specimens on flowers of *Aster canescens* var. *viscosus*. Prof. E. O. Wooton took one on the same flowers as late as the middle of October.

A species found on Senecio douglasii.

58. Perdita senecionis n. sp.

♀.—Length about 7 mm. Head and thorax dark, dull olive-green, even including the metathorax; conspicuously granular. Head a little longer than broad; face practically hairless, cheeks and occiput with short whitish hairs. Vertex depressed between ocelli and orbits. Mandibles stout, simple, gradually tapering, blunt at tips, pale yellowish with the apical half rufescent. Antennæ very dark brown, dull pale yellowish beneath. Face-markings cream color, very distinct, restricted to clypeus and sides of face. Clypeus high, flattened above, prominent, cream color with broad black bars. Supraclypeal region dark, elevated, convex. Lateral face-marks club-shaped, rapidly narrowing and continuing upward to a subtruncate termination on a level with the antennal sockets.

Thorax nearly hairless, as in *P. nuda;* the greater part of tubercles, and a broadly triangular patch on each side of hind margin of prothorax, shining pale yellow. (In *nuda* these pale markings are lacking.) Tegulæ hyaline, with a kidney-shaped pale yellow opaque patch. Wings slightly smoky, nervures and stigma dark brown, the latter pallid in center. Marginal cell rather long, appendiculate, its poststigmatal portion a little the longest. Second submarginal large, subtriangular, narrowed more than half to marginal. Third discoidal distinct. Legs black, knees pallid, anterior tarsi testaceous, anterior tibiæ yellow in front, middle tibiæ with a yellow stripe in front.

Abdomen above black, with eight creamy-white marks, just like those of *affinis.* Venter piceous.

Mut. ♀.—The abdominal pale marks reduced to six, the last two failing, one specimen.

Hab.—Las Cruces, N. M., six examples on flowers of *Senecio douglasii,* collected by Prof. E. O. Wooton, Oct. 9, 1895.

This interesting species is extremely close to *affinis,* and would be taken for it upon superficial examination. It differs, however, by the somewhat longer head, the narrower lateral face-marks, the larger size, and especially by the glossa presenting only a small patch of hairs near its tip, whereas in *affinis* it is strongly hairy for a considerable distance. *P. octomaculata* has the glossa also more hairy than in *senecionis.*

A small species found on Chrysopsis villosa.

59. Perdita vespertilio n. sp.

♂.—Length about 4 mm. Head and thorax shining black. Cheeks unarmed. Head rather large, especially in comparison with the small thorax, when seen from the front almost precisely circular. Front quite hairy, with white hairs; cheeks hairy. Antennæ dark brown above, pale yellowish beneath. Clypeus rather cocked-hat-shaped. Pale markings of face cream color, confined to clypeus and sides of face, with, of course, the labrum and basal portion of mandibles. Seen all together, they suggest the head of one of the long-eared bats, whence the specific name. The darkened upper portion of the labrum represents the bat's mouth. Clypeus cream-color, with the usual dots obscure. Lateral face-marks broadly triangular, the inner angle opposite the clypeal dots, the upper one (of about 45°) on a level with the antennal sockets. Thorax shining, smooth, tolerably hairy. Prothorax, including tubercles, dark, the tubercles brownish. Tegulæ hyaline; wings hyaline, iridescent, nervures colorless, stigma margined with very pale yellowish. Marginal cell fairly long and narrow, the poststigmatal portion a little the longer. Second submarginal subtriangular, narrowed a little more than half to marginal. Third discoidal absent.

Legs dark brown with the tarsi brownish-white; anterior tibiæ yellowish except a suffused brownish patch behind, middle tibiæ pallid in front.

Abdomen short and broad, above dark brown without pale markings, but the distal margins of the segments more or less pale. Venter brown.

Hab.—Las Cruces, N. M., Oct. 5, 1895, one specimen on *Chrysopsis villosa.* No more could be seen. The locality is about a mile southeast of the Agricultural College. This little species has some resemblance to *californica* and its allies, but a glance at the face will distinguish it.

Three species with large heads, from New Mexico, found on Compositæ.

60. Perdita grandiceps n. sp.

♂.—Length about 5 mm. Form stout; head quadrate, extremely large, larger than the thorax, eyes narrow, cheeks armed with blunt teeth. Face flattened, very sparsely and inconspicuously hirsute, cheeks hairy beneath. Color of head very dark bottle-green; vertex granular, it and front looking almost silky, cheeks much more shiny. Mandibles stout, curved, scimitar-shaped, base pale yellowish, end rufescent, blackish on inner side. Antennæ blackish above, yellowish-brown beneath; scape piceous, with a light yellowish spot at base in front. Clypeus rather low, anterior margin not produced into spines. Face-markings dull sulphur-yellow. Clypeus with a yellow longitudinal band, uniting with the broadly yellow anterior portion—or one might say, clypeus yellow with a pair of large triangular dark patches, the triangles having one side coincident with the hind margin. The extreme anterior edge of the clypeus is bordered with a black line. The supraclypeal mark is represented by a pair of squarish yellow patches; the dog-ear marks, on each side of these, are not much larger. The lateral yellow face-marks would form nearly equilateral triangles, but that the innermost angle is narrowly produced. The upper angle scarcely reaches the level of the antennal sockets.

Thorax not very shiny, the surface granular. No pale markings. Prothorax with prominent shoulders. Color of thorax black with a slight metallic tinge, becoming distinctly brassy-green on anterior half of mesothorax; metathorax blue-black. Pleura and sides of metathorax with white hairs; mesothorax with sparse hairs. Tegulæ hyaline subtestaceous. Wings milky-hyaline, nervures (except the dark costal nervure) practically colorless; stigma very pale yellowish. Marginal cell obliquely truncate, substigmatal portion a little the longer. Second submarginal narrowed hardly one-half to marginal, third discoidal excessively weak.

Legs shining black, with white hairs. Anterior coxæ with a very noticeable tuft of white hairs. Tarsi becoming brownish. Anterior knees, and anterior tibiæ in front, yellow.

Abdomen oval, shining piceous without light markings. Margins of the segments a little rufescent. Venter brown.

Hab.—Las Cruces, N. M., on *Solidago canadensis*, Sept. 3, 1895, one specimen (Ckll., 4,746). It was associated on the flowers with *Melecta maculata, Anthophora maculifrons, Perdita semicrocea, Colletes, Heriades, Prosopis* 2 spp., *Oxybelus* 2 spp., *Philanthus* and *Odynerus.*

61. Perdita crassiceps n. sp. Fig. 15 (head.)

♂.—6 mm. long. Smooth and shiny; head and thorax so dark green as to seem black, metathorax very dark blue. Head quadrate, extremely large, eyes comparatively small and narrow. Vertex minutely granular, but nevertheless shining, with a transverse ridge behind the ocelli. The punctuation is sparse. Cheeks unarmed; mandibles rather long, scimitar-shaped, blunt at tips, pale yellowish becoming rufescent distally, the tips blackish. Antennæ dark brown above, yellow beneath. Clypeus wholly pale yellowish, except the usual black dots, and a pair of obscure suffused brownish spots adjacent to hind margin. Supraclypeal mark wanting. Dog-ear marks present. Lateral face-marks white, broad, subquadrate, the lower border occupied by a black line, the upper border passing somewhat obliquely from the point on orbital margin opposite the antennal sockets, to slightly below the upper end of the dog-ear marks.

Thorax smooth and shining, mesothorax sparsely punctured; hairs on thorax above sparse, brownish, those on pleura white. No light markings except that the tubercles are pale yellow with a dark spot, and the collar shows a little yellow.

Fig. 15.

Tegulæ pale testaceous; wings hyaline, nervures practically colorless, stigma very pale yellowish. Marginal cell rather long and narrow, its poststigmatal and substigmatal portions about equal. Second submarginal subtriangular, narrowed more than half to marginal. Third discoidal very weak.

Legs black with the knees and tarsi testaceous; anterior and middle tibiæ testaceous in front. Abdomen above shining dark brown, the hind margins of the segments a little pale; no light marks. Venter light brown.

Hab.—Albuquerque, N. M., June 30, 1895, one specimen on a yellow-flowered species of Compositæ not identified. (Ckll., 3,253.)

62. Perdita laticeps n. sp.

♂.—5½ mm. long. This greatly resembles *crassiceps,* in fact I had regarded them as the same until a close examination was made when writing the description of the latter. *P. laticeps* differs from *crassiceps* as follows:

The head is a little larger, the face is much more hairy, the sides of the cheeks are covered with short hairs (whereas in *crassiceps* they are bare and shining), the clypeus is distinctly panama-hat-shaped, the supraclypeal mark is represented by a narrow transverse line, adjacent to the upper border of the clypeus, the dog-ear marks are absent, the antennæ are dark brown above and below, the mandibles are stouter, the anterior and middle tibiæ are not testaceous in front, the hind tibiæ are more hairy, the abdomen is considerably shorter and broader, with the hind margins of the segments broadly hyaline. The tip of the abdomen is narrowly but abruptly truncate. There is no transverse ridge behind the ocelli, but this area shows strong punctures, which are wanting in *crassiceps.* The wings are as in *crassiceps.*

Hab.—Las Cruces, N. M., one collected by Mr. A. M. Holt on *Verbesina encelioides,* Sept., 1895. This species is allied to *interrupta* and *californica.*

Species found on Verbesina encelioides in the Mesilla Valley, N. M.

63. Perdita beata n. sp.

♀.—Length 8–8½ mm. Entirely bright canary-yellow; except the flagellum blackish above, the usual clypeal dots, an obscure black line round the lower part of the dog-ear marks, especially on the inner side; a black band, not quite as long as the scape, before each orbit; a short black line on each side of second abdominal segment; a dark shining pit on the hind part of the metathorax; and the lower (ventral) half of the pleura black. Wings hyaline, nervures and stigma very pale yellow. Marginal cell large, poststigmatal portion longest. Second submarginal narrowing hardly one-half to marginal. Third discoidal distinct. Hind tibiæ and tarsi very hairy. Mesothorax, scutellum and postscutellum with short dense erect yellow hairs. Ocelli dark. Ends of mandibles dark, the mandibles being quite abruptly bent before the dark portion. Terminal portion of glossa not hairy.

Hab.—Las Cruces, N. M., on flowers of *Verbesina encelioides.* The first was taken in September, 1895, by Mr. A. M. Holt. On Sept. 20th I took one, and again another on Sept. 28th.

This lovely insect is a sort of gigantic *P. luteola;* but the mesothorax of *luteola* is bare, while that of *beata* is very bristly; *luteola* also does not show the black on under part of pleura.

64. Perdita perpulchra n. sp.

♀.—Length 8½–9 mm. Head and thorax bronzy-green, densely covered (except the smooth disc of metathorax and middle of face) with short erect pale yellowish hairs, which become longer on the the pleura and cheeks beneath, and sparse on the vertex. Head of ordinary size, subtriangular or broadly subcordiform; vertex dullish, granular; clypeus approximately cocked-hat-shaped. The conspicuous white hairs on face are arranged so as to seem to radiate from the antennæ; but the disc of the clypeus, and the area above it and between the antennæ, are bare. Mandibles abruptly bent before their dark ends. End of glossa with a conspicuous brush of hairs. Antennæ yellow; flagellum, funicle and end of scape black above. Clypeus (except the usual pair of dots) and lateral face-marks yellowish-white. No supraclypeal or dog-ear marks. Lateral pale marks subtriangular, the inner angle next to clypeal dot, the upper one (of about 30°) on a level with the antennal sockets. Mesothorax dullish, finely punctured as well as very bristly. Disc of metathorax bare and shining, with very fine striatulate sculpture. Prothorax (including tubercles) yellowish-white, except a transverse dark line widening centrally into a large dark patch.

Tegulæ hyaline. Wings hyaline, nervures and stigma very pale yellowish.

Stigma small; marginal cell long, its poststigmatal part much the longest. Second submarginal large, subtriangular, narrowed considerably more than half to marginal. Third discoidal distinct. Legs yellowish-white, posterior tibiæ very hairy; anterior femora below, except at distal end, a patch on anterior tibiæ behind, middle femora below, a patch on middle tibiæ behind, hind femora with a band above and an oblique streak near base within, hind tibiæ, except proximal fourth and middle and hind tarsi, black.

Abdomen above white with black bands. First segment with two black spots in front, and a large broad black triangle, having for its base the whole distal margin of the segment. Segments 2–4 each with a distal black band, which is swollen in front sublaterally, and behind laterally, the swelling or patch in the latter case being on the next segment. Tip of abdomen dark brown, the pygidial area smooth and shining, though microscopically subpunctate, extreme tip rather broadly truncate, subemarginate. Venter mostly black, with a white spot on hind margin of each segment, and the sides largely whitish.

Mut. ♀.—The dark triangle on first abdominal segment with a small central light triangle. Abdominal bands broader, and continuously invading the segment following.

Hab.—Las Cruces, N. M., on flowers of *Verbesina encelioides*, one taken by Mr. A. M. Holt in the fall of 1895, and one by myself on Oct. 5th. A very beautiful and distinct species. It differs at once from *albovittata* by its larger size, non-hairy clypeus, lateral face-markings narrowing above, etc.

65. Perdita albovittata Ckll., Proc. Phila. Acad., 1895, p. 15. ♀. (Hab., San Augustine, N. M.).

The two specimens taken at San Augustine on Aug. 29th are both females, not ♂ and ♀, as formerly stated. Miss Mae Gilmore took a ♀ in the Mesilla Valley, close to the Agricultural College, Sept. 23d, on *Verbesina encelioides*.

On Oct. 4th, at the same locality, Mr. C. Rhodes was so fortunate as to find a ♂ on *Verbesina encelioides.* The glossa of the ♀ shows two brushes of hairs, separated by an interval; that of the ♂ is bare.

The ♂ is only about 4½ mm. long (♀ 5½), and differs at once by the abdomen, which is short and broad, black, with the margins of the segments appearing broadly whitish because hyaline. The sides of the first three segments show obscure whitish marks—all that is left of the bands of the ♀. The venter resembles the upper surface. The tip is rufous, produced, narrowly truncate.

The face-markings, differently from most species, are as in the ♀. The antennæ are entirely brown-black. Cheeks unarmed.

There is a singularly close resemblance between the ♂ of *albovittata* and *laticeps,* so that the idea suggests itself that *laticeps* may be a dimorphic large-headed ♂ of *albovittata.* But this could not be taken as proven without positive evidence, or at least some analogous case in the genus to guide us. Cresson has referred to a ♂ specimen of *texana* (*megacephala*) in which the head was unusually large, but it may have been a different species.

66. Perdita vagans n. sp.

♂.—Length 4½ mm. Head and thorax shining, blue-black, with sparse hairs which are quite long behind the ocelli. Head moderately large, rather broader than long, cheeks unarmed, vertex shiny though feebly microscopically granular; clypeus panama-hat-shaped, with the crown rather high. Cheeks wholly dark; labrum and mandibles pale yellowish. Clypeus pale yellow with the usual black dots. Dog-ear and supraclypeal marks wanting, though the former are represented by hardly noticeable pallid specks. Lateral pale yellow face-marks subquadrate, nearly the shape of the mainsail of a schooner, though shorter, the upper outer angle (of about 50°) about on a level with the antennal sockets. Antennæ sepia-brown above, yellowish beneath. Thorax smooth and shining. Tubercles, and a couple of small spots on hind margin of prothorax pale yellow. Pleura not very hairy. Tegulæ hyaline. Wings hyaline; stigma pale yellow, nervures colorless. Marginal cell rather long, its poststigmatal portion a little the longest. Second submarginal nearly triangular, narrowed more than half to marginal. Third discoidal absent.

All the femora, and the hind tibiæ, black with the ends subtestaceous yellowish. Anterior and middle tibiæ yellowish with a dark patch behind. Tarsi all pale yellowish testaceous.

Abdomen rather broad, dark sepia-brown, without light markings, the distal margins of the segments more or less pallid. Venter pale brown. Tip pale testaceous.

Hab.—Las Cruces, N. M., one on *Verbesina encelioides*, Sept. 28, 1895.

I had considered the possibility that this might be the ♂ of *asteris*, but it differs too much from it for this to be likely, I think.

Group of P. albipennis.

67. **Perdita sparsa** Fox, Proc. Cal. Ac. Sci., 1893, p. 16. ♂ ♀ (Hab., Margarita and Magdalena Islands, L. Cal.)

Collected by Mr. Haines in March, being, therefore, distinct from the other members of the group by its vernal appearance. I have examined a ♀ from Magdalena I., March, 1889, one of the types. It is very near to *albipennis*, and the difference of punctuation, mentioned by Mr. Fox, is not a very satisfactory character. It is, however, readily distinguished thus:

P. sparsa ♀.	*P. albipennis* ♀.
Nervures dark.	Nervures colorless.
Stigma margined with brown.	Stigma not so margined.
Size a little smaller.	
Median mark of clypeus broad, lance-head-shaped, going to a point above.	Median mark broadening above to a T-shape.
Three yellow bands on abdomen, first entire, the other two with a linear interruption.	

68. **Perdita verbesinæ** n. sp.

♀.—Length 7 mm. Head and thorax green, abdomen black, wings milky-hyaline. Head rounded, moderately small, unusually pubescent, especially on occiput and cheeks, the hairs on occiput pale fulvous, those on face and cheeks white. Face and vertex brassy-green, vertex rather strongly rugulose, and sparsely punctured. Mandibles rufescent, yellowish at base, simple but strongly elbowed; clypeus black, punctured, with a longitudinal central yellow line, not always produced to the margins, and a more or less developed yellow patch on each side at anterior margin. Sides of face below, adjacent to clypeus, with a yellow patch. These face-markings are of essentially the same pattern as those of *albipennis*.

Antennæ blackish, a yellowish spot at base of scape beneath, and flagellum yellowish below. Mouth-parts much elongated, glossa almost naked, or with the terminal half hairy.

Thorax shining brassy-green, pubescent as in *albipennis*, and with the yellow also more or less developed on collar and hind border of prothorax, but not on tubercles, except in the form of a very small spot, which may be absent. Metathorax dark green, sometimes a little bluish.

Legs dark, pubescent, the hairs on posterior tibiæ especially long and dense, as in *albipennis;* tips of anterior femora, upper two-thirds of anterior tibiæ in front, yellow. Tegulæ yellowish-hyaline. Stigma very pale yellowish, nervures almost colorless, the portion of marginal cell beyond stigma conspicuously longer than that below it; second submarginal narrowed about one-half to marginal, third discoidal distinct.

Abdomen above black, nearly naked, except the last segment, which is densely fringed with white hairs. Fourth segment with two yellow spots, absent in specimens lacking the face-markings (mut. *nigrior*). Pygidial area conspicuously rufous. Venter dark.

Mut. ♀, *nigrior.*—Stigma colorless, pale marks of head and thorax absent, pubescence of mesothorax white instead of yellowish, vertex a slightly bluer green, metathorax tinged with blue above, last joint of antennæ with a slight hook, abdomen without yellow spots. (Ckll., 4,908.)

Mut. ♀, *intermedia.*—Stigma pale yellow; vertex rather more brassy, lateral pale marks of clypeus absent. Abdomen with segments 2–4 each with a pair of yellow marks, those on 2 and 3 transversely elongate, those on 4 larger and rounder. First taken by C. Rhodes on *Verbesina.* Sometimes the spots on segment 2 are lacking. The lateral pale marks of clypeus may also be more or less developed.

♂.—Head larger and broader, cheeks strongly bulging below, but not spined; antennæ with the scape and funicle black above and yellow beneath, flagellum orange with the first two joints black or blackish above. Lower corners of face, and clypeus, yellow, the clypeus with two longitudinal black marks, and a black dot on the outside of each, after the manner of *P. numerata.* In some examples the clypeus is black with a median longitudinal yellow line, and the lower corners broadly yellow, the yellow sometimes enclosing a black spot near its upper limit. (Ckll., 4,906, 5,054.) Prothorax without any yellow, except on collar above. Tarsi mostly pale, in addition to the pale leg-markings of the ♀. Ends of middle tibiæ also pale.

Abdomen without the two spots of the ♀, but the distal margins of the segments hyaline, with narrow dull yellowish bands, broadly emarginate on each side proximally.

Mut. ♂, *maculata*.—Hind margin of prothorax with two small yellow marks. (One on *Verbesina encelioides*, Sept. 28th.)

Mut. ♂, *cyanella*.—Size small. Metathorax blue. (One on *Helianthus annuus*, Sept. 21st). This agrees with true ♂ *verbesinæ* in the dull front, orange flagellum, absence of spots on hind border of prothorax, etc.

Hab.—Las Cruces, N. M., abundant on flowers of *Verbesina encelioides*, Sept. 11th to 20th of October. On Sept. 28th, after wet weather, they were freely copulating on the flowers. One had been caught by a *Phymata*. On Sept. 21st, a ♀ of mut. *intermedia* and the ♂ mut. *cyanella* were taken on *Helianthus annuus*.

69. **Perdita albipennis** Cr., Tr. Am. Ent. Soc., 1868, p. 386. ♀ (Hab., New Mexico, Colorado).

♂. *Perdita hyalina* Cr., Tr. Am. Ent. Soc., 1878, p. 68. (Hab., Colorado).

The original type of *albipennis* was taken in 1867 by Dr. Samuel Lewis, on a journey from Fort Wallace, Colo., to Fort Craig, N. M. The types of *hyalina* were taken by Messrs. Ridings and Morrison. In the latter part of July, 1895, I took the typical form, in both sexes, on flowers of *Helianthus annuus* at La Junta, Colorado. The males have the flagellum mostly orange, spots on hind margin of prothorax, front shiny. *P. hyalina* is apparently a slight variety.

Var. helianthi.

♂.—Differs from *verbesinæ* ♂ by its comparatively shining front, blackish flagellum, and two spots on hind border of prothorax. Differs from *albipennis* ♂ by having the yellow marking on abdomen as in *verbesinæ*, and the dark flagellum.

♀.—Abdomen striped as in *albipennis*, from which it is hardly to be distinguished. In *helianthi* the stigma, when well colored, is lemon-yellow, while in *albipennis* it becomes pale orange, and is quite large. From *verbesinæ*, the ♀ *helianthi* differs by its well-striped abdomen, and the head is a little larger.

The var. *helianthi* is occasionally taken (at least the ♀s) on *Verbesina encelioides* (Oct. 5th, etc.), at Las Cruces, N. M., but it is the usual form in that locality on *Helianthus annuus* (Sept. 22d, etc.).

Of 46 ♀s from *Verbesina,* 43 are *verbesinæ* and 3 *helianthi.* The The earliest date for *helianthi* is July 29, 1893. (Ckll., 339, a ♂.) On Aug. 26, 1893, I took both sexes at Juarez, Mexico; these were recorded as *albipennis* and *hyalina* in Ann. Mag. N. Hist., Feb., 1895, p. 206.

Mut. ♂, *pasonis.*—Length 8½ mm. Resembles *verbesinæ* in its dull front and the absence of spots on hind margin of prothorax. Resembles typical *albipennis* by the absence of yellow on the abdomen. Resembles *helianthi* by the dark flagellum which is black above, dull testaceous below. Maxillary palpi with the last four joints practically equal. Front and mesothorax olive-green, cheeks and metathorax greenish-blue or prussian-green, in strong contrast. Tip of abdomen unusually broad. Marginal cell somewhat longer than usual.

I took one specimen of this at El Paso, Texas, Aug. 25, 1893. I was a little perplexed whether to refer it to *verbesinæ* or *albipennis.* Mr. Fox named it *hyalina* Cr., and indeed it must come very near the form so named by Cresson, which had the dark flagellum, though the head and thorax were bluish-green.

Var. ♀ lingualis.

Length about 10 mm. Abdomen above with yellow bands on segments 2–4, the first two narrowly interrupted in the middle, the last two failing some distance before the lateral margin. Metathorax dark blue, head dark blue-green, mesothorax and scutellum dark olive-green. Front moderately shiny. Hind border of prothorax marked with yellow. Stigma inclining to pale orange. Second submarginal cell not narrowed half to marginal. Flagellum dark. Clypeus yellow with two black blotches above, sufficient to mark out the yellow T.

The above characters are probably, in part, individual ones, but the glossa is very conspicuously hairy all along, thus differing from that of *helianthi, albipennis* type, and *verbesinæ,* in which it is comparatively naked, except the terminal half in some examples of *verbesinæ.* When using a compound microscope to more accurately determine the character of the glossa, I was surprised to find also a difference in the maxillary palpi. In *lingualis* the last two joints of these palpi are short and of equal length, while the two before them are long and also equal. In *helianthi* the last joint is long, the two before it short and equal, and the two before them long and equal to one another and to the last.

The var. *lingualis* is founded on a single ♀ from Fort Collins, Colorado, Aug. 8, 1895. (Baker.)

The known range of *P. albipennis* is greatly extended by a ♀ sent to me by Mr. Fox, caught in Nowlin Co., South Dakota. The name of the collector does not appear on the label. The clypeus is marked practically as in *lingualis*, but the glossa is not hairy. Stigma pale orange. Second submarginal cell narrowed fully one-half to marginal.

Since the above was written, Mr. Fox has examined for me Cresson's types of *hyalina* (♂), and reports that one has the abdominal marks as in *verbesinæ* and *helianthi*; but the other must be held to be the true type, as Cresson does not mention the marks. The form above, described as *pasonis*, has only a very small clypeal mark, so it is in all respects very similar to what we must call *albipennis* var. *hyalina* (Cr.).

Many years ago, *P. albipennis* was taken by Belfrage in Bosque Co., Texas. (Cresson, Tr. Am. Ent. Soc., 1872, p. 261.) This is a little east of the 98th meridian.

70. Perdita lepachidis n. sp., or race.

♂.—Length about 6½ mm. Resembles the ♂ of *albipennis*, but head and thorax brassy-green, not at all bluish-green. Vertex quite densely and deeply punctured. Clypeal markings reduced to a yellow median line and yellow lower corners, occasionally the whole anterior margin of clypeus yellow, connecting with the longitudinal line. Mandibles simple. Metathorax rather inclined to bluish. Wings and abdomen as in ♂ *albipennis*.

The flagellum is orange, the two spots on the hind margin of prothorax are feebly developed, the front is fairly shiny, not nearly so dull as in *verbesinæ*.

Hab.—On flowers of *Lepachys tagetes* (James), Santa Fé, N. M., July 30, 1895, and Socorro, N. M., June 29th. I do not know how late it flies, but the *Lepachys* is over sooner than the *Verbesina* or *Helianthus*. The characters of this species or race are slight, but constant in the specimens examined. The ♀ is unfortunately unknown.

Appendix: Species received since the above paper was written.

Perdita utahensis n. sp.

♀.—Length 8 mm. Head dark blue-green, thorax brassy-green; *Metathorax green, not blue*, but so dark as to be almost black. Head of ordinary size, about as broad as long; face and cheeks hairy, the hairs dull white, those on occiput gray. *Front strongly granular, with moderately close punctures; facial ridge with a median* *linear groove,* extending down on the ridge as far as the level of the antennal sockets. Clypeus cocked-hat-shaped, but rounded and broad above, and unusually high, *entirely pale yellow except the usual two dots.* Lateral pale yellow face-marks triangular, the inner angle opposite the clypeal dot, the upper angle (of about 40°) level with the antennal sockets, on the orbital margin. The inner side of the triangle is straight or nearly so, not notched as in *bigeloviæ.* Supraclypeal and dog-ear marks absent. Mandibles simple, with the basal three-fifths very broad and pale yellowish ; and the terminal two-fifths strongly bent inward, dark rufous-brown, slender, coming to a point. Antennæ with the *scape all yellow,* funicle yellow with a brown blotch above ; flagellum brown, dark above, pale below, first joint all yellow below.

Thorax, including mesothorax and pleura, *quite hairy,* disc of metathorax bare. The abundant short bristles on the mesothorax have a yellowish tinge. Pleura all dark. *Collar and hind border of prothorax broadly, connecting with tubercles, pale yellow.* The prothorax is thus practically all yellow except a large wedge-shaped portion on each side. Mesothorax shiny.

Tegulæ hyaline, with a yellowish opaque subreniform mark. Wings hyaline, *nervures and stigma pale brown,* the latter not centrally hyaline. Marginal cell long and rather narrow, squarely truncate, its poststigmatal portion much the longest. Second submarginal large, not narrowed half to marginal. Third discoidal distinct, rather narrower below than is usual. Legs hairy ; femora yellow, middle femora with a little brown at base below. Tibiæ and tarsi pale brown ; anterior tibiæ yellow in front and with a yellow streak behind.

Abdomen above with *about equally broad dull yellow and black bands,* the latter five in number, but the last not so well-defined. First segment with an oblique black mark on each side before the band. The first band touches on each side a black longitudinal groove such as is seen on the side of the second segment in *luteola* ♀. The second and third bands present a small lobe on each side below. The fourth band below has a median projecting tongue. Venter pale dull yellow, broadly mottled with brown medially.

Hab.—Southwest Utah, collected by Mr. Palm, sent by Mr. C. F. Baker, one specimen. Type in coll. Baker.

This, the first *Perdita* recorded from Utah, belongs near *albipennis,* etc., but will be readily recognized by the characters I have italicized.

THE MOLTING OF BIRDS WITH SPECIAL REFERENCE TO THE PLUMAGES OF THE SMALLER LAND BIRDS OF EASTERN NORTH AMERICA.

BY WITMER STONE.

The lack of definite information regarding the seasonal plumages of our birds which characterizes most of the works on North American ornithology, as well as the scarcity of recorded facts relative to the methods by which the plumages are assumed, must have impressed all who have had occasion to seek for information upon these subjects. This is unquestionably due, in a great measure, to the scarcity, in collections, of molting specimens and adults in fall or winter plumage. Molting specimens are only to be obtained during July and August in this latitude, and collecting at this season is not only difficult on account of the retiring habits of the birds during the period of molt, but also exceedingly unpleasant, being the height of our hot season. Furthermore, professional collectors have not been encouraged to collect molting birds since the most marketable specimens are full-plumaged spring birds. To this cause, too, is probably due the great scarcity of North American birds from the tropics, showing the progress and nature of the early spring molt, since collectors visiting these regions have paid more attention to securing fine specimens of the native species.

In view of the state of our knowledge of molts and seasonal plumages and the scattered nature of the literature bearing upon the subject, I have prepared the following pages, more with the hope of attracting attention to this branch of ornithological investigation, than of assuming to present a finished treatise.

For some years past I have been paying special attention to the acquisition of a series of molting specimens of our eastern North America birds and my own collection, together with that of the Academy of Natural Sciences of Philadelphia, furnishes a considerable amount of such material. I have also examined a large number of specimens in the United States National Museum, and additional series have been kindly loaned by Mr. Robert Ridgway of the above institution, Mr. Wm. Brewster, of Cambridge, Mass., and Dr. J. A. Allen of the American Museum of Natural History.

In spite of this, however, I have frequently been confronted with questions which can only be settled by the acquisition of additional material. Owing to this lack of specimens, I have no doubt that alterations will have to be made in my accounts of the molt in several species, in the light of future investigation. I nevertheless think it desirable to publish, at once, such information as I have collected, as a basis for future work.

In the first part of this paper will be found a general account of the methods of plumage change, based upon my studies, and all statements will be understood to refer only to the groups here under consideration. As no general paper on molting has appeared recently, it seemed best to treat the subject at some length in this connection; but it must be understood that I do not claim originality for all the statements given below as many of the facts have long been known. I have, however, made no statements that have not seemed to be verified by my own investigations. The second part consists of brief accounts of the molts and seasonal plumages of most of the smaller land birds of eastern North America, from the Cuckoos through the Passeres in the order of the American Ornithologists' Union Check List. The Raptores, Columbæ, Gallinæ and all the Water Birds have been omitted for want of sufficient material for their proper study, though they will probably exhibit still more interesting facts than those furnished by the groups here under consideration.

The difficulties that present themselves in a study of this nature are many. Chief among them is the impossibility of telling the age of most of the specimens upon which we must base our investigation. The study of live birds is, of course, out of the question, and even were it possible the results would not prove satisfactory, as it has been shown that plumage changes in captive birds are often abnormal.

Thrown back upon a study of prepared skins, our only method of telling what year in the life of the bird a certain plumage represents, is by having a sufficient series of specimens, taken while actually in the molt, to connect the various known plumages. Such series are at present very hard to obtain, as has already been stated, and we are, therefore, often forced to judge from comparison of series taken before and after the molts, which is of course much less satisfactory. Many specimens, however, which are apparently not molting, often show traces of an old plumage which has just been lost or a new one just appearing, when the feathers are carefully raised on various parts of the body; and much of my information has been gained from such specimens.

It is generally considered, and in many cases actually proven, that the most perfect and brilliantly plumaged individuals of a species are the oldest, or at least are birds of several years of age, and I have followed this idea in treating of the species in the latter part of the present paper. It is, however, quite likely that certain individuals, whether from excessive vitality or some other cause, assume the adult dress at an earlier period in their life than others and that certain other individuals never attain the highest development of plumage coloration exhibited by the species.

The scarcity of adult birds in winter plumage (*i. e.* the dress assumed at the end of the breeding season) has already been mentioned. The fact that the number of these birds taken in September and October is often so remarkably small as compared with the birds of the year, seems to me good evidence that they not only start on their southward migration sooner than the young, but that they make a more continuous journey with fewer and shorter stops.

The difference in the numbers of these birds taken by autumn collectors is real and not imaginary. Mr. C. W. Beckham in 1887 called especial attention to it[1], giving the above explanation. He stated that between Sept. 1 and Nov. 22, 1886, he collected 367 birds of which 348 were birds of the year, the determination of age being based upon examination of the skeleton. In the fall series that I have examined, where the difference between the bird of the year and adult was clearly indicated by the plumage, I find the proportion of old birds very small; but I think that careful collecting carried on through August will result in the discovery of a large number of adult birds present at that time, which leave before the usual fall collecting begins.

As a result of the studies given in detail farther on, the following generalizations may be made:

I. The annual molt at the close of the breeding season is a physiological necessity and is common to all birds.

II. The spring molt and striking changes of plumage effected by abrasion are not physiological necessities and their extent is dependent upon the height of development of coloration in the adult plumage, and does not necessarily bear any relation to the systematic relationships of the species.

It naturally follows that closely related species may differ materially in the number and extent of their molts, and that

[1] Auk, 1887, p. 79.

males and females of the same species differ greatly in this respect when the nuptial plumage of the adult male is highly developed as compared with that of the female or with its own winter plumage.

III. The amount of change effected in the plumage at any particular molt varies considerably in different individuals of the same species and sex.

IV. Some species which have a well marked spring molt in their first and second years may discontinue it afterwards, when the adult plumage has once been acquired. And, on the other hand, some individuals may continue to molt in the spring, while others of the same species cease to do so.

V. The remiges are molted less frequently than any other part of the plumage. As a rule, they are only renewed at the annual molt (exception *Dolichonyx*).

VI. Variability in the order of molt in the remiges and presence or absence of molt in the flight feathers at the end of the first summer are generally family characters *i. e.*, *Ceryle* differs from any other species treated of in this paper in the order of molt in the primaries. All Picidæ and all Icteridæ except *Icterus*, (and *Dolichonyx* ?) molt the flight feathers with the rest of the first plumage. None of the Oscines except Icteridæ (as above), some (all?) Hirundinidæ, *Otocoris* and *Cardinalis* molt the flight feathers at this time.

Some other exceptions to the above statements no doubt occur, but they cover the vast majority of cases.

In connection with the second statement attention should be called to *Ammodramus sandwichensis savanna* which has practically the same plumage at all seasons, but which has an extensive molt of the body plumage in spring. *Melospiza fasciata*, which closely resembles it in plumage at all seasons, has scarcely a trace of spring molt. *Ammodramus caudacutus* is the only other species that shows any considerable spring molt, and in which the sexes are not strikingly different.

As stated above, the number and extent of the molts do not of necessity bear any relation to the systematic position of the species. The Fringillidæ include species which exhibit the simplest series of molts as well as some examples of the most complicated molting known among the Passeres. The species of certain families do show practical uniformity in their molts, but in such cases there is also uniformity in the relative development of plumage of the sexes.

The Icteridæ exhibit the greatest number of exceptions to the general rules of molting and are more complicated in their molts than any other family. In most families complicated molting is the exception, in the Icteridæ it is the rule.

ORDER OF MOLT.

The molt is occasioned by the growth of new feathers from the old papillæ, each new feather forcing out the old one on its tip. The point of attachment, however, is so brittle that the old feather is almost immediately broken off, but in young birds molting from the first plumage into their winter plumage, the old feathers are not infrequently found still attached to the tips of the new ones. A young Meadow Lark, *Sturnella magna*, in my collection shows this very nicely, and Mr. William Palmer[2] mentions a young Hooded Warbler, *Sylvania mitrata*, in which the down of the nestling was to be seen at the tip of the first-plumage feather while it was in turn attached to the new feather of the winter plumage (Pl. IV, figs. 5, 6).

The feathers are, of course, not all shed at once, but the new feathers on certain parts of the body have nearly completed their growth before those on the other parts make their appearance.

The first body-feathers to appear, in our passerine birds at least, are those of the abdominal tracts, forming a conspicuous V-shaped patch against the old plumage of the rest of the lower surface. Almost coincident with these appear the feathers of the inter-scapulary region and shortly afterward those of the throat and crown; there is, however, a good deal of variation in the order of appearance of the other body feathers (in fact, of all, after the development of the abdominal tracts) in different species and also, I think, a good deal of individual variation. This will be seen in the table on page 115.

In the molting of the wings, the feathers are shed one or two at a time, and symmetrically from the two wings. The first of the quill feathers to molt are the two innermost primaries which are probably shed at almost the same time, as they are at nearly all stages of about the same size (Pl. IV, figs. 1, 2 and 3). Following these the primaries are shed at short intervals, one at a time, finishing with the outermost. The only exceptions that I have noticed to this order are in the Belted Kingfisher, *Ceryle alcyon*, and the Snow Bunting, *Plectrophenax nivalis*.

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[2] The Auk, 1894, p. 287.

The Kingfisher is strikingly different from any other bird examined, in that the first wing feather molted is the fourth primary followed successively by the third, second and first (Pl. V, fig. 3). Three specimens taken at Sicamous, British Columbia, July 18, 1892, show precisely the same order of molt and are in almost the same stage. How the molt proceeds after the first primary is shed, I am unable to say, though the fifth is probably the next to be renewed, followed by the others in regular order inward.

One male *Piranga erythromelas* shows the 7th and 8th primaries molted first, followed by the 6th; while the 9th was shed simultaneously with the 5th. This, however, seems to have been an individual exception.

In the Snow Buntings two molting females (Disko, Greenland, Aug. 11th) show that the innermost primary is lost first, followed by the next four almost simultaneously and then the others in rapid succession. The loss of all these feathers occurs so nearly at the same time, that all but two of the old primaries are shed before *any* of the new ones have grown as long as the secondaries (Pl. V, fig. 4).

The first secondary feather to be molted is the outermost, followed by the others in regular order. The secondaries, however, do not begin to molt until the primaries have nearly all been renewed, the first new secondary appearing simultaneously with the 4th or 5th primary—*i. e.* when only three or four of the old primaries remain (Pl. V, fig. 5).

The first tertial generally appears a little before the first secondary.

The primaries and secondaries seem to be the most persistent of the bird's feathers, and when they are shed, there is always, so far as I have been able to ascertain, a complete molt.

The tertials on the other hand are frequently renewed independently of the other wing feathers during the spring, when there is a partial molt in some species.

As regards the molt of the tail, it has generally been stated that the feathers are shed symmetrically and successively a pair at a time while this may be true it is nevertheless a fact that in many, probably most, of our smaller land birds, the molts of the successive pairs occur in such rapid succession that the bird is for a brief time practically tail-less, and the half grown feathers appear to be all of nearly the same size as in the case of the first tail of the nestling, when partly grown. In other words the first pair of new tail-feathers does not reach a functional length before the last pair of old feathers is shed.

In cases where there is an appreciable difference in the time of shedding the different pairs of tail-feathers, it is the general rule that the outermost pair is the last to be shed, and birds are not infrequently found with the new central pair of tail-feathers half-grown, while the old outermost pair is still retained (Pl. V, fig. 2). The swallows are especially good examples of this, as the molt of the tail in this group seems to be very gradual (Pl. IV, fig. 4).

In *Quiscalus* and some other birds the central pair is the last to be molted, all the others having nearly completed their growth before the old middle feathers are shed.

In the Woodpeckers the molt begins with the pair next to the middle[3] and extends outward while the central pair is the last to be shed (Pl. V, fig. 1).

In this family the tail has a particular function,—*i. e.* in climbing; hence the slow molt, as the birds would be at a great disadvantage if the whole tail was lost at once. The central pair of feathers are of particular importance, and the old ones are, therefore, retained until the new quills of the next pair have become sufficiently developed to temporarily take their place during their own renewal.

The tail-feathers generally correspond with the primaries and secondaries in the number of molts which they undergo during the year, but in some cases where there is a spring molt of the body feathers, together with the tertials, there is also a complete molt of the tail, while the primaries and secondaries are not renewed. This takes place—in certain individuals at least—in the Sharp-tailed Finch, *Ammodramus caudacutus*.

Another peculiarity of the tail-feathers is their renewal at times other than those of regular molt, when they have been lost through accident. This does not occur in the wing feathers so far as I am aware. Perhaps owing to the fact that the wing feathers are so much more firmly rooted than any of the other feathers, they are rarely if ever lost through accident, and hence the necessity for renewal does not arise; while the tail-feathers on other hand are the most frequently lost of any of the feathers, for, owing to their position, they are often caught and pulled out by beasts or birds of prey.

Having considered the order of the molt in the body-feathers, wing and tail separately, it remains to consider the relative time of molt

[3] In one specimen of *Dryobates pubescens* examined, this pair and the next outer pair were shed simultaneously.

in the three. So far as I can judge from the material that I have, the first two or three primaries are generally shed before the feathers of the abdominal tracts are expanded and the outermost primary is lost at about the time that the body-plumage is completely renewed, while the tail in the majority of species is shed just previous to this—*i. e.* when one or two of the old primaries still remain.

A knowledge of these relations is very valuable in determining whether early fall specimens are adults or birds of the year. In the former the outer primary will be found not quite completely grown, or at least with remains of the embryonic sheath at its base, while in the birds of the year no trace of recent growth or immaturity will be found in the wing or tail feathers, except in a few species which molt the remiges and rectrices of the first plumage in the fall.[4]

As regards species in which the molt of the tail occurs gradually the first tail feathers are shed about the same time as the sixth primary, while the last are shed simultaneously with the last or next to last primary.

In the Tyrannidæ, the body feathers begin to molt sometimes before the first flight feather is shed, and in young *Sphyrapicus* much of the first plumage is retained till long after the flight feathers have been renewed.

The following tables show the relative molting of the feathers in some of the specimens examined, and referred to above :—

I. RELATIVE MOLT OF BODY PLUMAGE.

	New Plumage on Breast.	Interscapulum.	Top of Head.	Throat.
Piranga erythromelas, 1,904, W. S.	just appearing.	just appearing.	half renewed.	just sprouting.
Sturnella magna, 1,191, W. S.	nearly complete.	complete.	half renewed.	no molt.
Colaptes auratus, 1,532, W. S.	nearly complete.	sprouting.	just appearing.	just appearing.
Quiscalus quiscula, 154, W. S.	nearly complete.	just appearing.	no molt.	no molt.
Plectrophenax nivalis, 26,987, A. N. S.	complete.	half renewed.	just appearing.	just appearing.
Dolichonyx oryzivorus, 32,783, A. M. N. H.	complete.	complete.	complete.	center of abdomen not molted.

NUMBER AND TIME OF MOLTS.

When the young bird emerges from the egg, it is enveloped in a more or less complete covering of down ; in ptilopædic birds the cover-

[4] In any case, a specimen showing molt or evidence of recent molt in the body-feathers, while the rectrices and remiges present no signs of molt, may be regarded with certainty as a bird of the year.

II. SHOWING RELATIVE MOLT OF RECTRICES.

Adults in Annual Molt.	Middle Pair.	2	3	4	5	6
Dryobates villosus, 26,644, A. N. S.	Old.	—	—	Old.	Old.	—
Dryobates pubescens, 30,750, A. N. S.	Old.	2.5	2.5	Old.	Old.	.1
Dryobates villosus, 26,646, A. N. S.	Old.	2.0	2.0	Old.	Old.	F. G.
Colaptes auratus, 26,694, A. N. S.	Old.	F. G.	F. G.	1.5	1.5	F. G.
Colaptes auratus, 26,693, A. N. S.	—	F. G.	F. G.	F. G.	.2	F. G.
Dryobates pubescens, 26,651, A. N. S.	.5	F. G.	F. G.	F. G.	F. G.	F. G.
Tachycineta bicolor, 28,595, A. N. S.	.7	Old.	Old.	Old.	Old.	Old.
Tachycineta bicolor, 1,660, W. S.	F. G.	.3	1.3	Old.	Old.	Old.
Tachycineta bicolor, 1,921, W. S.	F. G.	F. G.	F. G.	F. G.	.2	1.0
Cyanocitta stelleri, 30,923, A. N. S.	3.2	3.5	Old.	Old.	Old.	Old.
Spizella pusilla, 1,170, W. S.	.2	.5	.8	1.5	1.7	Old.
Plectrophenax nivalis, 26,987, A. N. S.	2.0	2.0	2.0	2.0	2.0	2.5
Passerina cyanea, 28,516, A. N. S	1.5	1.5	1.5	1.5	1.5	1.7
Myiarchus cinerascens, 29,456, A. N. S.	F. G.	.3	.5	1.0	1.5	2.2
Lanius ludovicianus, 1,429, W. S.	F. G.	.5	1.7	1.8	2.2	2.5
Seiurus aurocapillus, 1,138, W. S.	.1	.1	.1	.1	.2	.5
Icterus galbula, 28,096, A. N. S.	F. G.	F. G.	F. G.	.1	.2	.6
Melospiza fasciata, 1,667, W. S.	F. G.	F. G.	F. G.	F. G.	F. G.	.2
Ammodramus caudacutus, 1,155, W. S.	F. G.	F. G.	F. G.	F. G.	F. G.	.1
Quiscalus quiscula, 28,117, A. N. S.	Old.	3.6	2.0	1.5	1.2	1.0

The four divisions represent four styles of molting.

Numerals denote the amount in inches that the new feathers lack of their full growth. "F. G." denotes "Full Grown." Dashes show that the old feather has been shed but the new one has not yet appeared.

III. SHOWING RELATIVE MOLT OF WING FEATHERS.

	Last Primary Shed.	Molt in Secondaries.	Molt in Tertials.	Molt in Greater Coverts.	Molt in Lesser Coverts.
Molothrus ater, 28,028, A. N. S.*	6	none.	none.	complete.	nearly comp.
Agelaius phoeniceus, 1,579, W. S.	6	none.	none.	complete.	just begun.
Dolichonyx oryzivorus, 28,000, A. N. S.	5	none.	half grown.	half grown.	none.
Piranga erythromelas, 1,904, W. S.	5	none.	mid. shed.	none.	just begun.
Colaptes auratus, 1,532, W. S.	5	first ½ gr.	½ grown.	complete.	complete.
Quiscalus quiscula, 1,900, W. S.*	5	first sprouted.	sprouted.	complete.	nearly comp.
Quiscalus quiscula, 1,541, W. S *	4	first ½ gr.	sprouted.	complete.	nearly comp.
Sturnella magna, 1,191, W. S	4	none.	inner spr't'd	complete.	nearly comp.
Chaetura pelagica, 1,521, W. S.	4	½ gr.	sprouted.	partly molted.	partly molted.
Plectrophenax nivalis, 26,987, A. N. S.	3	none.	complete.	complete.	partly molted.
Dolichonyx oryzivorus, 32,783, A. M. N. H., †.	2	1st and 6th.	complete.	complete.	complete.
Melospiza fasciata, 1,667, W. S.	1	nearly comp.	complete.	complete.	complete.
Tachycineta bicolor, 1,921, W. S.	1	nearly comp.	complete.	complete.	complete.

* Molt from first plumage. † Spring molt.

All others are adults in annual molt.

ing is complete, while in psilopædic birds it is but very slightly developed. In præcocial species the downy dress is retained for a considerable time before the first feathers appear, but in altricial birds it is soon replaced by what is known as the "first plumage." The remiges and rectrices of the first plumage are usually the same as those of the adult, but the body feathers, while of the ordinary structure, are much more plumulaceous than the covering of the adult.

This first plumage is retained for some time (three or four months) in some species, but in others it is very soon replaced by a more permanent winter plumage in which all the feathers are of the same structure as those of the adult. The entire body plumage is molted at this time as well as most of the wing coverts; but the rectrices, remiges and the primary coverts are, in the great majority of our smaller land birds, retained until the next annual molt.

The species in which *all* the first plumage feathers are molted are the following: *Otocoris alpestris, Cardinalis cardinalis, Agelaius phœniceus, Quiscalus quiscula, Molothrus ater, Sturnella magna, Scolecophagus carolinus, Tachycineta bicolor* and all the Woodpeckers. Of *Ceryle, Trochilus, Chætura* and a few *Oscines* I have been unable to examine sufficient specimens to speak with certainty on this point.

In early spring, probably about the time of revival of sexual activity and immediately preceding the vernal migration, there is in the vast majority of birds a more or less complete molt. Sometimes, as in the case of the Bobolink, the change is absolutely complete, but as a rule the remiges and rectrices are not renewed, while in other species the molt may only amount to the acquisition of a few new feathers on the throat or sides of the head. The tertials are often renewed at this time and seem to correspond more with the body feathers than with those of the wing as regards their molting. It is at this season that many birds acquire marks of maturity which are lacking during the first winter of their life, as for instance, the yellow superciliary and loral stripes of certain finches, while markings characteristic of the breeding season as opposed to the winter, also appear at the time of spring molt.

In studying the species of our smaller land birds which molt in the spring it will be noticed that of necessity, species which differ radically in their spring and fall plumage, have the most complete spring molt; while, as a rule, in those in which the plumage is nearly the same throughout the year, the spring molt is least marked. The

Savanna Sparrow and Sharp-tailed Finch are interesting exceptions to the latter statement.

The annual molt which occurs at the close of the breeding season, in late summer or early fall, is common to all birds, and is generally coincident with the molt of the first plumage of the young birds of the first broods, varying, however, in this respect in different species. The annual molt is always complete, and when the new feathers are assumed, the plumage is richer in color and fuller than at any other time. In the breeding plumage, the colors may be in stronger contrast, but this is generally due to the wearing away of the blending colors of the tips of the feathers[5] which necessarily makes the plumage rougher.

CHANGE OF COLOR BY ABRASION.

During the time intervening between two molts, the feathers undergo a certain amount of abrasion. In such birds, specimens taken just before the annual molt, present a very dilapidated appearance, and the abrasion, combined with bleaching, has generally altered the appearance of the plumage very materially from that of the preceding fall.

While this effect of abrasion is seen in the plumage of all birds just before the annual molt, the feathers of some are so constructed as to render possible a complete change in the color of the exposed plumage by abrasion, long before the time when the effects of the general wear and tear above described are apparent. These feathers have their terminal portion differently colored from the basal, so that when the plumage is in its normal "shingled" position, only the terminal part of each feather is exposed, and the general color of the plumage is the same as this portion of the feather. By the loss of this terminal portion, the differently colored base of the feather comes into view and the general color of the plumage is thus completely changed (Pl. IV, fig. 7). This result is attained by general wear and tear and also, doubtless, by the agency of the bird itself in preening its feathers.

The differently colored tips to these feathers wear off very rapidly, and generally disappear entirely before any perceptible wear is noticeable on other parts of the plumage which are uniform in color. This would indicate that the terminal portions of these feathers are more brittle than the basal part, especially as the breadth

[5] Except when a complete spring molt occurs.

of the terminal portion varies on different feathers, while the abrasion always takes place exactly to the line of demarcation of the colors.

In the body feathers, the terminal part is less perfectly pennaceous in structure than the base, and many of the barbs are entirely free at their tips, which naturally makes them more liable to rapid abrasion down to the point where the strongly pennaceous structure begins.[6] This is particularly well seen in the Snow Bunting. A

Fig. 1. Tips of several barbs from feather of Snow Bunting showing the difference in structure between the light and dark portions (greatly enlarged) Photograph by Dr. A. P. Brown.

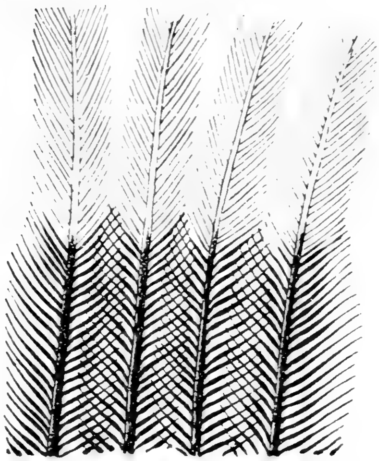

Fig. 2. Same, further enlarged, with the barbs undisturbed showing the interlocking of the barbules in the black area. Somewhat diagrammatic, after photograph by Dr. Brown.

microscopical examination of these feathers, conducted at my request by my friend Dr. A. P. Brown, shows further that the hooklets on these terminal parts are fewer in number and less perfectly developed, while the basal portion of the feather where the dark pigment begins is thicker and probably tougher in structure, the barbules and hooklets being here well developed (Fig. 1 and 2).

[6] A paper by Mr. Frank M. Chapman has appeared since the above was written "On the Changes of Plumage in the Snowflake, *Plectrophenax nivalis*," Bull. Amer. Mus. Nat. Hist, VIII, pp. 9–12. In this he reaches exactly the same conclusions as are here set forth by the writer and Dr. Brown, and the fact that we were working entirely independently gives additional interest to the statements.

Certain wing feathers show a still more interesting phase of abrasion. In the Rose-breasted Grosbeak, as is well known, secondaries and tertials in autumn and winter are marked on their edges with spots of white (Plate V, figs. 7, 8), while in the Meadow Lark and Curlews at the same season, many of the feathers have regular tooth-like indentations of lighter color along the sides (Plate IV, figs. 8, 9). By the time the breeding season has arrived these light-colored areas have been completely lost, while the dark parts remain intact, the line of demarcation having been followed as closely as if cut by a pair of scissors, except that some curved lines become straight owing to the whole barb breaking off beyond the light colored area (Plate IV, fig. 9). In these feathers, both portions are equally pennaceous, and do not exhibit any difference in structure, so that we must regard the light portions as peculiarly brittle. It is a noticeable fact that in all the birds that have been examined, the black feathers or black parts of a feather seem less subject to abrasion than those of any other color.

In most cases where marked abrasion takes place, the lighter tips serve to produce the blended appearance characteristic of the winter plumage of all birds, while their loss brings out the strong contrast of colors characteristic of the breeding season, and produced in other species by actual molt.

The case of the Bobolink is of particular interest in this connection, differing from that of any other species, unless it be some individuals of the Rose-breasted Grosbeak. It has a complete spring molt, but instead of assuming the breeding plumage at this time, as in the case of most birds which molt in the spring, it assumes a dress almost as dull and blended as its winter attire, but which is transformed to the breeding plumage by the abrasion of the long buff tips which adorn all the feathers.[7]

The utility of such a process is difficult to see. The long tips are "acquired to be lost" as it were; they begin to break off immediately and within two months have disappeared.

SEASONAL PLUMAGES.

The number of recognizable plumages, which a bird may assume, is obviously dependent upon the length of time that is required for it to acquire the mature dress. The simplest case is where this is accomplished when the first-plumage is molted or at the end of the

[7] See Chapman, Auk, 1890, p. 120.

summer in which the bird is hatched. In such a species then, there are only three plumages: 1. First Plumage. 2. Winter Plumage. 3. Nuptial Plumage;—the latter being acquired in early spring, either by actual molt or abrasion. Sometimes it is so like the winter plumage that they can scarcely be distinguished, but this is the exception, for even when no molt takes place, the abrasion gives such a different appearance to the plumage by wearing off the blending shades that the spring and fall birds can easily be separated.

In other species the winter plumage of the young bird is not absolutely like that of the adult, every shade of difference existing from those that are scarcely separable to those that are radically different.

In such cases there are, of course, four or five recognizable plumages: 1. First Plumage. 2. Plumage of First Winter. 3. Plumage of First Nuptial season. 4. Adult Winter Plumage. 5. Adult Nuptial Plumage. In most species the Adult Nuptial Plumage is assumed at the first spring molt, in which case there will be only four distinct plumages. Sometimes the number of plumages is still further increased by the fact that the bird does not acquire the complete adult dress for three or four years. The changes, however, do not progress as regularly in these instances after the first year, a greater or less amount of the adult plumage being assumed at each molt by different individuals; so that a large series instead of being divisable into several lots, each characterized by distinctive marks, represents on the contrary a complete gradation from the bird of the year to the adult. Such instances have been made to serve as examples of the alleged change of plumage by direct change in the coloration of the feathers.

Another point bearing upon the plumages of species that require several years to acquire the mature dress, is the question whether there are not some individuals which never do acquire this plumage. The fact of the remarkably small proportion of birds in fully adult plumage in such species as the Purple Finch, Pine Grosbeak, White-throated Sparrow, etc., lends weight to such a theory, although its actual demonstration is, perhaps, impossible.

Then again, there are occasional peculiar plumages, which, though they may be abnormal, are nevertheless by no means unique, such as the bright orange plumage of the male Scarlet Tanager, the Black-headed plumage of the female Rose-breasted Grosbeak, and the occasional extremely brilliant plumage of the male of the same species, etc. The two latter instances may be considered as: 1. Partial adoption of the characters of male plumage by the female; and 2. Extreme development of color in the male probably due to excessive vitality.

Another complicated series of plumages pointed out by Mr. F. M. Chapman[8] exists in the case of the Bobolink. In these birds there are four distinct plumages: 1. First Plumage. 2. Winter Plumage. 3. Early Spring Plumage. 4. Nuptial Plumage.[9] This early spring plumage is acquired by direct molt, and passes into the Nuptial Plumage by an extensive abrasion of the differently colored tips.

DIRECT CHANGE OF COLOR IN FEATHERS.

There have always been, and are to-day, ornithologists who believe thoroughly that feathers actually change their color, and that the change from the winter plumage to the nuptial dress in some species is accomplished solely in this manner without either molt or abrasion.

Schlegel, one of the greatest exponents of this theory, considered the phenomenon as nearly universal, and Gätke, another of its staunch supporters, seems to be of much the same mind. Other writers while supporting it, have regarded it as of much less general application and some consider it of very rare occurrence.

If such a change actually does take place, it would seem strange if it should not play a very important part in plumage-changes, and, if we admit that it does occur in any species, we may as well grant its possibility in a great number.

The importance of the question warrants a very careful consideration, and, in order not to be misunderstood, I may state at the outset that in spite of the instances that have been cited to illustrate this phenomenon, I have not yet found a single case that cannot be otherwise accounted for, and, cannot, therefore, admit that we have any proof of an actual change of color in a feather apart from what may be produced from abrasion or bleaching.

In most instances which have been cited in support of this theory, the writers have, it seems to me, fallen into the same error—*i. e.*, they have taken a series of specimens, showing all sorts of mottled intergrades from one plumage to another, as indicating that each

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[8] Auk, 1890, p. 120.

[9] If we consider the birds of the year as recognizably distinct from the fall adults we must regard "2" as First Winter Plumage and add "5". Adult Winter Plumage.

individual bird passed through all those gradations; or they have taken a series of feathers from different individuals or different parts of the same individual, which show regular gradations from one style of coloration to another, as proof that each feather passes through all those gradations.

As a matter of fact, these mottled plumages are permanent for the time being, and at each regular molt a greater proportion of the adult plumage is assumed. Scarcely any two individuals, however, correspond exactly in the amount of change that is effected at a given molt;[10] hence a series of breeding birds taken during the late spring or early summer, representing individuals of different age, will often show a nearly complete series of intergrades between the two styles of plumage, and there will, of course, be no signs of a molt.

A study of several of the more recent examples that have been brought forward to illustrate the actual change of color in feathers, will be of interest in this connection.

Dr. R. Bowdler Sharpe, in the Catalogue of Birds in the British Museum, seems to regard this alleged phenomenon as of rather common occurrence, and in some instances goes into much detail with regard to the subject. This is especially the case in treating of *Motacilla lugens*,[11] in which he claims, not only a change from gray to black in the plumage of the back, but also a remarkable change in the color of the primaries and secondaries from brownish to pure white, the adult plumage being assumed according to Dr. Sharpe's theory, in the first spring.

With the same material examined by Dr. Sharpe, and a little more showing the molt in progress, Dr. Stejneger[12] shows conclusively that this species requires several years to acquire the fully adult plumage, and that the changes in the color of the wing feathers is effected by actual molt and not by a change in the color of each individual feather. This shows conclusively the importance of having specimens in the molt for examination and comparison, and what a different aspect they may put upon the case.

While combating the theory of direct color change in *Motacilla*

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[10] It is not intended that only a part of the plumage is changed; while this may be true of the spring molt, the annual molt is always characterized by a complete change, but, in the cases referred to, part of the new plumage comes in exactly like the old, while in other parts the color of the new plumage is different.

[11] Cat. Bds. Brit. Mus., X, 1885, p. 474.

[12] Proc. U. S. Nat. Mus., 1892, p. 307.

lugens, Dr. Stejneger, nevertheless admits it in the case of *Zanthopygia narcissina*,[13] on what seems to me insufficient evidence.

This bird he believes changes without molt from an olive plumage to one of brilliant orange-yellow and black, while the wings and tail change from a dull brownish-gray to a deep black. I have examined the series which Dr. Stejneger had in hand, and I fail to see anything it in that cannot be found in a similar series of *Icterus spurius* or any other species that acquires its mature plumage by successive molts, the mottled plumage being permanent for the time. So far as I can see, an actual molt of black and yellow feathers might occur in early spring, or patches of them might be acquired at the annual molt at the end of summer. As there are no specimens in Dr. Stejneger's series taken earlier than the 29th of April, and no fall adults, it is hardly justifiable to conclude that the change in color does not take place by a direct molt, either in early spring or in late summer.

Furthermore, a specimen of the closely allied *Z. tricolor*,[14] which agrees very well with Dr. Stejneger's most advanced "transition" specimens, having a few patches of olive-brown feathers above and brown remiges, but otherwise adult, shows by the presence of numerous "pin feathers" that the yellow breast, and the black on the head have just been assumed by direct molt.

That this specimen is an early spring bird I assume from the fact that the remiges and rectrices show no signs of recent molt, which they would do if it was the annual molt that had just occurred.

In regard to the remiges and rectrices of *Zanthopygia*, which Dr. Stejneger thinks change suddenly from dull brown to deep black, precisely parallel cases are to be found in *Piranga erythromelas* and *Habia ludoviciana*, and a series of either collected in May or June will show just the same variety of color in the quills as in the case of *Zanthopygia*.

In these species the dull colored quills are retained during the first spring when the winter body plumage is molted for the adult dress, but at the annual molt the jet black quills are assumed and there is certainly no direct change in the color of the feathers.

Gätke in his "Heligoland," gives us the most recent endorsement of the theory of actual color-change, a theory of which he was always a strong advocate. The instances which he treats in detail are

[13] Proc. U. S. Nat. Mus., 1892, p. 334.

[14] 791, Coll. Acad. Nat. Sci. Phila.

almost entirely from the water birds, and we are not informed of the exact character of the material which came under his observation, all that we have is his interpretation of the facts. The species to which he calls especial attention are the Dunlin, Knot and Sanderling.

"In the Dunlin" he says "the change of colour develops itself in the following manner: In the ash-grey feathers of the back the shaft first becomes black; this color spreads rapidly over the feathers, finally leaving only broad gray margins. The latter at first change to a dull rusty-grey, which, however, subsequently passes into a beautiful ferruginous color. At the same time the dull ash-grey tips of the feathers pass into a whitish-grey, their margins being simultaneously rounded off to their former entirety."

How such a theory could have been advocated, after the examination of a large series of specimens, I cannot understand, for a series of spring examples of the American Dunlin taken on the coast of New Jersey show the black and rusty feathers coming in abundantly and supplanting the worn gray feathers of the winter plumage.[15]

In the Sanderling Gätke states there is a change from a uniform light gray to a deep black, and from a beautiful ferruginous color to a pure white. Here again spring specimens, from the coast of New Jersey and Florida, show the black and ferruginous plumage molting in and superceding the light gray plumage of winter.

Gätke says (p. 163) that he "confines his description to what actually takes place, without embarking on any hypothetical conjectures." In this, however, I cannot agree with him; he does not claim to have seen the change in color actually take place in any individual feather, and to make the assertion that feathers change from one style of coloration to another when the only facts before him are that he has feathers which represent those styles of coloration, one of which might change to the other, involves entirely too great an assumption.

In his chapter on "colour-change without moulting" Gätke supports another theory, also originally advanced by Schlegel, but which

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[15] Since the present paper was presented to the Academy for publication (see Proc. Acad. Nat. Sci. Phila., 1896, p. 12), Mr. F. M. Chapman has published an article on "The Changes of Plumage in the Dunlin and Sanderling" (Bull. Amer. Mus. Nat. Hist., VIII, p. 1--8), in which he criticises Gätke's statements on the same grounds as above. Here again, it is interesting to note that Mr. Chapman and the writer working independently, arrived at exactly the same conclusions.

Gätke formerly repudiated, and one which other advocates of the "color-change" theory have generally left untouched, *i. e.*, the theory that simultaneously with the change in color there occurs a rebuilding of the worn edges of the feathers which restores all the even contours and gives them the appearance of newly molted feathers.

The acceptance of the theory of color-change without molt or abrasion, necessitates the adoption of some such theory as this, since the bright spring feathers are generally much more perfect in outline and often in striking contrast to the worn winter plumage from which Schlegel and Gätke would have us believe they have been produced. A slight knowlege of the development of feathers would tend to show the absurdity of such a theory as this, since the barbs of a feather do not continue to grow out from the shaft like the limbs of a tree, but are really formed from the tip inward toward the shaft. And once being unfolded from the sheath of the "pin feather," no further structural development can possibly take place in them.

Too many writers have made arbitrary statements and then questioned the accuracy of the investigations of histologists because they did not support them. In investigating these questions, we must accept at the outset the testimony of physiologists and histologists, that from the very nature of the structure of a feather it is incapable of renewing its barbs or barbules, and that after the contents of the quill have once dried up there is no connection between the vanes of the feather and the life fluids of the bird. This at once precludes the change of pigment, except by chemical action from without, and it is difficult to see how this should only exert an influence during a certain short period and have no effect at other times.

It has been suggested that the presence of innumerable bubbles of air would tend to obscure the pigment in a feather and cause it to appear white, while the expulsion of air from a white feather might bring out a dark pigment previously concealed. In the case of the *Motacilla*, however, portions of the plumage turn white and other parts black at the same time and it is hard to understand how an external action could affect different feathers in an exactly opposite manner, and if there was proved to be exhalation from the body into the feather, the structure of the feather would preclude a passage of air into the barbs from the quill. It might further be added, that the yellow feathers of *Zanthopygia*, which should according to this theory contain a concealed dark pigment, have really no pigment at all, as has been ascertained by careful microscopical examination by my friend Dr. Thos. H. Montgomery.

The only instance where I know of an actual change of color in the plumage, except by fading, is in the case of certain delicate pink tints on the breasts of gulls, which disappear after death, but this color, I think, is probably due to a peculiar surface structure which is destroyed or altered by the drying out of the plumage, when removed from contact with water or the oil of the bird.

PLUMAGES AND MOLTS OF THE SMALLER LAND BIRDS OF EASTERN NORTH AMERICA.

Below I have recorded such facts as I have been able to gather regarding the molts and plumages of our smaller land birds.

In a number of species I have been unable to ascertain the exact extent of the molts or their number from lack of necessary material, but have thought it best to give such facts as I have rather than to omit the species altogether. Some species on the other hand I have been able to treat with much detail, and have referred to them in describing others with a similar series of molts. I have as a rule omitted any detailed description of the plumages, as these can be obtained from any of the manuals or general works on North American birds, and have made my remarks as to colors, etc., mainly comparative.

Where I had sufficient material to warrant it, I have given after each species a list of its plumages, considering three as the smallest number of plumages exhibited by any species. In many, however, the winter and nuptial dresses are practically alike except for a slight abrasion.

Where male and female are not definitely indicated their molting is the same.

Family CUCULIDÆ.

Coccyzus erythrophthalmus (Wilson). Black-billed Cuckoo.

Coccyzus americanus (Linn.). Yellow-billed Cuckoo.

I have been unable to examine any adult Cuckoos in the molt. The young molt the body plumage the last week in August. I am inclined to think that there is no spring molt in either species. Spring and fall specimens it is true are scarcely distinguishable, but I do not consider the unworn appearance of spring birds as a necessary proof that there has been a spring molt, as an examination of late summer specimens, just previous to the annual molt, shows that abrasion produces scarcely any effect in the Cuckoos. The sexes are alike in molts and practically so in plumages.

Family ALCEDINIDÆ.

Ceryle alcyon (Linn.). Belted Kingfisher.

The Kingfisher presents several peculiarities in its molting and I have not yet been enabled to examine sufficient material to satisfactorily describe it. So far as my material goes I think the rufous edgings to the breast band belong only to the bird of the year, as old birds in the annual molt have the new feathers of the breast band plain bluish slate or slightly edged with white. Whether the young molt the flight feathers with the rest of their first plumage I cannot say, but the wing feathers of the rufous tipped fall birds are very fresh and perfect, which may be considered evidence that they do.

That there is a partial molt in early spring is evidenced by the fresh feathers in spring specimens which are in strong contrast to the older worn plumage, especially on the pectoral band.

The wing feathers of some spring birds are unusually bright with the white tips scarcely worn and one example, (June, 1881, Palo Alto Co., Iowa, No. 26,640, A. N. S.), has the remiges all of this character, except the innermost pair of primaries and one of the secondaries on the left side, which are very much worn and abraded. This may indicate a spring molt of the wings in some individuals but in the majority it apparently does not occur. The peculiar order of molt in the primaries has already been noticed.

Family PICIDÆ.

The North American Woodpeckers,[16] as already pointed out by Mr. Brewster, (Bull. Nutt. Orn. Club, 1878, p. 179), always molt the wing and tail feathers along with the rest of the first plumage. The molt of this plumage, especially on the head and breast, goes on slowly and the birds start on their southward migration before it has been entirely renewed. In some individuals indeed the molting is not completed till well into the winter.

Dryobates villosus (Linn.). Hairy Woodpecker.

Male.—Three plumages, first, winter and nuptial.

All plumages of this bird are very similar. There is no spring molt apparent in any specimens examined and but little effect is

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[16] And probably all of the family.

produced by abrasion. *Female* molts exactly as in the male, but its plumage lacks the red nuchal band.

Dryobates pubescens (Linn.). Downy Woodpecker.

Molts and plumages as in the last. Some spring specimens show a renewal of some of the breast feathers, but this may also take place in *villosus*. A fall specimen of each species exhibits a remarkably worn "moth-eaten" appearance on the breast and flanks probably due to a peculiarity in the habits of these individuals.

Sphyrapicus varius (Linn.). Yellow-bellied Sapsucker.

Male.—Three plumages, first, winter and nuptial.

The molt of the first plumage of the head and breast of this species continues all through the fall and winter and one taken April 8th, (Philadelphia, Pa.), shows a few new feathers appearing on the crown and throat. The winter plumage is, therefore, a mottled one. The breeding bird is hardly different from the full plumaged spring individual, as abrasion produces but little effect. *Female* molts like the male. Adult plumage differs in having the throat white, some individuals have the crown black, others red; whether this is due to age or purely individuality I cannot determine.

Ceophlœus pileatus (Linn.). Pileated Woodpecker.

Three plumages, first, winter and nuptial.

This species shows but little variation in plumage. There is no spring molt, but the nuptial dress is somewhat abraded and browner than the winter plumage.

Melanerpes erythrocephalus (Linn.). Red-headed Woodpecker.

Three plumages, first, winter and nuptial.

The first plumage is retained for a long time; of four specimens showing the transition to the adult, only one has data, *i, e.*, Haddonfield, N. J., Dec. 2, 1880, No. 1,405 Coll. W. Stone. This I think is probably the regular time for the molt, as specimens taken in October show no signs of a change. The annual molt of the adult occurs during the middle of August as usual. Whether they have any spring molt I am unable to say positively. The plumage is but little affected by abrasion, so that the unworn appearance of spring birds is not necessarily an evidence of a recent molt. Very highly colored individuals have a red patch on the center of the abdomen.

Melanerpes carolinus (Linn.). Red-bellied Woodpecker.

Without a satisfactory series I am unable to describe the molt of this bird in detail, but it is apparently the same as in the preceding species.

Colaptes auratus (Linn.). Flicker.

Three plumages, first, winter and nuptial.

The molt from first plumage begins in July, a specimen taken August 9, 1893, in Montgomery Co., Pa. shows it about half completed. The annual molt of the old birds occurs at the same time. I can find no trace of spring molt and abrasion produces little effect upon the plumage until after May. Mr. F. M. Chapman has described in detail the variation in the upper tail coverts in this genus.[17]

Unfortunately I have been unable to examine a sufficient series of the *Macrochires* to give a complete account of the molting of any of the species, but have included such notes as I have.

Family CAPRIMULGIDÆ.

Antrostomus vociferus (Wils.). Whip-poor-will.

As shown in Wilson's figure this bird has an early downy plumage which almost immediately gives place to the usual "first" plumage, a specimen taken at Haddonfield, N. J., July 2, 1893, (Coll. W. Stone), shows the transition. As regards the number and time of molts, a comparison of specimens would indicate that they are the same as the following.

Chordeiles virginianus (Gmel.). Night Hawk.

Mr. Wm. Brewster has described transition specimens from the early downy plumage to the first plumage and similar ones are in the collection of the Academy of Natural Sciences of Philadelphia from Florida. A specimen taken Sept. 10, is in the first plumage, with many new feathers appearing on the breast and elsewhere, but no molt of the flight feathers; how complete this molt is I cannot not say. An adult specimen taken Sept. 1, shows much renewal of the body plumage, but no trace of it in the wings or tail. It would seem from this that the molt was quite late, and the loss of the flight feathers relatively later than in most birds. I have seen no trace of spring molt.

Family MICROPODIDÆ.

Chætura pelagica (Linn.). Chimney Swift.

Plumages, first, winter, nuptial.

The annual molt in this species occurs from Aug. 1 to the first week of September and there seems to be no spring molt. Abrasion

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[17] Bull. Amer. Mus. Nat. Hist., Vol. III, p. 311.

does not produce much effect upon the plumage but it loses the bright metallic luster which characterizes the fresh winter dress. I am inclined to think that the young do not renew the flight feathers at their first molt.

Family TROCHILIDÆ.

Trochilus colubris (Linn.). Ruby-throated Humming-bird.

The only molting specimens of the Humming-bird that I have seen are spring birds taken at Labna, Yucatan, March 15th, in which the feathers on the throat are being renewed. Probably, the young males acquire the ruby throat at this time.

Family TYRANNIDÆ.

The Tyrant Flycatchers show scarcely any seasonal variation, the first plumage being nearly the same as the adult, while the feathers are very little affected by abrasion. There are, therefore, as a rule only three plumages; first, winter and nuptial.

Tyrannus tyrannus (Linn.). Kingbird.

Adult Kingbirds, taken August 21, show some molt on the body but no trace of renewal of the flight feathers, which would indicate that the annual molt is not completed until quite late. Some spring specimens show a few new feathers appearing on the breast and back, but whether there is a more extensive renewal of the plumage before the birds start north from their winter quarters I cannot say. Abrasion plays little or no part in changing the plumage of this species. The first plumage gives way to that of the adult late in August but no molt occurs in the wing and tail.

Myiarchus crinitus (Linn.). Crested Flycatcher.

The annual molt in this species begins early in August and is indicated in the wings before any new feathers appear on the body, differing in this respect from the last. There seems to be no spring molt. The young birds of the first brood begin to renew their body plumage early in August. All the plumages of this bird are very similar.

Sayornis phœbe (Lath.). Pewee.

There is no spring molt in the Pewee but much abrasion takes place during winter so that the sulphur tint of the under surface, which is characteristic of fall specimens, is nearly lost by the breeding season. The molt of first plumage in the young is restricted to the body feathers.

Contopus virens (Linn.). Wood Pewee.

I am unable to say, from an examination of spring specimens, how much of a molt this spécies undergoes before its northward migration. Compared with specimens of the preceding they appear much less abraded, which indicates that a partial spring molt occurs.

Contopus borealis (Swains.). Olive-sided Flycatcher.

The above remarks apply equally well to this species.

Empidonax.

The species of this genus all resemble *Contopus* in the appearance of their seasonal plumages. The freshness of the spring feathers seems to indicate a partial spring molt at least, but without a satisfactory series of winter specimens; it is not possible to decide this point. The renewal of the body plumage at the annual molt, as in *Tyrannus*, begins before there is any molt of the flight feathers.

Family ALAUDIDÆ.

Otocoris alpestris (Linn.). Horned Lark.

Plumages, first, winter, nuptial.

There seems to be no spring molt in this species, but a great deal of abrasion takes place during winter and spring, by which the light edgings to the black crown and throat patch are lost and the other colors brought into stronger contrast. The young birds molt the flight feathers at the end of summer along with the rest of the first plumage.

Family CORVIDÆ.

Cyanocitta cristata (Linn.). Blue Jay.

Plumages, three; first, winter and nuptial, though, except for the slight effects of abrasion, there is no difference between the last two.

There is no spring molt and the young molt only the body plumage at the end of their first summer.

Perisoreus canadensis (Linn.). Canada Jay.

Three plumages, first, winter and nuptial.

I have not been able to examine a satisfactory series of this species but feel pretty sure that its molt is the same as in the preceding.

Corvus corax principalis Ridgw. Raven.

I have been unable to prove the number of molts in the raven by actual examination of molting specimens, but such material as I have before me indicates a precisely similar molt to that of the crow.

A molting specimen from Sitka, Alaska, June 15, 1895, shows that the central tail feathers are the first to be renewed, and are well grown before any of the others are dropped.

Corvus ossifragus (Wils.). Fish Crow.

Corvus americanus (Aud.). American Crow.

Three plumages, first, winter, nuptial.

The Crow has no spring molt so far as I can ascertain; the annual molt is quite early, occurring in June or July, while the young birds molt the first body plumage about the end of the latter month. As in most black birds abrasion is but little marked. Many specimens, however, are dingy and have the tips of the wings bleached to a brown tint. The Fish Crow apparently molts exactly the same.

Family ICTERIDÆ.

The Icteridæ may be arranged in three groups as regards their molt.

Dolichonyx has two complete molts each year standing alone among our smaller land birds in this respect. The young probably has no molt of flight feathers at the close of its first summer. The two species of *Icterus* have a more or less complete spring molt of the body feathers the first year at least, and the young do not molt the flight feathers in August. The rest of our species have no spring molt whatever, but the young have a complete molt at the end of the first summer, including both wing and tail. This occurs in only three other instances among our Passeres—*i. e.*, in *Cardinalis, Tachycineta* and *Otocoris.*

Dolichonyx oryzivorus (Linn.). Bobolink.

Male.—Plumages, first, winter, early spring, nuptial.

The molting of this species has been so carefully treated by Mr. F. M. Chapman who was the first to describe the early spring plumage and the manner in which it is acquired, that it is hardly necessary to go into details in this connection. When the young bird has acquired the buff winter plumage it is practically undistinguishable from the winter adult.

Early in spring (March 1st,) this plumage is entirely molted even to the wings and tail and a new black plumage is assumed, all the feathers of which are so broadly edged with brownish buff that the general plumage appears to be of this shade. By the breeding season the aspect of the plumage is again changed, this time entirely by abrasion, and the bird appears in its black and white dress.

The Bobolink furnishes the only instance known to me, among the species here treated, of a molt of the remiges in the spring. The molt of the Rose-breasted Grosbeak, with this exception, is almost parallel for the first season, though the buff edgings which are lost by abrasion are not quite so much developed. Afterward, however, the Rose-breast has a winter plumage quite different from that of the first year while the Bobolink, year after year, returns to the buff "Reed-bird" garb. The old winter birds are perhaps of a little different shade of buff and I think it is only the old birds that show the occasional black feathers in fall.

Mr. Chapman's specimen in the spring molt as well as specimens in the annual molt have been examined. I have been unable, however, to ascertain whether the young bird molts the wing and tail feathers with the rest of the first plumage or not.

Female.—Plumage always similar to winter dress of male. I have not been able to ascertain whether there is any spring molt or not, the breeding plumage, however, is much lighter than the winter dress owing to abrasion. A curious plumage is shown in a specimen from Raleigh, N. C. May 2, 1893, No. 86, Coll. W. A. Shryock, in which there are many black feathers on the breast, belly and head, evidently an approach to the male pattern of coloration.

Molothrus ater (Bodd.). Cowbird.

Male.—Plumages; first, winter and nuptial; the last two, however, are scarcely distinguishable, owing to the very small effect produced by abrasion in this species.

There seems to be no spring molt whatever, and almost the only effect of the abrasion is to emphasize the line of demarcation between the brown head and the black back. The young molt the wing and tail at the end of summer with the rest of the plumage.

Female.—Molts as in the male. The adult plumage is entirely gray and the abrasion is very marked in spring, presenting a "clipped" appearance exactly as in *Ammodramus maritimus.*

There is no change in the coloration of either sex of the Cowbird after the first winter dress has been assumed.

Agelaius phœniceus (Linn.). Red-winged Blackbird.

Male.—Five fairly marked plumages may be distinguished:—first, first winter, first nuptial, adult winter and adult nuptial, the last two, however, as in many other species, differ very slightly.

At the end of the first summer the entire plumage of the young bird is shed, including the wing and tail, and a black dress broadly edged with brown is then assumed.[18] This becomes almost entirely black by the breeding season through abrasion. Owing to the extent of the abrasion, however, the plumage presents a somewhat worn appearance and there is always more or less trace of the brown edgings present. The subsequent winter plumages show much less of the brown borders and eventually this dress is nearly pure black; except, of course, the shoulders. This is well shown in a fall male of *A. phœniceus sonoriensis* in the U. S. Nat. Mus. Coll. Whether the brown edges are ever entirely lost at the second annual molt or whether birds in such plumage are always several years of age I cannot say, but incline to latter view. The less brown margins to the winter plumage, the less abrasion takes place and the nuptial plumage appears relatively smoother. The depth of color of the red shoulder patch is not necessarily an index of the age, as some birds in the first year have deep red shoulders.

Mr. Brewster describes (*l. c.*) an occasional, though not unique plumage, which has a "crescentic patch of pale yellow tinged with rose-color upon the breast," which he regards as an "exceedingly high phase of ornamentation."

Females.—Vary considerably in the tints on the throat; the buffest ones I take to be birds in their first year and those with the pinkest throats are probably the oldest. The red on the shoulder of the females increases in proportion to that on the throat. The molts are exactly the same as in the male, and the abrasion in spring always well marked.

Sturnella magna (Linn.). Meadow Lark.

Male.—Plumages, first, winter and nuptial.

The Meadow Lark, as in the preceding species, molts both wing and tail at the end of the first summer. There is no spring molt, the change to the breeding dress being produced entirely by abrasion. All the under surface is veiled in winter with long brownish or buff tips. The bright yellow and black tips are only brought out when these are lost. On the upper surface the abrasion affects the light margins to the body feathers and the light bands and indentations on the tertials, which become worn in a most remarkable manner (see Plate IV, figs. 8 and 9). There is some variation in the extent

[18]First described by Mr. Wm. Brewster, Bull. Nutt. Orn. Club, 1878, p. 175.

of the brown margins of the winter plumage, birds showing the least being probably the oldest.

Female.—Like the male in molts and plumages.

Icterus galbula (Linn.). Baltimore Oriole.

The males of this species assume four distinct plumages. The first plumage is ashy on the back passing into dull orange on head and rump and whitish below, wings suffused with yellow-brown bordered with white and tail dull orange. The body feathers of this dress are soon shed and the plumage of the first winter assumed, generally by the middle of August. In this the back is dull orange, brightest on the head and rump and mottled with dark-brown on the interscapulum; below nearly uniform bright orange-yellow. These two plumages are remarkably similar, the latter being uniformly brighter and richer and easily distinguished by the different structure of the feathers.

In early spring there is a molt which as usual varies exceedingly in its extent in different individuals. Usually the entire black body plumage of the adult is assumed covering the back, entire head and throat, also the reddish-orange on the breast, sides of the abdomen and a certain amount on the rump. The middle of the abdomen and the greater part of the rump, however, retain the old yellowish winter plumage. There is great irregularity in the molt of the tail as well as the tertials and greater wing coverts. All but one of the specimens examined show some molt in these feathers, but in none is it complete.

One has renewed all the tail but the four outer feathers of the left side, another has renewed only the middle pair and one other; and still another retains three old feathers on the right side. The specimen which shows the least molt in the first spring (No. 25,734, Coll. A. N. S. May 24, 1864, Republican Riv., Kas.), has only acquired part of the black head, the old yellow plumage remaining in a large nuchal patch, while below the reddish-orange feathers have appeared only on the breast. There has been no molt, whatever, in the wing or tail.

The black interscapulary plumage, which is assumed by the Baltimore Oriole at the first spring molt, shows the same variation as exhibited in the Rose-breasted Grosbeak, *i. e.*, in some individuals the feathers are uniform black while in others they are bordered with orange. At the annual molt in July the entire plumage is renewed and the perfect plumage is acquired. This is like the previous dress, but the whole abdomen and rump and lesser wing coverts are bright reddish-orange, while the black is more intense. All the other wing feathers are jet black bordered with white; the two middle rectrices are black, the next pair largely black, the others orange with more or less black on the base. The interscapulary feathers are generally slightly tipped with orange.

In the second spring there is no molt, unless there may be a renewal of some of the scattered feathers but the light tips of the interscapular feathers are entirely lost from abrasion and the white on the wings is greatly reduced and on the tertials entirely lost from the same cause.

Icterus spurius (Linn.). Orchard Oriole.

Notwithstanding the large amount of material that I have examined, I have been unable to procure specimens which show conclusively the history of the molts of this bird. The large series, aggregating several hundred skins, contained in the collections of the Academy of Natural Sciences of Philadelphia, National Museum, American Museum of Natural History and the private collection of Mr. William Brewster, contains all together only four specimens in the molt, of which but two bear the date of capture. In view of this scarcity of molting birds, we are compelled to judge of the molts mainly from comparing specimens taken before and after the plumage has been renewed.

Male.—The young birds change the first plumage for that of the first winter in July or August. This dress is as a rule scarcely different from the first plumage. Some few individuals, however, show a few black feathers on the throat. In February or March there is a molt of the feathers of the head and throat, and all the males that reach us from the south in the spring have a black throat, the extent and purity of the black varying in different individuals. I have no green males in the annual molt nor after the molt is completed. One specimen (No. 91,034, U.S.Nat. Mus. Coll.), taken in Nicaragua, Feb. 23, 1883, shows the throat and head to be molting. That this bird is not in its first spring molt is shown by the fact that some old throat feathers which have not yet been shed are black. The plumage of the second spring is similar to that of the first, but the black throat is more complete and there are traces of chestnut on the breast. The tail is also clouded with black, but as the specimen just referred to is not molting the tail, I think that this change is effected at the preceding annual molt. It is probably at the next annual molt that the chestnut and black plumage is acquired. It is impossible to tell from an examination of spring males in the green plumage, how many years they remain in this dress, as the individual variation in the amount of change effected at a given molt is so great, that there is a complete series of intergrades from one extreme to the other. Between the most advanced specimen and the adult chestnut plumage, however, there is quite a gap, and I have never seen any specimens like those figured by Wilson and Audubon.

The variation in the marking of spring birds is shown by the following table:

Males, 1st. and 2nd. Years.	Tail green.	Tail partly black.	Trace of chestnut on rump.	Trace of black on head.
Throat-patch incomplete (4)............	4	0	1	0
Throat-patch complete, little or no chestnut (14).......	13	1	1	4
Considerable chestnut on breast (12).	5	7	12	12

The spring molt is generally confined to the head and throat but in some second year birds it is more extensive and in one, (122,073, U. S. Nat. Mus. Washington, D. C., May 2, 1887), the body molt must have been nearly complete, while the tertials and indeed the wing feathers show scarcely a trace of abrasion. Old chestnut colored birds have the plumage, especially above, edged with buff, which is lost by abrasion before the breeding season.

Female.—Remains as the male in first winter. Spring specimens differ in showing much abrasion but there is little if any spring molt.

Scolecophagus carolinus (Müll.). Rusty Blackbird.

Male.—Plumages, first, winter and nuptial.

Only one molt a year, the change from winter to nuptial dress is effected entirely through abrasion.

Female.—Molts as in the male. Adult plumage always gray instead of black. I have seen no molting birds of either sex, but Dr. J. A. Allen writes me that the young renew the flight feathers at their first molt, as in the allied genera.

Quiscalus quiscula (Linn.). Purple Grackle.

Male.—Plumages, first, winter and nuptial.

The young birds molt the wing and tail along with the first body plumage and assume the adult plumage in its entirety the first winter. There is no spring molt and very little effect is produced by abrasion, owing to the uniform color of the plumage, so that the nuptial plumage is scarcely distinguishable from that of winter.

Female.—Molts as the male. Plumage always duller.

Family FRINGILLIDÆ.

A summary of the molting of the species of finches described below shows that thirteen species have no spring molt, while six species have a spring molt of the body feathers. In *Spinus tristis*, *Passerina cyanea*, *Ammodramus sandwichensis savanna*, *A. princeps* and *A. caudacutus*, this seems to occur regularly every year. In the first two a radical change of color is effected, in the last three the new plumage is the same as the old.

In *Habia ludoviciana* the extent of the molt varies, probably decreasing in succeeding years.

In four other species, *Zonotrichia leucophrys*, *Z. albicollis*, *Spizella socialis* and *Melospiza georgiana*, a partial spring molt occurs, less marked after the first year.

Habia ludoviciana molts the tail the first spring, *Ammodramus caudacutus* molts it in many cases though probably not regularly.

Cardinalis cardinalis molts both wing and tail with the first plumage at the end of summer and *Passerina cyanea* and *Ammodramus caudacutus* molt the tail at this time.

Carpodacus purpureus (Gmel.). Purple Finch.

Male.—Plumages, first, first winter, first nuptial, adult winter, adult nuptial.

I have not been able to examine any molting specimens of *Carpodacus*, but a large series of winter and spring specimens shows that no spring molt occurs. The change to the pink plumage is evidently effected at an annual molt either the second year or still later. The birds retain the brown dress during the first breeding season at least. Fall specimens in brown plumage differ from spring examples in the loss of buff tints through abrasion, while pink birds lose the gray or brown edgings of winter in the same way. The great predominence of brown birds makes it seem at least possible that some never acquire the pink plumage.

Female.—Retains the brown plumage permanently; there is no spring molt.

Pinicola enucleator (Linn.). Pine Grosbeak.

So far as I can judge from winter specimens the account of the Purple Finch applies equally well to this.

Loxia curvirostra minor (Brehm). American Crossbill.

Loxia leucoptera Gmel. White-winged Crossbill.

The molting of the Crossbills is more complicated than would appear at first sight and there is probably great individual variation as to the time and extent of the change in coloration of the plumage. Mr. W. E. D. Scott has shown that some males assume the red dress immediately upon losing the first plumage, while others are known to breed in the yellow or green dress. The tints are subject to great individual variation, as also the purity of the red plumage, many specimens showing a greater or less mixture of green. Furthermore, the red plumage may be partly replaced by green at a subsequent molt, as one molting specimen has the throat quite red while a majority of the new throat feathers, just coming in are green. The annual molt of the Crossbill begins about August 1, (Somerset Co., Maine). There seems to be a slight spring molt, most pronounced on the throat and breast.

Female.—Retains the green plumage at all seasons.

Acanthis linaria (Linn.). Redpoll.

While I have no molting specimens of the Redpoll for examination, I think from a comparison of a large winter series, that the change of plumage is effected in the same way as in *Carpodacus.* The variation in the extent of the pink color on the breast of males is probably largely individual.

It is generally stated that the crimson patch on the head is intensified by a "scaling off" of the surface of the feathers but I cannot furnish any evidence upon this point.

Spinus tristis (Linn.). American Goldfinch.

Male.—Three plumages are recognizable, first, winter and nuptial. The birds of the year seem to have more brown on the edges of the wing feathers which in the older birds are nearly pure white, but I am not sure that this is constant. Annual molt occurs between the middle of September and the middle of October, and at about the same time the young bird renews its body feathers. There is a complete molt of the body feathers in spring from about the middle of April to the middle of May, but none of the wing feathers, not even the tertials, are renewed at this time. Throughout the winter and spring the white edgings to the tail and wing feathers are being lost by abrasion, so that in the summer breeding dress the wings are almost entirely black. The Goldfinch continues to have these two molts every year throughout its life, and the molting specimens present a very peculiar appearance in their mottled dress of brown and yellow.

Female.—The female has exactly the same number of molts and plumages as the male.

Spinus pinus (Wils.). Pine Siskin.

Plumages, first, winter and breeding.

So far as my material goes, there is indication of but one molt a year in this species, *i. e.*, the annual molt at the end of summer. Some abrasion takes place during the winter and spring, by which the buff edgings to the feathers are lost and the markings are thus intensified in the breeding plumage and more strongly constrasted with the white of breast. The white edgings to the wings are also lost by abrasion. A male taken Jan. 28th, (Cape May, N. J.), has the feathers of the throat and breast very much suffused with brown, so that the dark stripes are almost obliterated. Whether this is a peculiarity due to age or purely individual I am unable to say.

Plectrophenax nivalis (Linn.). Snow Bunting.

Male.—Plumages, first, winter and nuptial.

In the series which I have examined I have not detected any constant differences between the young of the year, and the adults. There seems to be no spring molt in the Snow Bunting, but the remarkable change from the winter to the nuptial dress is effected entirely by abrasion, which probably is more marked in this species than in any other. Furthermore, the abrasion is scarcely apparent until after the middle of February.[19]

Female.—Molts as in the male.

Poocætes gramineus (Gmel.). Vesper Sparrow.

Plumages, first, winter and nuptial.

Molting exactly as in *Melospiza fasciata* which it so closely resembles in plumage. Young of the year seem rather buffer than old birds.

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[19] See Stone, Science, 1893, p. 52; Chapman, Bull. Amer. Mus. Nat. Hist., 1896, p. 9.

Ammodramus princeps (Mayn.). Ipswich Sparrow.

Plumages, first, winter and nuptial.

Molting exactly as in *A. sandwichensis savanna*. Specimens taken March 15th, Atlantic City, N. J. and March 29th, Cape Charles, Va., show the spring molt in progress.

Ammodramus sandwichensis savanna (Wils.). Savanna Sparrow.

Plumages, first, winter and nuptial.

Another winter plumage occurs much browner than the usual one which may be characteristic of the birds of the year. A complete annual molt occurs at the end of the breeding season, and a more or less complete molt of the body feathers takes place in spring. Birds taken just before the spring molt show effects of abrasion, especially on the tertials and resemble July birds. After the molt new tertials have been acquired and a general renewal of the feathers of the breast, head and rump has taken place, so that the birds are in most respects indistinguishable from September specimens; the yellow stripe over the eye is also acquired at this molt. Whether this spring molt is universal with all the individuals or occurs every year, I cannot say with certainty. A series of specimens taken January 25–26 (Cape May, N. J)., shows a good deal of variation in the amount of abrasion.

Ammodramus savannarum passerinus (Wils.). Grasshopper Sparrow.

Plumages, first, winter and nuptial.

After the annual molt the plumage of this species is subject to continued abrasion which materially alters the depth of colors by the following breeding season, the under surface becoming much lighter and losing much of the brown cast while the colors elsewhere are in sharper contrast. In such material as I have examined I can find no trace of a spring molt. The spotted first plumage is retained until about the middle of August. A specimen taken Aug. 10, in Chester Co., Pa., shows the beginning of the molt of the body feathers while another Aug. 26, from the same locality, shows no sign of molt, this, perhaps, belonging to a later brood.

Ammodramus henslowii (Aud.). Henslow's Sparrow.

Such specimens of this species as I have been able to examine indicate molts and plumages exactly parallel with the last.

Ammodramus caudacutus (Gmel.). Sharp-tailed Finch.

Plumages, first, winter and nuptial.

After the annual molt the Sharp-tailed Finch is subject to great abrasion of plumage, which by March presents almost as worn an appearance as characterizes most birds in July or August. In April occurs a complete molt of the body plumage, together with the tertials and sometimes the rectrices; a specimen taken April 16 at Atlantic City, N. J., shows the new tail about half grown. After the completion of this spring molt the birds are indistinguishable, except upon close examination of the wing feathers, from October specimens. The feathers soon begin to show the effects of abrasion again and by August, just previous to the annual molt, the birds present about as dilapidated an appearance as can be found among any of our species. The wear and tear upon the plumage of this species is doubtless due to its habit of living entirely among the coarse grass and sedges of the salt marshes, which may also have something to do with the unusual extent of the spring molt. The young birds generally, but, perhaps not always, renew the tail when the first body plumage is molted at the end of summer. The remiges are not renewed at this time. The series of specimens, upon which the study of this species was based, consisted of upward of one hundred skins, taken at Atlantic City, N. J., during every month of the year by Mr. I. Norris De Haven and myself.

Ammodramus maritimus (Wils.). Seaside Finch.

Plumages, first, winter and nuptial.

In this species the spring plumage differs from the winter plumage only by abrasion, there being but one molt a year. Not only are the blending olive and brown tints of the fresh fall dress quite worn away, but the whole plumage presents the appearance of having been trimmed with a pair of scissors. It seems strange that in this species there should be no spring molt whatever, while in its nearest relative, the Sharp-tailed Finch, it should be so extensive.

Zonotrichia albicollis (Gmel.). White-throated Sparrow.

Male.—Five plumages may be distinguished, *i. e.*, first, first winter, first nuptial, adult winter, adult nuptial. The difference between second and third, and fourth and fifth is often very slight, especially in the case of the latter two. After the change to the first winter plumage the bird has a fairly well marked white throat, but the black crown stripes are much mixed with brown and the central stripe is quite dull. In spring a partial molt occurs, practically confined to the throat and head. At this time many black and pure white feathers appear in the crown, the yellow superciliaries receive bright fresh feathers and more pure white feathers are acquired on the throat. The black stripes of the crown are, however, still mixed with brown posteriorly, for the first season at least. Subsequently, whether at the following annual molt or later I cannot say, the plumage of the head becomes still brighter, with the crown stripes jet black reaching back on the neck while the white throat is sharply defined against dark gray cheeks and breast. I do not think there is any spring molt after the first year, but subsequent increase in the brightness of the markings takes place at the annual molt. The bright markings when once attained are not lost again, as some of the handsomest specimens examined are fall birds, although it is possible that some birds never acquire the brightest markings to which I have referred. Mr. W. E. D. Scott states that some birds acquire the highly colored feathers immediately after shedding the first plumage, judging the age of fall birds by osteological characters.

Female.—Apparently has no molt in spring, and though it attains the yellow eye-brow and partly black crown stripes, it does not approach the brilliancy of the old male.

Zonotrichia leucophrys (Forst.). White-crowned Sparrow.

Plumages, first, first winter, nuptial, adult winter.

Besides the annual molt, a molt of the crown, tertials and many of the breast and intescapular feathers occurs in spring. This is very marked in the first spring when the brown and buff crown is replaced by black and white. Whether it continues to the same extent in subsequent seasons I cannot say positively, though the appearance of spring specimens would indicate that some molt always occurred at this season. The full plumage once attained is not lost again, and spring and fall adults are hardly distinguishable.

Spizella monticola (Gmel.). Tree Sparrow.

Plumages, first, winter and nuptial.

There is only one molt a year, though a few odd feathers are often replaced during spring, probably when lost or damaged. Breeding specimens show great abrasion, which brings the colors into much stronger contrast, but this is not apparent until after April 1st, so that there is scarcely any variation in specimens taken within the winter habitat.

Spizella socialis (Wils.). Chipping Sparrow.

Plumages, first, winter and nuptial.

When the young bird loses the spotted first plumage, at the end of summer, it acquires a winter plumage practically identical with that of the old birds except in the purity and extent of the chestnut crown. In spring the dusky feathers of the throat are replaced by pure white ones and those of the crown by new ones, which are richly colored and have no dark spots. Apparently the older birds do not molt at all in spring, the pure chestnut crown being gained entirely by abrasion of the dusky tips of the feathers. Adults vary, however, in the purity of the chestnut crown acquired at the annual molt, some of them showing much mottling of brown. In consequence of this a partial spring molt may be necessary in some individuals after the first season. Some change is effected in the other plumage during spring and winter by abrasion.

Spizella pusilla (Wils.). Field Sparrow.

Plumages, first, winter and nuptial.

After the annual molt the winter plumage changes gradually by abrasion, and there is no spring molt except the occasional renewal of odd feathers. The contrast between October and August specimens is striking. The former have the back buff with reddish-brown centers and black shaft streaks, while the latter have reddish-brown backs with distinct black streaks.

Junco hyemalis (Linn.). Snow Bird.

Plumages, first, winter, nuptial.

No spring molt is apparent in the Snow Bird. The brown tints of autumn disappear entirely through abrasion, but this is not marked until after May 1st. Birds of the year are probably always browner than old birds.

Melospiza fasciata (Gmel.). Song Sparrow.

Plumages, first, winter, nuptial.

No spring molt occurs but abrasion is very marked, all the buff tints being lost in the spring bird, while the black streaks on the breast appear as if their ends had been cut off with a pair of scissors.

Melospiza georgiana (Lath.). Swamp Sparrow.

Male.—Plumages, first, winter, nuptial.

The molt of this species appears to be precisely like that of *Spizella socialis*, which it so closely resembles in the pattern of its plumage. The chestnut crown is acquired in spring as well as a certain proportion of white throat feathers. The chestnut crown once acquired is not lost at the annual molt but some individuals do not seem to acquire it in its entirety, at least until the second year. No spring molt seems to occur after the full chestnut crown is attained. As in most Fringillidæ, abrasion causes marked change in the general plumage during winter and spring.

Female.—Apparently like the male, though generally with the crown patch less pure.

Passerella iliaca (Merr.). Fox Sparrow.

Plumages, first, winter, nuptial.

Apparently no spring molt occurs in this species apart from a slight renewal of the throat feathers in some examples. The rusty red tints are to a great extent lost, especially on the head and neck, by the breeding season, but the abrasion is scarcely noticeable up to the time the bird leaves its winter habitat, so that specimens taken there, from November to March, are hardly distinguishable.

Pipilo erythrophthalmus (Linn.). Towhee.

Male.—Plumages, first, winter, nuptial.

There is apparently only one molt a year in the Towhee and, although the feathers are subject to abrasion during the winter and spring, scarcely any change is effected in the coloration owing to the fact that they are not parti-colored. The young birds assume the adult winter plumage about the end of August, when they present a very pecúliar mottled appearance. The wing and tail as usual are not renewed at this time.

Female.—Molts as in the male, the only difference in plumage being the substitution of brown for black in the adult.

Cardinalis cardinalis (Linn.). Cardinal.

Male.—Plumages, first, winter, nuptial.

There is no spring molt; the winter plumage shows extensive gray margins to the feathers of the back which are lost by the nesting season through abrasion. In some specimens, evidently younger birds, these edgings are brownish rather than gray. Contrary to the rule which governs others of our Fringillidæ, the young Cardinal renews the rectrices and remiges at the end of the breeding season. A specimen obtained Sept. 18, 1881, at Haddonfield, N. J. shows the first plumage nearly lost. The primaries have all been renewed as far as the third, while the new tail, still showing the sheaths at base, is nearly full grown, except the middle pair of feathers, which are not quite two inches in length. The renewal of the flight feathers in the first autumn in this species is a matter of great interest (see p. 117).

Female.—Molts as in the male, a young female changing from the first to winter plumage (Tarpon Springs, Fla., Aug. 11, 1891), shows the wings beginning to molt as described above in the case of the male. The adult plumages differ from those of the male in intensity of coloration, being generally gray and brown, though some Florida specimens are quite red. Much of the brown tint of the lower surface in winter is lost by abrasion.

Habia ludoviciana (Linn.). Rose-breasted Grosbeak.

The Rose-breasted Grosbeak exhibits probably the most complicated series of plumages of any of our smaller North American birds. Five regular plumages of the male and three of the female are recognizable, while the great range of individual peculiarity in the amount of change effected at a given molt produces many other variations.

I have treated the plumages and molts of this species at much length and have referred to them in other parts of this paper. As some of my deductions may not meet with universal endorsement, it seems proper to state at the outset the nature of the material at my disposal while writing the paper. This is as follows: First plumage, 1; first plumage, molting, 2. Males in first winter, 12; in first spring, 10; in first annual molt, 2; in second winter, 5; in second spring molt, 2; in second spring, 12. Females in spring, 8; annual molt, 1; winter, 2. Besides this, I have examined the entire series in the U. S. National Museum, the numbers of which I have not recorded.

Male.—There is in this species a complete annual molt and a more or less complete molt of the body feathers in early spring, generally including a molt of the tail in the first season. Much abrasion occurs between these two molts and in feathers not molted in the spring it continues until the next annual molt. The recognizable plumages are as follows:

First Plumage [30,236, Acad. Nat. Sci. Phila. July 1, 1892. Beaverkill, N. Y.].

Beneath white. Above, head dull black, with buffy superciliary and median stripes, all meeting on the hind neck. Rest of upper surface olive-brown, mottled with blackish-brown. Wing and tail (about half grown) olive-brown with spots and bands buffy-white.

First Plumage Molting [31,924, A. N. S. Phila. July 6, 1891. E. Hartford, Conn.].

Similar to the above, but with wings and tail of full dimensions, while the breast and abdominal tracts are newly molted buff feathers with dark centers. The head and throat are also beginning to change to the following plumage.

Plumage of First Winter [28,502, A. N. S. Phila. Aug. 10, 1879. Winnebago Co., Iowa].

Beneath buff, throat somewhat suffused with pink, and belly white, many of the feathers with a central dash of blackish-brown. Above much as in first plumage, but feathers of back and head more strongly edged with buffy-brown.

No specimens showing the molt from this plumage to that of the following spring have come under my observation; birds in the latter plumage are as follows.

Plumage of First Breeding Season [1,029 Coll. W. Stone].

Below, abdomen white, breast pink, throat black, mottled with pink and white. Above black, with more or less traces of buff edgings, rump white somewhat mottled with black, flight feathers generally as in first plumage, greater coverts and generally the tertials black, tail partly black.

Annual Molt [1,028, Coll. Wm. Brewster. Aug. 20, 1874. Upton, Oxford Co., Maine].

Below, as in the following specimen, but with many black feathers remaining on the throat, above as in first breeding plumage, except the back which has molted into fall plumage. Wings entirely molted except secondaries and outermost primaries. The old wing feathers are olive-brown, the new jet black.

Winter Plumage of Second Year [1,027, Coll. Wm. Brewster. Sept. 1871. Mt. Carmel, Ill.].

Differs from first fall plumage as follows: Belly whiter and throat and breast much more pink, feathers on back black, with comparatively narrow buff edgings. Wing and tail jet black, with pure white spots.

Breeding Plumage of Second Year [34,225, A. N. S. Phila. Haddonfield, N. J. May 16, 1882].

Differs from first year as follows: Throat uniform, black down to the breast, which is brilliant pink. Wings and tail jet black, with spots pure white, head and back solid black, rump pure white.

While the above descriptions give a pretty accurate idea of the seasonal variations of plumage in the Rose-breasted Grosbeak, they by no means cover all the peculiarities of plumage found in this variable species. It seems quite possible that the male requires three years to gain the perfect plumage described above as the "breeding plumage of the second year"; but different individuals differ so much in the amount of change that they undergo at the spring molt, that they present an almost unbroken series from one extreme type of spring plumage to the other. It is, therefore, quite impossible to do more than separate them into two groups, with brown and black remiges respectively, the former representing one year old birds, the latter those of more than one year.[20]

The remiges, I think, are only shed at the annual molt, as is the rule in nearly all passerine birds. The brown wing feathers of the fledgling are, therefore, retained until August of the next year. I think they are all replaced by jet black feathers at this annual molt. One spring specimen (1,029 Coll. W. Stone), it is true, has one black feather in an otherwise brown wing, but this is evidently an exception, and the black feather may have been assumed in spring; in any case, it can hardly be considered as evidence that the brown wings are retained for more than one year. Furthermore, all the brown-winged birds I have examined which show the annual molt in progress, have new black feathers coming in.

The tertials, as usual, do not accord with the primaries and secondaries in the time of their molt. Birds in the first winter plumage (*i. e.*, with brown wings) almost always molt the tertials with the body feathers in spring, the new ones being jet black with white spots. Two specimens before me, however, retained the old brown tertials throughout the breeding season. An example of the other extreme is a specimen (No. 501 Coll. W. Stone), a bird of the year, shot in September, which has just completed the molt from the first plumage to that of the first winter, has lost the brown tertials and greater wing coverts and has a new set of black ones which still have the embryonic sheaths adhering to the base of the quills.

Old birds, as a rule, do not renew the tertials in spring, though some of the most highly plumaged examples seem to have done so In judging of the renewal of these tertials, I have based my opinion on the condition of these feathers in spring specimens. In some birds they are very much abraded so that the white spots appear to have been cut away, while in others they are fresh and show no abrasion at all (Pl. V, figs. 7 and 8). The former I regard as acquired at the previous annual molt and latter at the spring molt.

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[20] As already stated, the most perfect plumage may not necessarily denote an old bird, but perhaps one of exceptional vitality. Though it is undoubtedly the fact that the successive plumages of an individual become more perfect, up to a certain point, at least, it is also quite likely that some individuals never reach the so-called perfect plumage.

The tail is generally shed at the first spring molt and a new black one assumed,[21] though sometimes only a few of the feathers are changed, frequently only the middle pair. In these latter cases the complete black tail is assumed at the next annual molt.

As regards the spring molt of the body plumage there is a great deal of individual variation. In some specimens, especially in birds in their first spring plumage, this molt is practically complete, as far as the body feathers are concerned, while in others, a good many of the old feathers, showing much abrasion, are retained. This often gives a mottled appearance to the interscapular region, while in the pink breast patch the old feathers may be recognized by their worn whitish tips. One curious specimen (No. 31,922, A. N. S. Coll., E. Hartford, Conn., May 11, 1891), has the pink of the breast thickly spotted with black. Careful examination shows that but little molt has taken place on the breast; the buff margins, however, which bordered the feathers in the winter plumage, have been completely worn away, while the black portions being apparently less brittle have withstood the abrasion and remain as prominent as in the winter bird (see Pl. V, fig. 6). Furthermore, the feathers of the interscapular region, which are acquired at the spring molt, seem to vary in character, some are jet black throughout, while others are bordered with very light buff on the sides. These might be considered to be remnants of the winter plumage, but in many spring specimens (notably in 1,029, Coll. W. Stone, May 8, 1892) the feathers are fresh and perfect while if they had been acquired at the previous annual molt they would certainly have shown more or less abrasion. These buff-edged feathers in spring birds do not necessarily denote younger birds than those having the the pure black feathers, since in the specimen (28,499, Coll. A. N. S., June, 1881) which shows the least amount of spring molt of any in the series, such new feathers as have been acquired on the back are entirely black.

Female.—Molts and plumages quite different from male. So far as my material goes, there seems to be a partial molt in spring in addition to the annual molt at the end of the breeding season, but in many individuals the nuptial plumage is much abraded and shows but little renewal of the feathers. There is a curious plum-

[21] I have not seen any specimen which shows this molt of the tail in progress, but I have seen such a specimen illustrating an exactly similar molt in *Piranga erythromelas.*

age of the female which I do not regard as belonging to the regular cycle of changes, but rather an abnormal tendency toward the color pattern of the male. This differs from the normal female plumage in having the head and forepart of the back, sides of neck, and chin black, slightly edged with gray, the median crown stripe being obsolete. Below white slightly tinged with yellow on the breast, where are also a few narrow shaft streaks. The specimen described was taken in Chester Co., Pa., May 5, 1888 (No. 1,957, Coll. W. Stone). A similar one is in the U. S. Nat. Museum Collection.

Passerina cyanea (Linn.). Indigo Bird.

Male.—Four distinct plumages are recognizable in this species.

First Plumage.

Much like the following but distinguished by the different structure of the feathers.

Plumage of First Winter. [No. 841, Coll. W. Stone. Sept. 30, 1891. Chester Co., Pa.].

Reddish-brown above, with darker shaft lines on back, below quite buff, brownish on breast, with distinct dark shaft lines.

Breeding Plumage.

Brilliant blue above and below, varying as described below.

Winter Plumage of Adult.

Reddish-brown above, shaft stripes obscure, rump feathers more or less blue with brown tips below, tinged with brown, many feathers with bluish bases, which give it a mottled appearance. Some specimens have much blue on the bases of all the feathers above.

The breeding plumage exhibits a great range of variation and the most brilliant and perfect dress is certainly not acquired before the second or third year. The primaries and secondaries are only renewed at the annual molt, but the tertials and some of the rectrices are often molted in spring, when the brown body feathers are lost and the blue plumage acquired. It is the irregularity in the extent of this molt that causes the variety in the breeding plumage of different individuals. Old brown tertials of the winter plumage are frequently retained through the breeding season and also many of the old coverts as well as brown patches or single feathers on various parts of the body. The white belly of the winter plumage also frequently escapes molt in the spring. Individual variation in the extent of the molt is so great that the specimens cannot be separated in definite groups. Fourteen spring and summer males show only six in which the molt of body feathers has been complete and no trace of brown feathers remain, but even some of these have one or two brown wing-coverts. Eight of the fourteen have renewed the tertials in the spring molt while three have partially renewed them and three retain the old feathers. Winter specimens of more than one year also show a good deal of variation in the amount of blue on the feathers. Some which appear brown superficially, have the bases of the feathers quite blue; while others have broader brown margins and but little blue. Much abrasion takes place between the annual and spring molt but a scarcity of winter specimens and general lack of dates on such as I have, prevents a careful study of this matter. The young birds of this species molt the tail at the close of the summer when they renew their body plumage but do not molt the wing feathers.

Females.—Have but one molt a year, and the change in the nuptial plumage is due entirely to abrasion. Whether the young renew the tail at the end of the summer, as in the male, I am uncertain.

Spiza americana (Gmel.). Dickcissel.

Plumages, first, winter, nuptial.

No spring molt occurs in this species, unless in the first season.

Family TANAGRIDÆ.

Piranga erythromelas Vieill. Scarlet Tanager.

The seasonal changes of this species are analogous to those of the Rose-breasted Grosbeak, though the individual variations do not seem to be so great. Five regular plumages of the male are recognizable, as follows:

1. *First Plumage* [No. 1,906, Coll. W. Stone. Aug. 17, 1895. Chester Co., Pa.].

Above olive, below yellowish-white, yellow on middle of the abdomen and crissum, breast and sides of abdomen coarsely spotted and streaked with olive. Wings half grown, tail one-quarter grown.

2. *Plumage of First Winter* [No. 830, Coll. W. Stone. Sept. 18, 1891. Haddonfield, N. J.].

Above olive, below olive-yellow, wing and tail brown, edged with olive, except the greater median and lesser wing-coverts, which are jet black.

3. *First Breeding Plumage* [No. 34,001, Coll. A. N. S. Chester Co., Pa. May 18, 1881].

Above and below scarlet, tail jet black, wings brown, edged with olive, except greater median and lesser coverts and tertials which are jet black.

4. *Plumage of Second Winter* [No. 19,688, Coll. Wm. Brewster. Buncombe Co., N. C. Sept. 15, 1886].

Above olive, below yellow-olive, wings and tail entirely jet black.

5. *Breeding Plumage of Second Year* [No. 716, Coll. W. Stone. Harvey's Lake, Pa. June 16, 1891].

Above and below scarlet, wings and tail entirely jet black.

From these descriptions it will be seen that the dull brownish wing feathers of the first plumage are retained until the first annual molt, except the tertials which are molted in the spring when the red body plumage is first assumed. The jet black tail is also acquired at this time in all the specimens that I have examined, except one. In this the molt of the tail has been incomplete, only three black feathers having been assumed. In many birds in the first breeding plumage a few olive feathers persist on the sides of the body and flanks and more rarely on the back. Specimens in the plumage of the second winter also frequently show a few red feathers on these parts.

A peculiar plumage of the male which does not belong in the regular cycle, but which is of more than casual occurrence, has the scarlet of the normal plumage replaced by bright orange. Other peculiarities, which are of rather frequent occurrence, are the presence of red or orange feathers among the lesser wing coverts. Specimens taken in August, showing the annual molt in progress, are striking looking birds. One of these before me is about half molted; the crown, ear coverts, interscapulum, throat, sides of the abdomen, and spot on the breast are olive, while the hind neck, sides of head, rump, breast, center of abdomen and crissum are scarlet. Specimens showing the spring molt are, of course, exactly the reverse of this, but the only one that I have seen was so far advanced that nearly all the green plumage was lost. It was a bird entering upon its first spring, and showed the jet black tail about half grown while the brown remiges were retained and showed no signs of molt.

Specimens examined: First plumage, 1; first winter, 5; spring molt, 2; first breeding plumage, 14; annual molt 4; second winter 2; second spring molt, 1; second breeding plumage, 11.

Female.—I have been unable to examine any specimens in the winter, but from a comparison of spring and fall birds, I should think there was at least a partial molt in spring.

Family AMPELIDÆ.

Ampelis cedrorum (Vieill.). Cedar Waxwing.

Plumages: first, winter, nuptial.

Only one molt a year occurs in this species and but little effect is produced by abrasion, except that the plumage becomes lighter, especially above. The molt is very late; in a specimen taken Sept. 27, it has just begun while young birds molt the first plumage (?) of the body in November as shown in specimens taken Nov. 2–22.

Family HIRUNDINIDÆ.

The swallows exhibit certain peculiarities in their molt which have already been described (p. 111). In addition to this they differ from most Passerine species in having the first plumage better developed and more nearly like that of the adult. This plumage is generally retained much longer than in most birds and the young of most of our swallows seem to start on their migration with little or no molt having taken place. Sharpe and Wyatt think that swallows molt in their winter quarters, but in the case of *Tachycineta* and *Chelidon* this is certainly an error and Dr. J. A. Allen[22] has shown that it is equally erroneous in the case of *Stelgidopteryx*. Some individuals probably start on their migration before the molt has begun. Certainly great quantities of swallows, mainly *Tachycineta* and *Chelidon*, congregate along the southern New Jersey coast in August, the majority of which are surely migrants, and many of them are molting. In the same way, molting *Tachycinetæ* occur in abundance in the lower Delaware Valley in October, where there are none in the summer. An adult *Chelidon erythrogaster*, taken at Philadelphia, Sept. 1, with the one described beyond, had just begun to molt on the head, but showed no trace of shedding any flight feathers. This bird would hardly have staid to molt, as this species is rarely seen here after that date.

Progne subis (Linn.). Purple Martin.

The Martin apparently has no regular spring molt, but some young males acquire scattered black feathers on the under parts at this time. The complete steel-blue plumage is not acquired till the end of the second summer (or perhaps the third ?).

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[22] Auk, 1895, p. 374.

Petrochelidon lunifrons (Say). Cliff Swallow.

From such series of this bird as I have examined, I should judge that it had no spring molt; whether the young molt the flight feathers at the close of the summer I cannot say, as none of my specimens show any molt.

Chelidon erythrogaster (Bodd.). Barn Swallow.

The scarcity, in collections, of adults in winter plumage or in the molt prevents a complete account of the molting of this species. I have only one specimen showing the annual molt in progress, which was taken Aug. 7, 1878, at Philadelphia. New feathers are coming in on the breast, throat, and back, and the tail is just beginning to molt. None of the remiges have been cast. Another specimen, taken Sept. 1 at the some locality, shows a complete molt just finished. As I am not sure whether the young molts its flight feathers with the rest of its first plumage I cannot say whether this is an adult or bird of the year, but my impression is that the young do not molt the wing and tail at this time and that the specimen is, therefore, an adult. In any case it presents one curious question: The outer rectrices are only .35 in. longer than the next pair (as in all young summer birds). Now all the spring birds that I have examined have the feathers much longer (.75–1.25 in. longer than the next pair), so that there must be a molt of part of the tail at least, in the spring. I do not think there is any spring molt of the wings or body feathers.

Tachycineta bicolor (Vieill.). White-bellied Swallow.

Plumages: first, winter, nuptial, adult winter.

Male.—A large series of this species, collected in southern New Jersey illustrates the changes of plumage very satisfactorily. The annual molt in the adults takes place from July 20 to September 1, at which latter date the winter plumage is generally completed. The birds of the year do not begin to molt until the first week of September and are in full plumage, indistinguishable from the adults, by October 15. Apparently there is no spring molt, but the white tips to the wing feathers disappear by abrasion.

Female.—Two plumages of the female are found, one indistinguishable from the male, the other much duller and quite brown in the spring. The latter, I think, is the plumage of the first year; at any rate, in one specimen, it is certainly assumed at the molt of the first plumage.

Clivicola riparia (Linn.). Bank Swallow.

I can find no evidence of a spring molt in this species, but the plumage shows considerable abrasion at this season. I have seen no molting specimens.

Females.—Resemble the males at all times.

Stelgidopteryx serripennis (Aud.).

The above remarks apply equally to this species.

Family LANIIDÆ.

Lanius borealis Vieill. Northern Shrike.

There seems to be a partial molt in spring, but not extensive enough to produce a change in the plumage. One specimen, taken March 20, shows new feathers coming in on the breast and head.

Lanius ludovicianus Linn. Loggerhead Shrike.

A specimen taken October 20, Haddonfield, N. J. (No. 1,429, Coll. W. S.), which shows no sign of molt on the wings, except the tertials, and appears, therefore, to be a bird of the year, has nearly completed the body molt and has likewise renewed the tail. Spring specimens show a slight renewal of feathers, as in the preceding species.

Family VIREONIDÆ.

The uniform coloration of the feathers in the Vireos helps to obscure what little abrasion takes place in the plumage; and notwithstanding the fresh appearance of the spring dress, I do not think there is a spring molt of any great extent. The few winter specimens that I have examined show no signs of molt. The young in the first winter are like the adults, and the males and females are alike. There are, therefore, only three plumages: first, winter and nuptial, the last two are often scarcely distinguishable.

Vireo olivaceus (Linn.). Red-eyed Vireo.

Spring birds are, perhaps, duller colored, but show but little signs of wear. A specimen taken Aug. 27 has nearly completed the molt of body feathers while it is also molting the tail. The wings show no signs of molt, except the tertials which are generally renewed with the body plumage, so that the specimen must be a bird of the year.

Vireo gilvus (Vieill.). Warbling Vireo.

Vireo philadelphicus (Cass.). Philadelphia Vireo.

Molt as in the preceding. The winter plumages have respectively more buff and olive-yellow beneath than the nuptial dress. No young birds in the first molt have been examined.

Vireo flavifrons Vieill. Yellow-throated Vireo.

Vireo solitarius (Wils.). Solitary Vireo.

These two birds seem to correspond exactly in the condition of their plumages. The tertials of some individuals show so little abrasion and have the light edgings so perfect that it seems as if they must be renewed in the spring. A young *V. flavifrons* in the first molt, is renewing only the body plumage.

Vireo noveboracensis (Gmel.). White-eyed Vireo.

A young bird in first molt is renewing its tail exactly as in *V. olivaceus.* Spring specimens show more abrasion than any of the other Vireos, and the edge of the tertials are very much worn, in striking contrast to the last two species.

Family MNIOTILTIDÆ.

A more or less complete spring molt of the body plumage seems to be the rule in the Warblers but as is usually the case with spring molts we have a very unsatisfactory series of specimens available for study, and are thrown back largely upon a comparison of spring and autumn material. Species of which I have actually seen specimens in the process of molting in spring are *Dendroica blackburniæ, D. discolor, D. castanea, D. palmarum, D. tigrina, D. coronata,* and *Geothlypis trichas.* The question of course arises as to the extent of this molt after the first year. The young of most Warblers in the first autumn differ materially from the adults, and an extensive molt is necessary in the following spring, but upon once gaining the adult plumage they do not change their appearance materially at the next annual molt and, therefore, a complete spring molt in subsequent years is not necessary. Some species, however, change regularly, twice a year. Probably nearly all Warblers have some spring molt, but in many it is restricted to the head and breast after the first season. Regarding the relation of their seasonal plumages, the species may be grouped as follows:

1. Adult male at all seasons and young of the year practically alike, *Seiurus, Helmitherus, Sylvania mitrata* (winter plumage with light tips on black parts).
2. Winter and nuptial dress of adult male different: *Mniotilta varia, Dendroica pensylvanica, D. maculosa, D. striata, D. castanea, D. blackburniæ.*

3. Adult males alike at all seasons, young of the year different: *Geothlypis, Sylvania canadensis, S. pusilla, Setophaga, Helminthophila pinus, H. ruficapilla, Dendroica æstiva, D. virens, D. cærulescens, D. vigorsii, D. tigrina, D. discolor, Compsothlypis.*

Regarding a few I am in donbt.

So far as I know, no Warblers molt the flight feathers in spring, nor do the young molt them with their first plumage.

Mniotilta varia (Linn.). Black and White Warbler.

Plumages: first, first winter, nuptial, adult winter.

Male.—The worn condition of the plumage of some birds would indicate that the spring molt is not as complete as in most Warblers. Some individuals do not molt the tertials at this time while others certainly do. The plumage of the first winter has only the sides of the body streaked and the streaks dull. The adult winter plumage is as heavily marked as the nuptial dress but has the throat white.

Female.—Remains in the plumage of the first winter.

Helminthophila pinus (Linn.). Blue-winged Warbler.

Plumages: first, first winter, first nuptial, adult winter, adult nuptial.

Male.—Spring birds are always much worn on the tertials and back, and probably have only a partial spring molt. The yellow cap is wanting in the first winter, the lores are dull and the under surface quite dull. Some spring males are dull and tinged with olive below, with the cap ill-defined, these I take to be first year birds. Adults are brilliant yellow.

Female.—Like male, with the same two forms of spring plumage.

Helminthophila chrysoptera (Linn.). Golden-winged Warbler.

Apparently the same plumages as the above. What I take to be the plumage of the first spring is tinted with yellow below. The female has the black replaced by gray.

Helminthophila ruficapilla (Wils.). Nashville Warbler.

Plumages: first, first winter, nuptial, adult winter.

The plumage of this species shows still more abrasion in spring, and there would seem to be little or no spring molt at this season, after the first year. Birds in the first winter lack the pure gray on the head, and show little or no chestnut on the cap.

Helminthophila peregrina (Wils.). Tennessee Warbler.

Apparently has the same number of plumages and molts as the last. Spring birds are much worn.

Helmitherus vermivorus (Gmel.). Worm-eating Warbler.

Plumages: first, winter, nuptial.

There is scarcely any variation in the plumage of this species after the nestling stage. Spring birds show but little abrasion.

Compsothlypis americana (Linn.). Parula Warbler.

Plumages: first, first winter, nuptial, adult winter.

The spring molt is probably not very marked, as the birds show much abrasion. Fall adults have the breast markings fringed with yellow, which is lost by the breeding season. How much variation there is in the nuptial plumage I cannot say. I had thought the dark-breasted individuals to be birds of the second or third year, but Mr. Brewster has shown that they represent a geographical race, *C. americana usneæ.* Perhaps the younger birds of this race will still be found to be lighter colored.

Dendroica tigrina (Gmel.). Cape May Warbler.

Plumages: first, first winter, nuptial, adult winter.

A nearly complete spring molt of body plumage takes place the first spring, and a good deal of abrasion follows during May, which brings out the spots on the back and throws all the markings into stronger contrast. Birds in the first winter are very dull and tinged with gray, while adults in winter differ little from spring birds, except that all the feathers are broadly bordered with olive-gray or yellow. This plumage changes to the adult nuptial dress wholly by abrasion, which is very strongly marked in spring adults.

Dendroica æstiva (Gmel.). Yellow Warbler.

Plumages: first, first winter, nuptial, adult winter.

There is a complete molt of body feathers the first spring, but it is probably not so extensive in subsequent years, as some spring birds show that the tertials have not been renewed. Young in first winter are very dull, with the top of the head quite green. Adults in winter are scarcely distinguishable from spring birds.

Dendroica cærulescens (Gmel.). Black-throated Blue Warbler.

Plumages: first, first winter, nuptial, adult winter.

The freshness of the flight feathers in some spring specimens seems to indicate that they are sometimes renewed with the rest of the spring plumage. Others are so worn that they probably molted but little at this time. Most fall adults have white edgings to the throat feathers, but others are absolutely indistinguishable from the the freshest spring specimens. Females are always in the brown plumage, like the males in the first winter. One old (?) specimen (May 19, Coll. A. N. S., No. 29,592) is quite gray above.

Dendroica coronata (Linn.). Myrtle Warbler.

Plumages, first, first winter, nuptial, adult winter, adult nuptial.

A good series of winter and spring examples of this species from southern New Jersey shows the spring molt very satisfactorily. The entire plumage of the head and breast is renewed as well as the greater part of the interscapulum. The tertials are not molted. Old birds, in fall, have more or less gray feathers on the back and black centered feathers on the breast, but they all continue to molt in spring. A spring bird, which I take to be of the second or third year, has the black on the breast uniform, not broken up by white edgings to the feathers.

Dendroica maculosa (Gmel.). Magnolia Warbler.

Plumages and molts as in the last. Adults in winter differ from birds of the year in the heavy stripes on the sides of the body, and large black centers to feathers of the back. Spring birds of the second or third year have the interscapulum solid black, all the way to the yellow rump.

Dendroica pensylvanica (Linn.). Chestnut-sided Warbler.

Plumages, first, first winter, nuptial, adult winter.

Spring molt rather more extensive than in the last two species, and the adult in fall always more distinct from the nuptial plumage, only differing from the bird of the year in the chestnut stripes on the sides. The tertials are not renewed in spring.

Dendroica cærulea (Wils.). Cerulean Warbler.

According to the British Museum Catalogue, the winter adult is practically like the spring bird, so that the plumages will be as in *D. cærulescens.*

Dendroica castanea (Wils.). Bay-breasted Warbler.

Exactly like *D. pensylvanica* in number and relations of plumage.

Dendroica striata (Forst.), Black-poll Warbler.

Plumages, first, first nuptial, first winter, adult winter, adult nuptial.

This species, unlike the preceding, renews the tertials in spring. What I take to be the first nuptial plumage shows remains of the olive winter dress on the crown and sides of the neck. Adults in fall are much whiter beneath than the young and have heavier streaks above. Females remain in a plumage like that of winter. I am uncertain as to the extent of molt in spring.

Dendroica blackburniæ (Gmel.). Blackburnian Warbler.

Plumages, first, first winter, nuptial, adult winter.

Some individuals molt the tertials in spring, others do not. Adults differ from young in winter, in the brighter yellow throat and breast.

Dendroica virens (Gmel.). Black-throated Green Warbler.

Plumages, first, first winter, nuptial, adult winter.

After the first season, the spring molt is much less extensive than in the species just preceding and in some individuals there seems to be little or no molt. Adults in fall have the black throat as in spring, but all the feathers are edged with white, which is afterwards lost by abrasion.

Dendroica vigorsii (Aud.). Pine Warbler.

Plumages, first, first winter, nuptial, adult winter.

After the first year there is little or no spring molt. Winter adults are nearly like summer examples.

Dendroica palmarum hypochrysea Ridgw. Yellow Palm Warbler.

Plumages, first, first winter, nuptial, adult winter.

The spring molt is restricted to the breast and crown, and the back shows much abrasion.

Dendroica discolor (Vieill.). Prairie Warbler.

Plumages, first, first winter, nuptial, adult winter.

The adult birds in autumn are practically like spring specimens but have the black stripes on the breast obscured by yellow edgings. Birds in their first winter plumage lack the chestnut on the back and have but few black streaks below. The tertials are not renewed in spring.

Seiurus aurocapillus (Linn.). Ovenbird.

Plumages, first, winter, nuptial.

Spring birds are practically indistinguishable from autumn examples and there is probably a pretty extensive spring molt. June and July specimens show much abrasion compared with those taken in April.

Seiurus noveboracensis (Gmel.). Water Thrush.

Seiurus motacilla (Vieill.). Louisiana Water Thrush.

The above remarks apply equally well to these species but without a series of winter specimens it is impossible to ascertain the extent of spring molt in any *Seiurus.*

Geothlypis trichas (Linn.). Maryland Yellow-throat.

Plumages, first, first winter, nuptial, adult winter.

The spring molt seems confined to the breast, throat and sides of the head. Adults in winter have the hood much obscured by lighter edgings, while young have it reduced to a patch on the ear coverts and sides of neck.

Female.—Sometimes has no spring molt whatever.

Geothlypis philadelphia (Wils.). Mourning Warbler.

Plumages and molts apparently as in the preceding species.

Geothlypis agilis (Wils.). Connecticut Warbler.

Plumages and molts as in *G. trichas.* The spring molt is mainly restricted to the throat. Adults in spring and autumn are practically indistinguishable below, but the former show abrasion above. Young in the first winter have the throat and breast brownish instead of gray.

Geothlypis formosa (Wils.). Kentucky Warbler.

Plumages and molts as in *G. trichas.* I have no specimens of the young in their first winter and cannot say whether the black mask is complete then or not.

Icteria virens (Linn.). Yellow-breasted Chat.

Plumages, first, winter, nuptial.

There is scarcely any difference in spring and autumn specimens, except that the former show abrasion above. The spring molt is probably restricted to the under surface.

Sylvania mitrata (Gmel.). Hooded Warbler.

Plumages, first, winter, nuptial.

Mr. Wm. Palmer,[23] has shown that the male of this species acquires the full black hood the first year, and that the female varies in succeeding molts in the amount of black, finally attaining the full hood also.

Sylvania pusilla (Wils.). Wilson's Warbler.

Plumages, first, first winter, nuptial, adult winter.

Spring and fall adults are practically alike, and there is evidently a spring molt. Young of the year lack the black cap. Females

[23] Auk, 1894, p, 287.

have more or less black on the head and perhaps sometimes attain the full plumage of the male, as in the last species.

Sylvania canadensis (Linn.). Canadian Warbler.

Plumages and molts as in the last. The adult in autumn is exactly like the spring bird.

Setophaga ruticilla (Linn.). American Redstart.

Plumages, first, first winter, first nuptial, adult winter, adult nuptial.

Spring molt is mainly restricted to the under surface in the first season at least and probably afterward. Young in their first nuptial dress differ from that of the first winter only in the acquisition of a few scattered black feathers; new tertials are sometimes acquired in spring also. Some winter adults have gray edgings to the black feathers, others are indistinguishable from spring birds.

Family MOTACILLIDÆ.

Anthus pensilvanicus (Lath.). Tit Lark.

Plumages, first, winter, nuptial.

There is considerable molt of the body plumage in spring. Specimens taken in January and February are much abraded and resemble June birds.

Family TROGLODYTIDÆ.

Mimus polyglottos (Linn.). Mocking-bird.

Plumages, first, winter and nuptial.

There appears to be no spring molt, at least no specimens show traces of it. April birds show much abrasion, especially on the plumage of the back, and the buff tints of winter disappear entirely from the lower surface.

Galeoscoptes carolinensis (Linn.). Catbird.

Plumages and molt apparently as in the last. Some spring birds have the plumage quite fresh, but abrasion produces very little effect in this species, as shown by a comparison of spring and midsummer examples, so that I do not consider this as indicating a spring molt. Furthermore, none of the winter specimens examined show any indications of molt.

Harporhynchus rufus (Linn.). Brown Thrasher.

Plumages and molt as in *Mimus*. Spring birds are somewhat abraded, especially on the head, while the spots on the breast appear "clipped" at the tip and somewhat bifurcate. Some fall birds are rather pruinose on the head and back. One of these specimens in the molt is proved to be an old bird, while other undoubted old birds have the more tawny plumage, so that I am not sure whether this slightly different coloration represents a bird of any particular age or is merely an individual variation.

Thryothorus ludovicianus (Lath.). Carolina Wren.

The molts and plumages of this bird are exactly parallel to those of *Harporhynchus rufus* and, so far as I can ascertain, there is no spring molt. The feathers of the crown are much abraded in all spring birds, and in late summer the abrasion of the entire plumage is extreme.

Troglodytes aëdon Vieill. House Wren.

Plumages, first, winter, nuptial.

There is no spring molt in the House Wren and the contrast between spring and fall specimens, caused by abrasion, is striking.

Troglodytes hiemalis Vieill. Winter Wren.

Plumages and molt exactly as in the House Wren.

Cistothorus stellaris (Licht.). Short-billed Marsh Wren.

Plumages, first, winter, nuptial.

There is a complete spring molt of the body feathers in this bird as shown in a series taken at Tarpon Springs, Fla., April 15th. They become very much abraded by July.

Cistothorus palustris (Wils.). Long-billed Marsh Wren.

Molts as in the preceding.*

Family PARIDÆ.

Sitta carolinensis Lath. White-breasted Nuthatch.

Plumages, first, winter, nuptial.

There is no spring molt, and, excepting on the flight feathers, abrasion is not very apparent until after the breeding season.

Sitta canadensis Linn. Red-bellied Nuthatch.

Molt as in the preceding.

Parus bicolor Linn. Tufted Titmouse.

Plumages, first, winter, nuptial.

No spring molt, and but little effect produced by abrasion.

Parus atricapillus Linn. Black-capped Chickadee.

Parus carolinensis Aud. Carolina Chickadee.

Molt as in the preceding, all plumages very similar to each other.

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* *Certhia* apparently molts exactly as in *Troglodytes aedon.*

Family SYLVIIDÆ.

Regulus satrapa Licht. Golden-crowned Kinglet.

Plumages, first, winter, nuptial.

No spring molt.

Regulus calendula (Linn.). Ruby-crowned Kinglet.

Plumages and molt as in the last. Mr. C. W. Beckham[24] states that the young male generally acquires the red crown patch when the first plumage is molted but not always, and that the female never acquires it. Several variations in the color of the red patch have also been described.

Polioptila cærulea (Linn.). Blue-gray Gnatcatcher.

Plumages, first, winter, nuptial.

While none of the February or April specimens show signs of molt, I think that some individuals have a partial molt in spring and I have examined a specimen of *P. albiventris* Lawr., showing the spring molt in progress (March 19th.).

Family TURDIDÆ.

Turdus mustelinus Gmel. Wood Thrush.

Plumages, first, winter, nuptial.

Although I have no winter or early spring specimens of the Wood Thrush, I consider that there is only a slight spring molt if any.

Turdus aliciæ Baird. Gray-cheeked Thrush.

Turdus ustulatus swainsonii (Cab.). Olive-backed Thrush.

The above remarks apply equally to these species.

Turdus aonalaschkæ pallasii (Cab.). Hermit Thrush.

I have examined a large series of Hermit Thrushes, including winter specimens, and can find no traces of a spring molt. The abrasion is more marked than in the last two species.

Turdus fuscescens Steph. Wilson's Thrush.

Plumages and molt as in the preceding.

Merula migratoria (Linn.). Robin.

Sialia sialis (Linn.). Bluebird.

Plumages, first, winter and nuptial.

No spring molt occurs, but some abrasion is seen in spring birds.

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[24] Proc. U. S. Nat. Mus., 1885, p. 625.

EXPLANATION OF PLATES.

Plate IV.

Fig. 1. Wing of *Merula migratoria* with molt started; shaded parts represent the new feathers. Quill No. 6 has been shed but the new feather has not yet appeared.

Fig. 2. Wing of *Tachycineta bicolor;* molt of primaries well advanced.

Fig. 3. Wing of *Chætura pelagica,* with molt of primaries well advanced.

Fig. 4. Tail of *Tachycineta bicolor,* with molt of rectrices half completed.

Fig. 5. Breast feather of *Antrostomus vociferus,* first plumage, bearing a down feather at its tip (much enlarged).

Fig. 6. Tip of breast feather in sheath of *Sturnella magna,* winter plumage; forcing out a first plumage feather on its tip (enlarged).

Fig. 7. Feather from breast of *Dolichonyx oryzivorus* Ad. ♂ showing light border which is lost by abrasion.

Fig. 8. Terminal part of tertial of *Sturnella magna,* winter plumage.

Fig. 9. Same in late summer, showing loss of entire terminal portion even with the tips of the secondaries; also loss by abrasion of all the light border and spots, including the entire terminal part of the barbs, from where the light color begins to their extremities.

Plate V.

Fig. 1. Tail of *Dryobates pubescens* showing the beginning of the molt. The third quill has just been shed and the tip of the new one has not yet appeared.

Fig. 2. Tail of *Galeoscoptes carolinensis* showing the molt under way.

Fig. 3. Wing of *Ceryle alcyon* showing the beginning of the molt with the fourth primary, instead of the innermost as is usually the case.

Fig. 4. Wing of *Plectrophenax nivalis* with molt of primaries and tertials in progress.

Fig. 5. Wing of *Dendroica æstiva* showing molt of primaries and tertials almost complete, while the secondaries are about half grown. Dotted line represents the position of feathers when the growth is completed.

Fig. 6. Feather from breast of *Habia ludoviciana* showing the unworn projecting black tip. Dotted line indicates the original size of feather, the edge having been lost by abrasion (enlarged).

Fig. 7. Terminal portion of tertial of *Habia ludoviciana* in winter plumage showing white border spot.

Fig. 8. Same from spring specimen with white portion lost by abrasion.

FEBRUARY 4.

The President, SAMUEL G. DIXON, M. D., in the Chair.

Twenty-one persons present.

The deaths of the following members were announced:—Peter F. Rothermel, August 15, 1895; Henry Hazlehurst, January 11, 1896; Jesse S. Walton, January 30, 1896; H. Ernest Goodman, M. D., February 3, 1896.

FEBRUARY 11.

The President, SAMUEL G. DIXON, M. D., in the Chair.

Twenty-nine persons present.

The death of Charles Wachsmith, a correspondent, February 7, 1896, was announced.

A paper entitled "A Note on a Uniform Plan of Describing the Human Skull," by Harrison Allen, M. D., was presented for publication.

FEBRUARY 18.

The President, SAMUEL G. DIXON, M. D., in the Chair

Thirty-six persons present.

A paper entitled "Contributions to the Life History of Plants, No. XII," by Thomas Meehan, was presented for publication and referred to the Publication Committee.

FEBRUARY 25.

The President, SAMUEL G. DIXON, M. D., in the Chair.

Forty-five persons present.

The death of Owen Jones Wister, M. D., February 24, 1896, was announced.

Papers entitled as follows were presented for publication:—

"The Coloring Matter of the Aril of Celastrus Scandens," by Ida A. Kellar.

"The Crystallization of Molybdenite," by Amos P. Brown.

The following were elected members:—Homer E. Hoopes, A. Feldpauch, Vickers Oberholtzer, J. Edward Farnum, George L. Farnum, H. W. Wenzel, Morris Earle and Arthur N. Leeds.

The following were ordered to be printed:—

NOTE ON A UNIFORM PLAN OF DESCRIBING THE HUMAN SKULL.

BY HARRISON ALLEN, M. D.

In a recent study of the human skull I attempted to frame a method of uniform description which answers a useful purpose. Assuming that the skull presents a norma frontalis, a norma basilaris, a norma lateralis and a norma verticalis, the following order of procedure is recommended. Beginning at the norma frontalis and proceeding from above downward I note the following:

The *degree of prominence of the glabella and supraorbital ridges*, by defining an arc between nasion and ophryon, by a piece of flexible wire, drawing a chord for the arc and measuring the versed sine. (In a given case it would read as follows—g. and s. o. r.=5 mm.). Next the degree of deflection of the supraorbital margin is recorded on a protractor. (In a given case s. o. m.=40°).

The nasal bones yield three portions:—the *frontal portion* which is bounded above by the frontal bone; the *maxillary portion*, which lies between the frontal bone and premaxilla; the *premaxillary portion* which lies in contact with the premaxilla. The frontal portion is measured from the union of the nasal bone and the ascending process of the maxilla to the proximal free end of the lateral margin of the nasal bone. The maxillary portion constitutes the greater part of the bone and lies entirely in contact with the ascending process of the maxilla. The premaxillary portion is the least well defined and lies on the lateral margin of the bone a few millimeters above the free distal margin of the bone. The suture between the premaxilla and maxilla is never found after an early stage of development; notwithstanding this, the manner in which the premaxilla and the nasal bones unite in the apes, taken together with the ranges of variation in this same line, as noted in the human subject, give the observer an accurate impression of the extent of naso-premaxillary junction. The texture of the naso-premaxillary suture is distinctive. The nasal bone is further divided into two parts, that which lies in contact with the frontal bone and the ethmoid bone and is outside of the nasal chamber, and that which lies below the one last named and is entirely within the nasal chamber; the first part will receive the name of *radix* and the last part the name of *salient.* The degrees of angulation of both radix and salient being measured on a protractor we have in a given case the following formulæ: n. f. 4 mm.; n. mx. 10 mm.; n. pr. 2 mm.; r. 7 mm., 90°; s. 10 mm., 40°.

The next region in order is the vestibule of the nasal chamber, which is accepted as the nasal aspect of the premaxilla as seen at the floor of the nose. When the parts of this region are as in the child, it is called *pædomorphic,* but when the pædomorphic features have not been retained the departures from this type are defined as follows: The height and elevation of the vestibule just in advance of the incisive foramina receives the name of *incisive eminence*; the degree of definition of the line extending from the sides of the anterior nasal aperture to the anterior spine receives the name of the *alveolar line,* since it defines the alveolus proximally; the *alveolus* measured from the alveolar line to the alveolar point of Broca (a.=15 mm.). The nasal vestibule may be in addition macrolophic, microlophic or analophic, depending upon the degree of development of the *incisor crest.* This is held to be a better classification of the parts than that presented by writers. The most primitive type is the analophic; the most frequent in modern cultivated races is the macrolophic. The North American Indian tends to be microlophic and passes from this infrequently to the analophic. He is rarely macrolophic.

Turning to the norma basilaris and describing from before backward, the hard palate is described in the terms of Broca hyperbolic, parabolic, or U-shaped. The choanæ are either pædomorphic or broader at base than at apex; the diameter is to be taken (ch. pædom. diam. 22 mm.). The pyramidal process of the palatal bone measures in length in a given case 12 mm. (pyr. pr.=12 mm.).

The spinous process of the sphenoid bone, whether it separates from or unites with the tympanic bone, is to be noted; if united with this, whether the line of union is posterior to that of the Gasserian fissure. In a given case (sp. pr. not in contact with tym.).

The foramen lacerum medium whether open or closed is to be observed. In a given case (f. l. m. open). The petrosal part of the tympanic bone whether narrowed or broad, by being inflated on the median aspect. In a given case (p. inflated).

Passing now to the norma lateralis, it is noted that the temporal ridge is found interrupted at the stephanion; in a given case

(S-interruption=10 mm.) and that the temporal ridge is divided into two parts, the fronto-temporal ridge and the parietal-temporal ridge In a given case (fr. t. r. spinose: pt. r. *nil.*). The parieto-temporal ridge as it reaches the lambdoidal suture begins to be slightly raised above the plane of the parietal bone and is joined to the occipital bone near the asterion by a harmonic suture; or, as it reaches the lambdoidal suture it has no influence in changing the serrated character of this line which extends to the asterion in the manner described by writers. In a given case we have (p. t. r. harmonic near A., 3 mm.). The posterior margin of the frontal process of the malar bone may be produced in a conspicuous process, (the marginal process) or it may be absent. In a given case (marg. pr. trenchant.=5 mm. high). If desirable the height of the process could be measured by a line drawn across its base. The interruption of the temporal ridge at the stephanion, the harmonic character of the lambdoidal suture near the asterion, and the large size of the marginal process correlate with the size of the temporal muscle.

The line of the parieto-squamosal suture at its junction with the portion of the temporal bone back of the squamosa may be marked by a *mortise*, which answers to the summit of the petrosa as it joins the side of the skull; thus we have (m.=3 mm.).

The term " sconce " is used to express in a general sense the region on the norma verticalis which lies between the parieto-temporal ridges. This diameter at its narrowest part is recorded, in a given instance as (sc. 110 mm.).

The lower jaw yields at the *condyloid process*, two facets, the lateral, which articulates with the zygoma, and the median which articulates with the squamosa beneath the brain-case. The median facet is more variable than the lateral and may be horizontal and inclined upward, or horizontal, inclined downward. In a given case (condyl. pr. med. fac. horizontal). The *coronoid process* may project at base so far forward as to conceal in whole or in part the third molar when the parts are seen in norma lateralis, or it may lie so far back as to permit the third molar to be seen. In a given case (cr. pr. concealing 3 mm.). The *mental foramen* may be on a line with the first molar, in the interval between premolar and first molar, on the line of the second premolar, or on a line between the first and second premolar. In a given case (m. f. on line of 3 m.). The *masseteric impression* ends on a line answering to the angle of the jaw or stops at a distance proximal to it; the area between those two lines constitutes the *lemurine process.* In a given instance (lm. pr.=3 mm. wide). The genial spine may be single or double. The genial crest trenchant, rudimental, or absent. In a given case (g. s. double: g. c. nil.).

In reviewing the characters which have been thus employed the glabella and supra-orbital ridge (g. and s. o. r.) almost universally constitute male characters of low grade. We expect in primitive man, this character to be better developed than in more recent man and be more apt to enter into composition of the supra-orbital margin (s. o. m.). No doubt is felt in accepting these important features in the descriptions of skulls. The degree of declination of s. o. r. is of importance in distinguishing long, slender from broad, flat faces; indeed, it stands as a sign of character of face. Analysis of the nasal region needs no defence since craniologists are of one mind, that on the whole the best characters separating crania are to be found in this region; hence, the care taken to define the relations of the naso-frontal, the maxillary and the premaxillary portions. For the terms radix and salient I am alone responsible. The value of the vestibule would appear also to admit of no argument. The distinction between pædomorphic and other forms in the writer's judgment is the best means of separating the types of the anterior nasal apertures from one another.

The value of the alveolus and the shape of the hard palate as defined by Broca needs no comment at this place. The length of the pyramidal process has been neglected by writers. I find it of value in the comparative anatomy of race. The shape of the choanæ having been defined I recognize two types, one of which is pædomorphic and is oval and the other in which the base is wider than the apex. The group last named may be subdivided by the *rectangular* form in which the basal and the lateral contour unite to form a right angle; and the *produced* in which the basal contour is extended downward and outward beyond the line of the lateral contour. The study of the choanæ is of importance; the limitations have not been satisfactorily determined. The degrees of development of the spinous process of the sphenoid bone have likewise been neglected. It overlaps the line of the Gasserian and the sphenoido-tympanic fissures forward to a remarkable extent and, for the most part sex can be distinguished, the process being large and prominent in males, and rudimental or absent in females.

The divisions of the temporal ridge into two parts, the fronto-temporal and the parieto-temporal and an interruption between the two is one of the best characters by which sex can be distinguished; the same is true of the conversion of the asterionic portion of the lambdoidal suture from a serrated to a harmonic type.

The value of the marginal process of the malar bone in distinguishing sex is conceded. The mortise in the squamoso-parietal suture and the division of the condyloid process into two facets are of secondary value.

The degree of concealment of the third molar has been overlooked, considering the significance that this relation possesses in studies of the horizontal ramus. It is evident that the degree of concealment of the third molar is in direct ratio to the reduction of size of the dentigerous portion of the bone and (all things being equal) is an evidence of the departure from the primitive type. The phylogenetic value of the so-called lemurine process of Albrecht needs to be defined. I have noted this process in the gibbon. The position of the mental foramen with respect to the sockets of the premolars and the first molar teeth is a character in osteology not to be gainsaid. In view of the results of Topinard in studying the region of the mental symphysis in primitive man it is necessary to describe accurately all structural variation at this place, hence peculiarities in the shapes of the genial spine and the genial crest are given.

CONTRIBUTIONS TO THE ZOOLOGY OF TENNESSEE. No. 3, MAMMALS.

BY SAMUEL N. RHOADS.

In the following annotated list of the mammalia of Tennessee I have pursued the same plan of treatment as in the paper preceding this[1] on the avifauna of the same region. The list comprehends all the species known to belong to the Tennessee fauna, including not only the feral mammals now existing in the State but those which have been exterminated since the advent of the white man. An itinerary of the trip made during the months of May and June, 1895, when I secured the collection and field notes forming the basis of this paper, will be found on pages 376 to 381 of the Proceedings of the Academy of Natural Sciences of Philadelphia for 1895, and on the two following pages there is a brief *resumé* of the zoo-geography of Tennessee which may be of use to the more critical reader in this connection.

References to the mammals of Tennessee in scientific literature are so rare and, so far as I am able to search, are generally of so little value, that it would be useless to attempt to tabulate them in this paper. In popular literature the hunting stories of David Crockett form, perhaps, the most voluminous and reliable (?) source of earlier information on this topic, and these have been supplemented in later times by occasional papers and notes published in *Forest and Stream.* The historic literature of Tennessee, so far as I have read it, adds but little to the information which may be gleaned from literature devoted to the exploits of the aforementioned Crockett.[2] When taken from other sources the authority will be given.

Much of whatever value may attach to this contribution to our hitherto meagre knowledge of the mammals of Tennessee, especially the following notes on the habits of certain species, is due to the close observations and generous assistance of my friend Mr. B. C. Miles, of Brownsville, Tennessee, of whose labors in the ornithology of the same region I have already spoken in a previous paper.

[1] Proc. Acad. Nat. Sci., Phila., 1895, pp. 463–501.

[2] With the exception of references to the buffalo, nearly all of which date from Haywood's Civil and Political History of Tennessee.

Other aid in the preparation of this paper will be duly acknowledged in its proper place. The order of families and genera here adopted is largely based on the classification of Flower and Lyddeker in their recent work on the mammalia.

Order MARSUPIALIA.

Family DIDELPHYIDÆ.

Genus DIDELPHIS Linnæus.

1. **Didelphis marsupialis virginiana** (Kerr). Virginia Opossum.

I did not see this species, but it is accounted common all over the State below elevations of 2,000 feet. Mr. Miles says the negroes of Haywood and Lauderdale Counties claim two species, one with black, the other with white feet, but he thinks them identical. There is probably a tendency in the opossums of southwestern Tennessee to the Texan form, *D. m. californica.*

Order UNGULATA.

Family BOVIDÆ.

Genus BISON H. Smith.

2. **Bison bison** (L.). American Bison, Buffalo.

In his Monograph of The American Bisons[3] Dr. J. A. Allen presents us with nearly all that is obtainable in literature regarding the history of this animal in Tennessee. From these sources we know that they formerly passed over the Cumberland and Great Smoky mountain ranges by way of the Holston and French Broad Rivers, to and from the Valley of East Tennessee.

The number and frequency of these migrations, however, were not great, by far the larger number of buffalo being confined to the Cumberland Valley and its tributaries in Middle Tennessee and no mention being made of their occurrence in Western Tennessee.

The point of greatest abundance was undoubtedly in the "bluegrass region" of the vicinity of Nashville, especially about the salt and sulphur springs of Mansker's Creek, Madison's Lick, Lickton, etc., in Davidson County. Buffalo River is the most southwestern locality which appears to have been the haunt of this animal, and our authority for this rests solely on the traditional name. The same remarks apply to towns named Buffalo in Humphreys and Lawrence Counties, and seem to indicate that the bison ranged to a

[3] Mem. Mus. Comp. Zool., Cambridge, Vol. IV., No. 10, pp. 92, 102, 112, 114.

greater or less extent along the southern boundaries of the State in this region. On the west Cumberland plateau, there is Buffalo Valley, in Putnam County, and in the Smoky Mountain range, a Buffalo Ridge in Washington County, and a place called Bison on the Pigeon River in Cocke County.

At the period of its earliest settlement, the hills and coves of the Allegheny Mountains in Tennessee, were in many places covered with large tracts of native grasses[4] which formed the pasture lands of herds of elk, and attracted, in summer, the bison from the lowlands.

The pristine condition of the country around Nashville may be gathered from the following quotation from Ramsey's Annals: "When the first settlers came to the Bluff [site of Nashville,] in 1779–'80, Haywood says the country had the appearance of one which had never before been cultivated. There was no sign of any cleared land nor other appearance of former cultivation. Nothing was presented to the eye but one large plain of woods and cane, frequented by buffalo, elk, deer, wolves, foxes and other animals suited to the climate. The lands adjoining the French Lick [at Nashville] which Mansker in 1769, when he first hunted there, called an old field, was a large open space frequented and trodden by buffaloes, whose large paths led to it from all parts of the country and there concentred."

Numerous accounts from various sources indicate that the central basin of Tennessee and the blue-grass region of Kentucky, connecting therewith, were not inhabited by Indians when first discovered, but formed a sort of traditional game preserve and hunting ground upon which the hostile tribes of Chickasaws, Natchez, Creeks, Cherokees and Shawnees assembled at certain seasons, to hunt the buffalo and, incidentally, each other. In Ramsey (p. 193), we read that in the summer of 1777, Capt. De Membrune living at Easton's Station, near Nashville, "saw no Indians * * * but immense numbers of buffaloes and other game." In February of the same year, it is stated that the same party "in their excursions had seen no Indians, but immense herds of buffaloes. One of their companions, William Bowen, had been overran by a gang of these animals and died from the bruises he received."

From "A short Description of the State of Tennessee," a booklet printed for Matthew Carey in 1796, the following paragraph may

[4] Ramsey, Ann. of Tenn., 1853, p. 96.

be cited as showing the character of country, which formed the favorite buffalo range in the early days of Tennessee: "The land on the Cumberland and Tennessee Rivers is generally well timbered. In some places there are glades of rich land without timber, but these are not frequent or large * * * The glades are covered with wild rye, buffalo grass and pea vine. * * * The undergrowth in many places is cane 15 to 20 feet high, so close together as to exclude all other plants."

From the accounts in Haywood's History, we can gather that the buffaloes were not migratory in that latitude, but remained throughout the year. In 1779 a company of Watauga adventurers planted a field of corn on the present site of Nashville. "After the crop was made, Overhall, White and Swanson were left to keep the buffaloes out of the unenclosed fields of corn, while the rest of the party returned for their families." The abundance of these animals and other game in Middle Tennessee is proved by the following from Ramsey (p. 450). "Michael Stoner this year [1780], discovered Stoner's Lick and Stoner's Creek. The woods abounded in game, and the hunters procured a full supply of meat for the inhabitants by killing bears, buffalo and deer. A party of twenty men went up the Caney Fork as high as Flinn's Creek, and returned in canoes with their meat during the winter. In their hunting excursion they killed 105 bears, 75 buffaloes and more than 80 deer." This record is interesting, as it accounts for the naming of Buffalo Valley in the west end of Putnam County, and proves the former abundance of these animals in that and Smith County.

Regarding the presence of buffaloes in East Tennessee we have fewer and less definite records. Ramsey tells us, (p. 69) that in 1764, "Daniel Boon, who still lived in the Yadkin * * * came again this year [to Tennessee and Kentucky] to explore the country—Callaway [his hunting companion] was at the side of Boon, when approaching the spurs of the Cumberland Mountain and in view of the vast herds of buffalo grazing in the vallies between them, he exclaimed, 'I am richer than the man mentioned in scripture, who owned the cattle on a thousand hills—I own the wild beasts of more than a thousand vallies.'"

In other places we read that the route taken by explorers from North Carolina and Virginia to the Cumberland River valley was by way of Cumberland Gap, which lies on the boundary between Claiborne County, Tennessee and Bell County, Kentucky. There is little doubt that from some commanding point in that locality, Boon made these observations, and that they related to both the States upon whose common boundary line he then stood.

While at Allardt on the high plateau of Fentress County, I conversed with Mr. Bruno Gernt, who stated that he had heard from old residents in that country that buffaloes once abounded in the Obey River valleys of Fentress and Overton Counties. Writing to Mr. Gernt for more definite information, he referred me to other gentlemen on the subject who have failed to respond to my letters. Mr. Gernt says, however, he is informed that an old resident, now dead, named John Young, killed the last buffalo in Fentress County but he does not give the date of its capture.

In West Tennessee the buffalo seems to have been unknown, so far at least, as history, tradition or remains have given evidence. This condition of affairs, if a fact, seems unaccountable from a faunal or geographical standpoint, as the flora of much of this division of the State is almost precisely like that of the east bank of the Tennessee River, which was frequented by buffaloes. That the river could form any great barrier to the passage of this animal from Middle to West Tennessee is not credible, when we remember that they had already crossed the Cumberland, and have been known to swim waters even more formidable in the valleys of the Missouri and Red River during their migrations.

The absolute silence of Davy Crockett on this subject, is very significant proof of the absence of the buffalo on the western border of the State. Mr. Miles thus comments on the matter: "I have often thought of and asked in the last forty years about buffaloes in this section; never met any one who ever heard of a buffalo here, or saw indications that they ever were. * * * Blue grass is not indigenous to our section and I doubt if buffaloes were ever numerous here as in Kentucky and Middle Tennessee, though certainly there must have been isolated specimens. I never heard of the remains of one, nor did they have *roads* or *wallows*, which the only writers on Kentucky and Middle Tennessee tell of."

The reader is referred to later remarks on the elk for reference to the bisons once kept on the Belle Meade farm by General Harding.

Family CERVIDÆ.

Genus DORCELAPHUS Gloger.

3. **Dorcelaphus virginianus** (Bodd.). Virginia Deer.

When we consider the large amount of wild land in the three main divisions of the State, it is surprising how effectually the Virginia Deer has been exterminated over the greater part of Tennessee. This is probably owing largely to the number of negroes and "poor whites," who infest these districts, and spend their lives in the uncertain pursuit of hunting, rather than in earning an honest livelihood.

A few remain in wilder parts of the Cumberland table-land, but even there they are rarely taken. I found their fresh track on the bluffs near Sawyer's Springs. Mr. Miles refers to them in his vicinity as follows: "In my county, [Haywood] as far as I can gather, there are about 20 [wild ones] now alive—one buck was killed in February and a doe in August. * * * We are making a desperate effort to restore this animal, and I think, with the sentiment now prevailing, will make a success of it." Mr. Ragsdale, proprietor of Cloudland Hotel, thinks the deer have been extirpated from Roan Mountain and that one would have to go many miles into the mountain valleys of North Carolina to find them.

Mr. A. B. Wingfield, in *Forest and Stream* for December 14th, 1894, states "The Cumberland Mountain range has been almost entirely depleted of its stock of deer. Would you believe it if I were to tell you that last year there were 248 carcasses of deer shipped from the small town of Crossville in Cumberland County * * * I am glad to report that the last Tennessee legislature passed a law forbidding the killing of deer in five of our mountain counties (Cumberland, Claiborne, Scott, Morgan and Anderson) for a period of five years."

Genus **CERVUS** Linnæus.

4. Cervus canadensis (Erxl.). Wapiti or Elk.

At the beginning of the present century, this noble animal was probably a visitant to every county in the State. It not only abounded in the high passes and coves of the southern Alleghenies; but, associated with the buffalo, it frequented the licks near the present site of Nashville, gave its name to some of the rivers and creeks of the southern counties of Middle Tennessee, and roamed through the glades and canebrakes of the Mississippi bottoms. The redoubtable Crockett, during his residence in Obion and Dyer Counties, gives repeated instances of the occurrence of the Wapiti in the bottom lands, and it formed no small part of his larder in the period between the years 1820 and 1830.

Mr. Miles, after careful inquiry about the elk in his region writes me, "The last elk killed in West Tennessee that I can learn of was at Reelfoot Lake about 1849. The late David Merriwether of Madison County, Tennessee, killed it. In 1865 I heard that an elk was killed in Obion County."

In Putnam's History of Middle Tennessee, (page 127), there is a foot-note which states that on the famous Belle Meade farm, south of Nashville, General William G. Harding had "two hundred deer, twenty buffaloes and half dozen elk" in captivity. I understood in a conversation with gentlemen in Nashville, that these animals had come of native Tennessee stock, and that their descendants had been kept in this park until a recent date. Putnam's note applied to a period anterior to the year 1859. I have been unable to get any direct information from the Harding or Jackson families, now living at Belle Meade, as to these facts, or whether the elk and bison are still existing in their preserve.

Order RODENTIA.

Family LEPORIDÆ.

Genus LEPUS Linnæus.

5. **Lepus aquaticus** (Bachm.). Aquatic Hare.

On the borders of Reelfoot Lake, in the closest proximity to the water, I found this large hare. It preferred hiding among the half-submerged vegetation and piles of driftwood, and when it broke cover would run with bold, high leaps from log to log for so great a distance that it was difficult to find it again.

The following, relating to its habits in the vicinity of Brownsville, is from the pen of Mr. Miles: "Though resembling the Cotton Tail closely in color and in diet, as well as in movements, there the similarity of the Swamp Rabbit, as we term him, ends. Never seen on the hills and seldom in the open, he is at home in the canebrakes and deep woods, far from the homes of man. The more desolate the situation, the more certain he is to be found, ever wide awake and ready to test his speed and cunning with that of any enemy; and he has no friends. In the overflow [spring freshets] I have seen him for hours seated on a floating log, as much at home as a raccoon, and when disturbed take the water for a 300 yard swim as readily as any land animal that I know. When hotly pursued, he always takes the water, and, once there, I have never seen him caught. Twice only, while hunting at night, have I seen him take a hollow tree, seeming generally not to resort to such a refuge in the day. The young are born with eyes closed and without hair, and fewer in number than the cottontail.[5] I have only seen one nest, that in an old root. The Swamp Rabbit has fully held his own in numbers in my day, though nothing more, and I see about one specimen a day when hunting in our deepest bottoms. The largest specimen I ever weighed was thirteen pounds, and would say thirteen inches at the shoulders. Negroes think him good eating, and if properly prepared, I agree with them."

In another letter Mr. Miles again refers to this hare, as follows: "As to the aquatic habits of the Swamp Rabbit, they are very pronounced and he will take to water as readily as the raccoon. I have seen him when not pursued swim a slough 30 yards wide and shake himself when on the other side, hopping off as though it was all right * * * * I saw one swim several hundred yards down and across current when pursued by my pointer, and the dog did not gain on him, but was the most exhausted of the two when he gave up the chase. The rabbit makes the 'dog lick' when in the water, the rump rising and falling as in the swimming horse."

Specimen—Samburg, 1.

6. **Lepus sylvaticus** Bachm. Wood Hare.

In western Tennessee, especially in the woods and thickets skirting the cane-bottoms near the Mississippi, this hare has almost become a nuisance on account of its abundance. Near Brownsville, Mr. Miles declares the "Cotton-tail is nearly a pest with us, and since 20 years has increased fully 50 per cent. in my opinion, and this in spite of the fact that its young are destroyed by nearly everybody and thing. * * * During February last [1895] I could number 100 parties who killed in a single day's hunt 100 each, and the same ratio was kept up during the month; this too at the time of breeding, but there are apparently as many as ever and in the corporation of Brownsville, they eat up a large per cent of the gardens."

At Reelfoot Lake I found them very abundant, their range in the lowlands overlapping that of the Water Hare. In the uplands I rarely met with them. None were obtained in Middle Tennessee or

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[5] Mr. Miles contrasts this condition of the young at birth with that of *Lepus sylvaticus*, which he states are brought forth "with eyes open and fully haired."

East Tennessee. Those from West Tennessee apparently resemble *sylvaticus* from Pennsylvania and New Jersey, but not having summer skins from the Eastern States, the determination is unsatisfactory. Mr. Bangs[6] identified three winter specimens from Trenton (Gibson Co.?) Tennessee, as "perfect intermediates between *sylvaticus* and *mearnsi*, both in size and color."

Regarding the possible occurrence of *L. sylvaticus transitionalis* Bangs, in the Great Smoky Mountains, its describer writes me: "I examined a large series last winter from Roan Mountain, and they were all true *sylvaticus*."

Specimens—Samburg, 5; Raleigh, 1.

Genus SYNAPTOMYS Baird.

7. Synaptomys cooperi Baird. Lemming Vole.

Six specimens, a lately nursing female and five young, the latter apparently belonging to a single litter, and the former probably their parent, were trapped in a small, springy place on the Carolina side of the summit of Roan Mountain, where a quantity of their favorite tussock rush, *Juncus*, was growing. The adult is indistinguishable from Massachusetts and Pennsylvania specimens. The young are of much interest, no record or description of immature specimens having yet been published, to my knowledge. They are about half grown, their average measurements being, total length, 85 millimeters; tail vertebræ, 13; hind-foot, 18.5. Above, including the sides, they present a uniform blackish gray shade, which close examination detects to be obscurely mixed with dull wood brown. The prevailing hue is due to the long and very numerous dull black hairs, which are sparingly mingled with gray ones, and the faint brown shade arises from the exposed subterminal bands of the shorter fur which underlies the longer and coarser black hairs. The under parts are darker, but otherwise resemble those of the adult specimen. In the young skull the length of the upper molar series is nearly as great as in the adult skulls of twice the size, five millimeters longer. The incisors on the contrary, correlate in size with the relative bulk of old and young, those of the latter in this case being about half the caliber of the former. The sulcus of the upper incisors, which characterizes this genus so strongly in adults, is a nearly obsolete depression in the young and not more easily detected than in occasional specimens of *Microtus pennsylvanicus* which continue to exhibit this persistent index of their

[6] Proc. Bos. Soc. N. Hist., 1895, p. 409.

ancestry. On cutting away the premaxillary the exposed base of the incisor shows a constant increase in the development of the lateral sulcus, so that at its root the tooth may be said to be almost as characteristically grooved as in the adult. In the half-grown skull the cutting edges of the upper incisors are oblique, forming an acute angle in each at their median line; in the adult skull this obliquity is reversed, the outer sides of the teeth being longer than the inner. In the young, the alveolar breadth of the incisor exceeds its terminal breadth; in the old these dimensions are equal. The incisive foramina are wider and shorter, and the upper molar series more widely separated by the bony palate and maxillaries, than in old adults. The crown structure of the molars in young and old is identical, their only difference being due to the amount of wear, shown most conspicuously in the posterior upper molar, which has not protruded sufficiently to bring its posterior loop down to the triturating plane, and in consequence, that section retains its original cuspidate form.

All of the five young have white-tipped hind feet almost precisely like the young *Evotomys* taken in the same locality. This peculiarity, is not confined to the young of these genera. An examination of my series from the United States and Canada shows that several young and some of the old among four species have the hind feet so marked. In an adult *Evotomys gapperi* from Pennsylvania, both fore and hind feet are nearly pure white and in *E. g. saturatus* from Mt. Baker, B. C., all four feet, and the throat and the breast are similarly pied. Such cases are rare in my very large series of *M. pennsylvanicus*. It is an interesting question why *Synaptomys* and *Evotomys* should show this tendency to pedal albinism, while in *Peromyscus* and *Zapus* the same kind of variation seems confined to the tail. Indeed, in some of these instances this feature has almost assumed the dignity of a diagnostic if not specific character, and it may even be conjectured whether these white-footed voles do not foreshadow color patterns, which are destined to figure in the days to come. On the other hand it may indicate their past connection with some harlequin ancestry, such as has given us the variegated pelage of the Arctic Lemmings.

Specimens—Roan Mt., Mitchell Co., N. C. 1 ad.; 5 juv.

Genus **MICROTUS** Schrank.

8. **Microtus pennsylvanicus** (Ord). Wilson's Meadow Vole.

The most careful search and systematic trapping failed to reveal the presence of this common eastern and northern quadruped in any part of Tennessee west of the Great Smoky Mountains. In this respect its distribution, or rather its absence, corresponded exactly with that of the Song Sparrow, *Melospiza fasciata.* Wherever I found the supposed runways of this vole, the traps only yielded the Mole Shrew, *Blarina brevicauda* and the Pine Vole, *M. pinetorum* and even these in such small numbers that the residents of the State may well congratulate themselves on their immunity from these little pests.

On the summit of Roan Mountain two specimens of the Meadow Vole were secured in a little "bulrush" swamp below Cloudland hotel, about 100 yards from the Tennessee line in Mitchell County, N. Carolina. No specimens were taken in Tennessee, but I feel justified in including it here, not only on this nearby record, but because similar runways to those in which the Mitchell County specimens were taken were observed in swampy ground near the summit of the mountain in Carter County, Tennessee, during my ascent thither from the Doe River ravine.

There is not the slightest tendency toward any variation in the Roan Mountain specimens from those found near Philadelphia at the same season, and this is good proof that the distribution of this vole is continuous along the ridge of the southern Alleghenies and much farther south than in the adjoining lowlands.

Specimens—Roan Mountain, Mitchell Co., N. Carolina (6,300 ft.), 2 ♂s.

9. **Microtus pinetorum** (LeC.). Pine-woods Vole.

This seems to be the only representative of the Microtinæ in Western and Middle Tennessee. It may be said to be numerous in the woods and their vicinity, forming tunnels in edges of open grass fields, much after the manner of Wilson's Vole. None were taken east of the valley of East Tennessee. The seventeen specimens from Tennessee show no characters which are not to be found in specimens from Pennsylvania, New Jersey and Connecticut. Those from Samburg, however, are more uniformly dark beneath, the silvery sheen seen in eastern specimens being clouded, in Reelfoot Lake examples, by muddy brown over the entire underparts. The same may be said of those from Raleigh and Bellevue, while those from East Tennessee are similar to Pennsylvania skins. It may be remarked that while the Pine Vole shows great constancy in its characters over a large region included between and almost overlapping the Austroriparian and Alleghenian faunæ, the most southern and most northern extremes in the east show color differences which may eventually be recognized as subspecific. Examples of this variation may be found in comparing a series from the mountains of northern New Jersey with samples from the pine barrens of the southern part of that State. The former are blackish-brown above and plumbeous gray beneath, the latter rusty brown with silvery gray sides and underparts.

Specimens—Samburg, 8; Raleigh, 6; Bellevue, 2; Harriman, 2.

Genus EVOTOMYS Coues.

10. Evotomys carolinensis Merriam. Carolina Wood Vole.

My only specimens of this large and interesting woodland mouse, which Dr. Merriam discovered on Roan Mountain in 1877, are not much more than half-grown, and all of them were trapped in the border of the fir belt just below Cloudland Hotel, in Mitchell County, N. Carolina, two of the specimens being taken within forty yards of the Tennessee strip. Though their runways were abundant there, a strange fate prevented my securing any specimens on Tennessee soil. In my four young specimens the color is much darker than in *gapperi* of the same age, corresponding very closely to the shade characterizing *E. g. suturatus* of the northwest. In the oldest specimen the hoary appearance of the belly is untinged with fulvous; the others are plumbeous, with a scant mixture of gray and ochre. In all the specimens the claws of the three middle hind toes are each covered with a sheath or brush of white, bristly hairs, which exceed the claws in length and project beyond them.

Contrary to my expectations, the Wood Vole of Roan Mountain was not found in wet places but seemed to prefer rather open runways among the fallen logs, moss and ferns on the borders of the forest, and one specimen was taken under the shelter of a pigpen, just below the hotel. Such situations were preferred to the depths of the forest, owing to the variety of edible grasses and weeds only found in clearings. Dr. Merriam writes me that he has specimens taken on the Tennessee side of Roan Mountain.

Specimens—Roan Mt., Mitchell Co., N. C., 3.

Genus FIBER Cuvier.

11. Fiber zibethicus (L.). Muskrat.

Owing to high water in the rivers during my visit I was unable to reach the mussel shoals and collect specimens of the Unionidæ of many streams in Tennessee. This difficulty was largely remedied by the industry of the muskrats inhabiting every large stream in my course and whose diet seemed to consist very largely of these mollusks, which they would collect and deposit on logs by the margin of the water. When the mussel dies, the valves of the shells relax and the muskrat devours the contents, dropping the shells into the water. In some places I found many bushels of these shells representing ten or fifteen species and three genera in one dumping place, and was able to get a much better represention of this part of the mollusk fauna in an hour than would have been possible in a day's dredging or wading. In a fish-dam on the Holston River, near its junction with the French Broad, I found these shells wedged among the stones by the rats, and among them some newly-devoured specimens of the beautiful freshwater shell *Io spinosa*. The species most preferred in the Tennessee River was a small clam-like, thick-shelled and corrugated *Unio*, and it was noticeable that the the same species was by far the most numerous in the shell-heaps of the Cherokees on the river banks. It was rare to find even the most fragile species in these rat-larders broken, as if opened forcibly by the rats, a condition the reverse of those obtained in similar deposits east of the Alleghenies.

Genus **PEROMYSCUS** Gloger.

12. Peromyscus leucopus (Raf.). Deer Mouse.

Compared with specimens from eastern Pennsylvania and New Jersey there appears to be nothing to distinguish the upland Deer Mice of West and Middle Tennessee from typical *leucopus*. No specimens of this genus were taken in the lowlands of East Tennessee, but from our knowledge of the fauna of that region it is quite certain that the same species is the prevailing form there, associated in certain localities with the Golden Mouse, *P. aureolus*. I found this species numerous at Raleigh. A few were taken at Samburg, where they seemed to frequent the intermediate grounds between the overflowed bottoms and the bluff, and at this point their habitat overlapped somewhat that of the large Cane Mouse, *P. gossypinus mississippiensis*, described below.

Two specimens taken at the entrance of Mammoth Cave, Kentucky, are identical with those from West Tennessee.

Specimens—Samburg 6; Raleigh, 8; Bellevue, 1.

13. Peromyscus leucopus nubiterræ. Cloudland Deer Mouse.

Subsp. nov. Type, ad. ♂, No. 3,664, Coll. of Acad. Nat. Sci., Phila. Col. by S. N. Rhoads on summit of Roan Mountain (6,370 ft.), Mitchell Co., N. Carolina, June 19, 1895.

Description.—Size smaller than *P. leucopus*, with much longer tail and darker coloration.

Colors, above, blackish-brown or cinnamon with a broad, strongly defined, black, vertebral stripe from middle crown to base of tail. Sides of nose and a wide space around eyes, sooty. Ears dusky. Hair of underparts sooty at base, scarce concealed on parts of legs, throat and belly by the pure white tips. Tail sooty-brown above, white beneath, quite thickly clothed with long hairs which lengthen into a pronounced pencil at tip. Skull smaller than in *leucopus*, otherwise very similar.

Measurements (of type in millimeters).—Total length, 170; tail vertebræ, 87; hind foot, 20.5. Skull: total length, 23.8; basilar, length, 18; zygomatic expansion, 13; interorbital constriction, 4; length of nasals, 9.6: length of mandible, 12.3; breadth of mandible, 6. Average measurements of four adults from the same locality: total length, 167; tail vertebræ, 86; hind foot, 21.5.

The Cloudland Deer Mouse seems to be exclusively a dweller of the balsam or spruce belt which crowns the summit of Roan Mountain, and is undoubtedly found on all the summits of the southern Alleghenies, which rise above an altitude of 5,000 feet. That it intergrades with *leucopus* of the lowlands, a total lack of specimens from intermediate localities prevents me from determining.

In a superficial comparison of *nubiterræ* with typical *leucopus*, the smaller size, sooty color and very long tail immediately suggest a specific difference, but the cranial features of the two do not support such a conclusion. In all respects, except coloration and size, the Roan Mountain animal is an interesting counterpart of the *Peromyscus leucopus canadensis*, so fully described by Mr. G.S. Miller, Jr.[7] The differentiation of these two forms from *leucopus* has been on very similar lines, owing to the similarity of the climatic conditions affecting them. Their dissimilarity, on the other hand, is exactly correlated with the difference in the humidity and mean temperature of the balsam forests of Canada and those of the Great Smoky Mountains.

Specimens—Roan Mountain (5,500 to 6,300 ft.), Mitchell Co., N. Carolina, 6; Carter Co., Tenn., 2.

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[7] Proc. Biol. Soc., Wash., Vol. VIII, 1893, pp. 55–70.

14. Peromyscus gossypinus mississippiensis. Cane Mouse.

Subsp. nov. Type, ad. ♂; No. 3,729, Coll. Acad. Nat. Sci., Phila. Col. by S. N. Rhoads at Samburg, Obion Co., Tennessee, May 4, 1895.

Description—Larger than *gossypinus*, with much longer hind feet, relatively longer tail, lighter, grayish-fulvous coloration and lacking the dark orbital ring.

Color above, yellowish-brown, more fulvous along sides, darker along back and mixed with blackish.

Lower parts and feet, white, shaded by the plumbeous exposed bases of hairs on chest, belly and thighs.

Measurements (of type in millimeters).—Total length, 182; tail vertebræ, 77; hind foot, 24.5; ear (from crown, dry skin), 12. Skull: total length, 29; basilar length, 21.8; zygomatic expansion, 14.7; interorbital constriction, 4.5; length of nasals, 11.2; length of mandible, 15.2; greatest width of mandible, 7. Average measurements of five adults from same locality: total length, 182; tail vertebræ, 80.6; hind foot, 24; average total length of five skulls, 28; average zygomatic breadth of same, 14.5.

So far as I have made its acquaintance in Tennessee, the Cane Mouse is solely a denizen of the "bottom lands" of the Mississippi. At Samburg it confined its wanderings very closely to the immediate vicinity of Reelfoot Lake, and was abundant in the dense forest jungle that bordered its margin, seeming to prefer the lowest and wettest parts of the overflowed lands, from which, at that time of the year (May), the waters of the lake had receded. It is quite distinct from the common upland Deer Mouse of the same region, and the upper and lower borders of their habitats overlap sufficiently to make it possible to capture both species in the same trap.

A comparison of the Samburg mice with *leucopus* of the same locality having shown their differences, as above stated, to be specific, the question at once arises as to their relations to other southern *Peromyscus* of the Eastern States. I can find nothing, in examining the series before me, to separate these Cane Mice specifically from *gossypinus* of Florida and Louisiana, and of which I am so fortunate as to have a large collection, those from Louisiana being generously loaned me by Mr. Outram Bangs. The Louisiana specimens are of interest as showing the extension of *gossypinus* along the Gulf Coast across the Mississippi River. A comparison of some of these from near New Orleans with specimens from the west coast of Florida shows a great similarity, the former averaging darker and smaller but the variation is perhaps too slight to warrant recognition. On the other hand, the Tennessee form represents the maximum development of *gossypinus*, combined with a light coloration which together render it easily distinguishable as a subspecies.

The relation of eastern *gossypinus* to *leucopus* has been a question frequently discussed by mammalogists, but the lack of good material from regions intermediate between N. Carolina and Florida has prevented any final determination. I had hoped to obtain the desired series from the regions in question in order to intelligently discuss the matter now brought forward in West Tennessee, but a correspondence with our more prominent collectors of eastern mammals, including Messrs. Miller, Bangs and Brimley, shows that we are but little better off in this regard than thirty years ago, unless collections of the U. S. Dep. of Agriculture contain such series. I am, therefore, only able to predict, on the basis of the relationships of *gossypinus* and *leucopus* of the lower Mississippi Valley, that they will prove to be as distinct species in the east as in the west. In this connection the *cognatus* of Leconte again intrudes itself. Leconte states Georgia and South Carolina to be the type localities of this species. Dr. Coues declares[8] that "three dried specimens, labelled '*cognatus*' in what we presume to be Major Leconte's own handwriting, as it is the same as that upon his other types now in our possession," should be considered the types of *cognatus*. One of these, from Illinois, Dr. Coues says is "*H. michiganensis* pure and simple!" and adds, "The other two, Nos. 4,708, 4,709 are not marked for locality but probably came from Ohio, Wisconsin or Michigan, and are really his types!" It is very difficult to reconcile this statement with Leconte's assertion that *cognatus* is a native of Georgia, and if these two specimens really are original types of *cognatus*, it is far more reasonable to assign them to Georgia or South Carolina. On this basis, Dr. Coues' diagnosis of "Nos. 4,708, 4,709," viz., that "They are exactly the size of ordinary *leucopus*, the tail a little shorter, relatively, than the average of *leucopus*, but not shorter than is often found in *leucopus*, and they are colored exactly as in *gossypinus*, the upper parts being very dark, the under impure white, and the tail indistinctly bicolor," strongly points to the conclusion which Prof. Baird and Dr. J. A. Allen have advanced, that *cognatus* is a synonym of *gossypinus*, based, I might

[8] Mon. N. A. Rodentia, pp. 77, 78.

add, on a somewhat immature specimen of that species from near the same type locality. It is very probable that Leconte's positive statement, in his introductory paragraph to the description of *cognatus*, that he had never, during a long period of residence in Georgia, seen *leucopus* there, will be confirmed by future investigators.

Another species whose status is affected by the foregoing remarks is *Peromyscus megacephalus* of northern Alabama. Not having secured a series from that region I am unable to throw any light on the question of the affinity of this species to *gossypinus*, to which it is most closely related, and indeed it may be found to be only a case of aberrant and extraordinary individual variation from typical *gossypinus*, or may represent a mountain or foot-hill race of that species. In either case the validity of *megacephalus* nowise affects the status of *mississippiensis*, which represents the modifications of an environment quite the reverse of that obtaining in northeastern Alabama.

Specimens—Samburg, 16 ; Raleigh, 1.

15. Peromyscus aureolus (Aud. & Bach.). Golden Mouse.

Prof. Baird, in his great work on the North American Mammalia (p. 468), tabulates two specimens of this mouse which were taken near Knoxville, Tennessee, by Prof. J. B. Mitchell and presented to the Smithsonian Institution. Dr. Coues, in the Monograph of North American Rodentia, specially refers to one of these specimens as typical of the peculiar coloration of *aureolus*, so we may reasonably accept the identification and the record as the first for the State. Dr. C. H. Merriam writes me that his assistant, Mr. H. C. Oberholser obtained one of these mice at Roan Mountain Station. In view of these Tennessee records, which would indicate the presence of the Golden Mouse over the greater part of the State, it seems strange that I did not meet with it, although the Deer Mouse was taken in considerable numbers. The elevation of Roan Mountain Station is about 2,500 feet. Messrs. H. H. and C. S. Brimley inform me that they have received numbers of this mouse taken by J. S. Cairns near Weaverville, N. Carolina, about 25 miles east of the Tennessee line, at 2,300 ft. elevation, so it is reasonable to expect them in any of the passes of the Great Smoky Mountains below that altitude.

Genus NEOTOMA Say & Ord.

16. **Neotoma magister** Baird. Allegheny Cave Rat.

This large mountain-dwelling rat is found in the cliffs of Roan Mountain and other peaks of the Southern Alleghenies. I have no records of it from the Tennessee section of the mountain but the natives of Carter County do not state that it shows a decided partiality to North Carolina.

A careful examination of the cave deposits which came into my hands from Middle Tennessee failed to show any remains of this genus.

I have examined specimens of the rat which frequents Mammoth Cave, Kentucky, and am unable to detect any difference between them and those taken in Clinton and Cumberland Counties, Pennsylvania. The skull of an old specimen forwarded to me alive from Mammoth Cave is exactly like the largest adult skulls of fossilized specimens from the limestone caves of eastern Pennsylvania.

After particular inquiry among the hunters of southwestern Tennessee as to the existence of a Wood Rat in those parts I am inclined to think that it has been noted there, but the confusion of *Neotoma floridana* with the Old World rats of these parts makes the evidence of questionable value.

Genus MUS Linnæus.

17. **Mus decumanus** Pallas. Norway Rat.

18. **Mus rattus** L. Black Rat.

Mr. Miles mentions the former occurrence of the Black Rat in West Tennessee but he has not seen it for twenty years. The Norway Rat, however, has not been exterminated so successfullly, as the open streets of the larger cities of Tennessee can frequently testify.

19. **Mus musculus** L. House Mouse.

Found both wild and semi-domesticated.

Specimens—Raleigh, 1 ; Roan Mountain, 1.

Family CASTORIDÆ.

Genus CASTOR Linnæus.

20. **Castor fiber canadensis** (Kuhl). American Beaver.

In company with a trapper, I visited a beaver house in Reelfoot Lake. This was situated in a cypress swamp called the "Turkey-roost," about three miles west of Samburg. It was not tenanted, but there were signs that a beaver had been at work there within a few days. Other lodges were known to my guide, and Mr. H. B. Young of Samburg, who makes it his business to take some of these animals in the lake every winter, declared there were twenty of them left, and contracted with me to furnish the gardens of the Zoological Society of Philadelphia with some of their young ones the coming winter.

Mr. Miles says, "the beaver, in limited numbers, has been here always and is more numerous now than 40 years ago, because less hunted. Within 9 miles of Brownsville, I know personally of a 'house' now inhabited, and it has been so for 25 years. I know the locality of two others by report."

It is not likely that any beavers now exist in the eastern half of the State, though their former distribution over the whole of Tennessee is well known, and attested by the frequency of the name for smaller streams and meadows throughout the state.

Family SCIURIDÆ.

Genus ARCTOMYS Schreber.

21. Arctomys monax (L.). Woodchuck. Ground Hog.

Stated by Mr. Miles to be "very rare" in Haywood Co. A burrow, apparently used by one of these animals, was located on the banks of Indian Creek just above the overflow of Reelfoot Lake. From the character of the signs and paths leading from this den to an adjacent field, it could have belonged to no other animal. I did not find the woodchuck as numerous anywhere in Tennessee as we have it in eastern Pennsylvania. It is found high up among the Great Smoky Mountains, but does not, so far as I could learn, invade the fir belt, which occupies their summits down to an altitude of about 5,000 feet. Dr. Merriam says[9] of them in this region that they "were common in places in the Alleghenian belt, about halfway up the mountains."

Genus TAMIAS Illiger.

22. Tamias striatus (L.). Eastern Chipmunk.

This Ground Squirrel was very abundant on that part of Roan Mountain lying between the station and the foot of the fir belt. A few casually invade this belt, but never to a great distance. In the lowlands of Tennessee, the chipmunk was very sparingly and irregularly distributed, so far as my personal observations were made,

[9] Amer. Jour. Sci., 1888, p. 459.

but I was frequently informed they were often seen in districts where none appeared during my visit. I saw them at Johnson City, Greenville and Nashville, and heard one or two while riding through the woods in Obion Co., near Samburg. They are to be found near the Springs at Raleigh and on the road from Raleigh to Bartlett. None were seen at Chattanooga or Knoxville, nor on the Cumberland plateau. Two specimens from Roan Mountain are precisely like some of my skins from southern New Jersey.

Mr. Miles speaks of them near Brownsville as being "identical with the chipmunk of Virginia in color, though, I think, larger and not near so plentiful. * * * * I see five or six every summer." The Messrs. Brimley of Raleigh, N. C., record two specimens taken at Warner, Hickman Co., Tenn., in November and December, indicating that the hibernation of this animal in that latitude is of short and irregular duration.

Genus SCIURUS Linnæus.

23. Sciurus niger ludovicianus (Custis). Western Fox Squirrel.

We do not find this species numerous except in the heavily timbered bottoms of West Tennessee, more especially west of the Tennessee River in the direct drainage of the Mississippi.

A very interesting account of this species, as observed in Haywood and Lauderdale Counties by my veteran friend and sportsman, B. C. Miles, is too valuable to be lost, and with some emendations, I give it here: "The Fox or Red Squirrel is the largest of all the tribe and varies considerably in size in different neighborhoods. Wherever food to his liking is found, there he is, and always a glutton, putting in his whole time eating, drinking, or snoozing on a cozy limb, in such a position that he attracts attention neither of the hunter below nor of the hawk above. I am certain I have seen him clean up a quart of mulberries in a half-day and not move ten feet during the time, nor give utterance to a single sound. Early in the morning and late in the evening he chatters much and can even condescend to be a little gay in the mating season. I doubt his ever migrating, as do the gray and black, though an excursion of a mile from home through cultivated fields and small timber is no unusual tramp for the gentleman.

"He is a denizen of big timber always: more at home in the gums and cypresses of our swamps than elsewhere, though he is not infrequently found in the most unexpected places, on the hills near the house, or in the garden, where he goes for fruit. Of all the tribe he is the greatest eater of berries and the like, and I have even known of his scratching sweet potatoes out of the ground and making a dinner off one of half a pound weight.

" When closely hunted he is very much more wary than the Gray Squirrel and the way he can hug a limb and spread himself out flat on the bark is truly artistic. In his movements he is the very acme of animated silence, seeming at all times to fear a noise and it is not an infrequent ruse of hunters, by making a great outcry, to scare him from a secure hiding place. As a table game he is much inferior to his gray relation, being tougher, and the very red bones always give an uncanny appearance to the dish, cook it as you may. * * * * As a caged pet he is dull, gets over-fat, becomes stupid, is ill-natured, has no gloss to his hair and is a dismal failure. He is bravest of the tribe, often refusing to leave the ground when pursued by a small dog; has been seen to stand at bay and hold off such. Rarely he mates with the Gray Squirrel, when the produce is called a 'ferrydiddle.' I have killed two such in my forty years of squirrel hunting. One at all familiar with the two species would at once recognize its hybrid origin."

Referring to the black phase of this squirrel, Mr. Miles says: "I never saw any blacks save those like the Fox squirrel. Have seen two killed in this county, but when in Memphis, in 1871–'74, my uncle frequently purchased Black Squirrels in the markets. We understood they came from Mississippi (never from Arkansas), 10 or 20 miles below Memphis, and we both thought them a distinct species; no resemblance to Fox Squirrel save in size and that the tip of the nose in each is gray. Have frequently observed that the bones of Black Squirrel were the same color (violet) as in the Gray Squirrel, while the bones of Fox Squirrel were invariably a deep salmon or red when brought to table. * * * * I never saw or heard of the black phase of Gray Squirrel save through you."

Specimen—Samburg, 1.

24. ? Sciurus niger cinereus (L.). Northern Fox Squirrel.

I base the admission of this subspecies to the list, first, on evidence from hunters of the Great Smoky Mountains that the Fox Squirrel is found there, and secondly, because Dr. J. A. Allen includes the Southern Alleghenies in the geographical distribution of this form.

25. Sciurus carolinensis pennsylvanicus (Ord). Northern Gray Sqirrel.

Typical examples of this squirrel are confined to the high mountains of the extreme eastern part of the State. From thence westward there will be found to be a gradual transition to the form, peculiar to the bottom lands of the Mississippi, which is next considered. I saw hunter's skins of the Gray Squirrel, taken at an elevation of 4,000 feet on Roan Mountain. It is not common in the more settled parts of Middle Tennessee.

26. Sciurus carolinensis fuliginosus (Bachm.). Louisiana Gray Squirrel.

Mr. Outram Bangs has revived[10] the Sooty Gray Squirrel of Louisiana, described by Bachman under the name *fuliginosus*, as a valid subspecies of *carolinensis*. I was able to make close examination of a number of live Gray Squirrels in the city park at Memphis, where they have become domesticated and form one of the chief attractions to the large number of people who frequent this thoroughfare. These squirrels averaged fully up to the size of the northern Gray Squirrel of Pennsylvania and were distinctly darker than the eastern animal, so much so, in fact, that I attributed their sooty appearance to their smoky environment in a city exclusively burning bituminous coal. Memphis, however, can not be classed as a 'smoky city,' and I am now satisfied that these squirrels came by their colors legitimately, and represent Bachman's Louisiana species, as redefined by Mr. Bangs.

Writing of the migrations of this animal, Mr. Miles informs me: "I have seen them exhausted and wet on the east bank of the Mississippi River, when I know the emigration eastward was taking place on the west bank. About that time I was fishing on a lake in Arkansas and one came by my boat headed from the west to the east bank, looking very unconcerned, with tail curled over back and well out of the wet. I gave pursuit, which he soon noticed, and that tail was then put up on the sail principle and very much increased his speed, I thought at the time, though I overtook and killed him."

27. Sciurus hudsonicus (Erxl.). Red Squirrel, "Boomer."

Owing to the severe winter of 1894–'5, the "Boomer" was very scarce in its usual haunts on the summit of Roan Mountain. I spent parts of three days in careful search of it and only saw one in the fir belt. Another was seen and captured, during the descent of

[10] Proc. Bost. Soc. N. Hist., Vol. XXVI, p. 543.

the mountain, at an elevation of 3,500 feet. This species is not seen in Tennessee below an elevation of 2,000 feet, so far as I could ascertain, and the majority live above 4,000 feet. They are unknown on the Cumberland plateau. Lack of suitable specimens prevents me from making the necessary comparisons, but I am suspicious that the Red Squirrels of the Balsam belt of Roan Mountain are a dark, local race of *hudsonicus* which may merit separation from the typical form.

Specimen—Roan Mountain, Carter Co., 1.

Genus SCIUROPTERUS F. Cuvier.

28. **Sciuropterus volans** (L.). Southern Flying Squirrel.

From reports of the hunters, and what we know of its distribution in other parts of the United States, this elegant squirrel may be said to be common all over the State of Tennessee from the summit of Roan Mountain to the western "bottoms." Specimens from the highest altitudes would be of interest in determining whether subspecies *sabrinus*, the northern form, is not found there. In the lowlands of Haywood County, Mr. Miles observes that in the evening this species "makes a chattering sound, that sooner or later I hear whenever camped in the woods and don't think I ever miss hearing in clear weather, never in foul weather. Five years ago, in the country, they took possession of my martin box and ran the martins out. I got after them and routed out thirty."

Order CARNIVORA.

Family PROCYONIDÆ.

Genus PROCYON Storr.

29. **Procyon lotor** (L.). Raccoon.

The "Coon" is excessively abundant in the bottoms of West Tennessee and Mr. Miles thinks their numbers there are increasing. In other parts of the State they appear to be well represented.

Family MUSTELIDÆ.

Genus LUTRA Linnæus.

30. **Lutra hudsonica** Lacép. American Otter.

This fisherman is often seen by hunters at Reelfoot Lake. A specimen was killed at Open Lake, Lauderdale Co. this winter and was seen by Mr. Miles. The otter is a rare but constant inhabitant of all the larger streams in the State.

Genus LUTREOLA Wagner.

31. Lutreola vison Schreber. Mink.

32. Lutreola vison vulgivagus (Bangs). Louisiana Mink.

Only one specimen of mink from Tennessee has passed through my hands. It is a skull of a mink taken at Open Lake in Lauderdale County, by Mr. Miles. This specimen corresponds so closely to Mr. Bangs' diagnosis of *vulgivagus,* as contrasted with typical *vison,* that I am induced to class it with the former, but the cranial differences in *vulgivagus,* however, constant they may have proved, do not appear to me specific. There is little doubt that the minks of eastern Tennessee are typical *vison.*[11]

Specimen—Open Lake, Lauderdale Co., 1.

Genus PUTORIUS Cuvier.

33. Putorius noveboracensis Emmons. Carolina Weasel.

This weasel is said to be common in West Tennessee, and, from what we know of its general distribution, is nowhere rare. Regarding the possible occurrence of the Canadian Weasel, *Putorius richardsoni cicognani* (Bonap.), in the Smoky Mountains, Mr. Outram Bangs, who has been making a special study of the eastern forms, writes me that *Putorius noveboracensis* is numerous on Roan Mountain but that *cicognani* he has "never seen from any locality south of the lower Hudson Valley, although it may occur in Pennsylvania and West Virginia."

Genus MUSTELA Linnæus.

34. Mustela pennanti (Erxl.). Fisher. Pekan.

There is little doubt that the Pekan was long ago exterminated in East Tennessee, as none of the hunters with whom I conversed knew of such an animal. Dr. Merriam includes it among the Alleghenian species not to be found on Roan Mountain in 1887. Audubon and Bachman[12] speak of this animal's occurrence in the State as follows: "We have seen several skins procured in East Tennessee and have heard of at least one individual that was captured near Flat Rock in that State, latitude 35°."

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[11] To these may be added *L. vison lutreocephalus* (Harlan) which Mr. Bangs, (Proc. Bos. Soc. Nat. Hist., 1896, pp. 1-6.) considers separable from true *L. vison* of the Boreal zone. The latter Mr. Bangs thinks may range into the higher Alleghenies of North Carolina. On this basis I retain the name as above listed under No. 31.

[12] Quad. N. Amer., 1, p. 314.

The Pine Marten, *Mustela americana*, does not seem to have been noted farther south than central Pennsylvania in the Allegheny Range, no records for Tennessee or N. Carolina being extant, to my knowledge.

Genus MEPHITIS Cuvier.

35. **Mephitis mephitica elongata** Bangs. Carolina Skunk.

Reported to be rare in the Mississippi lowlands. I rarely detected the signs of this animal in Tennessee, though every one seems to be acquainted with the animal in all localities visited except, perhaps, on the summits of highest mountains.

Mr. Bangs has separated[13] the skunk of the East Canadian fauna from the southern animal, giving the latter a new subspecific name, as above.

Family URSIDÆ.

Genus URSUS Linnæus.

36. **Ursus americanus** Pallas. American Black Bear.

Bears are now very scarce, even in the wildest territory of the State, but formerly this species was wonderfully plentiful in the cane-brakes of West Tennessee. It is difficult to credit the straight forward anecdotes narrated by David Crockett of his experiences with this game in the bottoms of Obion County. On one occasion he killed four bears in one day and 105 in less than one year.

The hunters at Reelfoot Lake, think they are all killed off and say that none have been shot for several years. Mr. Miles writes that "A bear was killed in the west border of Haywood County in 1865—the last one I think—though in Lauderdale County, one is occasionally killed now."

Dr. Merriam found bears in the Great Smoky Mountains in 1887, but I was told that none have been seen on Roan Mountain for several years. On the Cumberland plateau they seem to have been practically exterminated.

Family CANIDÆ.

Genus UROCYON Baird.

37. **Urocyon cinereoargenteus** (Müll.). Gray Fox.

Found all over the State but said to be supplanted by the Red Fox in western portions, where it is less common than formerly. It

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[13] Proc. Bost. Soc. N. Hist., 1895, pp. 1--7.

sometimes courses over the balsam belt of Roan Mountain when pursued by dogs, but does not reside at so great an altitude.

Genus VULPES Baird.

38. Vulpes pensylvanicus (Bodd.). American Red Fox.

Always numerous in the mountains, the Red Fox has spread with the increasing population into West Tennessee, where it was unknown to the early pioneers. The same conditions are true of the Central Basin and of Middle Kentucky.

Mr. Miles calls it common in his locality now, though it was introduced or migrated thither only forty years ago.

Genus CANIS Linnæus.

39. Canis lupus nubilus (Say). American Wolf.

In 1887 Dr. Merriam found the wolf still existing in the Smoky Mountains. One was seen during the winter, about the year 1883, near Cloudland Hotel. A few may yet exist in the southern Alleghenies, but they are exceedingly rare.

In Middle Tennessee they seem to be extinct. Their status in the lowlands of West Tennessee may be gathered from the following quotations from letters sent me by Mr. Miles, the first of which was the result of a publication as to the specific identity of black and gray wolves made in *Forest and Stream* for August 31, 1895: "Since the article for *Forest and Stream* was written Major Shaw, an old hunter of this County, tells me that many years since he captured a a litter of seven wolf whelps, three of which were gray and four black. * * * Our present wolf is larger and very much fiercer than those of my childhood, at least those specimens were which came under my observation. I suppose our present big gray wolf has always been here and some favorable circumstance must have developed his numbers." In a more recent note Mr. Miles announces the killing of two wolves by poison about the 10th of December, 1895, within seven miles of Brownsville, "by a man who had killed hogs and heard the wolves howling near, when he put out poison with the above result."

Summing up the case for Lauderdale County, Mr. Miles says the "Large Gray" is "common" (!); the "Small Black" is "rare" and the "Yellow Medium, very rare."

Family FELIDÆ.

Genus LYNX Kerr.

40. Lynx rufus (Guld.). Wild Cat.

This species is yet numerous in all the wilder tracts of country. It is common in the swamps and bottoms of the western regions.

41. ? Lynx canadensis Kerr. Canada Lynx.

With no little hesitation, I include this species in the fauna of the Tennessee on the statements of Prof. E .D. Cope.[14] He says: "Like the Red Squirrel, the Canada Lynx extends to the southern limits of the Allegheny ranges, occupying the highest ground, though apparently not so restricted to the elevations as the first named. It is distinguished, by the name catamount, from the *Lynx rufus* which is called wild cat and is well known to the hunters." No cotemporary or previous writer that I have been able to consult, confirms these statements and unless Prof. Cope examined specimens it is probable he was misled by the statements of hunters.

Genus FELIS Linnæus.

42. Felis concolor (L.). Puma, Panther.

The panther appears to have been exterminated in all parts of the State except the most impassable brakes and "harricanes" of the bottoms of Lauderdale County. This exception is made on the authority of Mr. Miles, who is confident that a few yet exist in that locality.

Order INSECTIVORA.

Family TALPIDÆ.

Genus SCALOPS.

43. Scalops aquaticus (L.). American Mole.

No moles were captured. Their underground labors in Tennessee were in frequent evidence. It is not probable that any other form of this genus is to be found in the State than the one prevailing in our Middle States.

Mr. Miles reports the mole common in Haywood County "where-ever land is rich, and is troublesome in that he burrows in the rows and destroys growing plants, and runs tunnels up and down hill which I have seen in one season wash into gullies 18 inches deep." Any one who has noted the extreme solubility of the agricultural

[14] Fauna of S. Allegh., Amer. Nat., 1871, p. 395.

soils of West Tennessee and has witnessed the complete destruction of large areas for farming purposes, due to careless tillage and heavy rainfall, will appreciate the significance of this remark.

Family SORICIDÆ.

Genus BLARINA Gray.

44. Blarina brevicauda (Say). Northern Blarina.

Specimens from the summit of Roan Mountain correspond closely in size and color to Quebec examples. Those taken at Harriman are appreciably smaller, like specimens from the vicinity of Philadelphia. Bellevue skins and skulls show an exactly intermediate size and character between the northern animal and subspecies *carolinensis.* As in the east, I found this to be the most ubiquitous small mammal of subterranean habits.

Specimens—Bellevue, 1; Sawyer's Springs, 1; Harriman, 4; Roan Mt., Carter Co., 2.

45. Blarina brevicauda carolinensis (Bachman). Southern Blarina.

The southern mole-shrew inhabits the bottom lands of West Tennessee both in the open and in deep, swampy woods. Typical specimens from the shores of Reelfoot Lake and Wolf River confirm Dr. Merriam's recent (1895) diagnosis of this subspecies in North American Fauna, No. 10. Dr. Merriam records (l. c., p. 14) a specimen from Big Sandy, on the river of same name in Benton County.

Specimens—Samburg, 4; Raleigh, 1.

46. Blarina parva (Say). Least Blarina.

Prof. Baird records a specimen of what he called *Blarina exilipes* from Brownsville, Tennessee, obtained by Capt. S. Van Vliet. Baird's *exilipes* being proved a synonym of *parva,* I place it as above. Dr. Merriam[15] questions if Baird's record should not have been Brownsville, Texas. No evidence to the contrary being given, and the habitat of *parva* being in the faunal territory occupied by West Tennessee, I feel justified in accepting Baird's record as it stands. I did not secure any of this species, nor can I find other records of its occurrence in the State.

Genus SOREX Linnæus.

47. Sorex personatus (Geoff. St. Hil.). Masked Shrew.

In the deep balsam forests which crown the summit of Roan

[15] N. Amer. Fauna, No. 10, p. 7.

Mountain this tiny shrew was numerous. Its burrows were found under decaying logs and large stones in moist places along the bridle path leading directly from Cloudland to the Doe River valley.

Specimens—Roan Mt., Carter Co., 4.

48. **Sorex fumeus** Miller. Smoky Shrew.

Two specimens of this large *Sorex* were taken on Roan Mountain in similar situations to those frequented by the Masked Shrew. A large number of specimens of both species were taken by Dr. Merriam and his assistants on the North Carolina side of the mountain.

To the painstaking and intelligent studies of my friend Gerrit S. Miller, Jr.[16] we are indebted for the identification and naming of the Smoky Shrew, as well as the simplification of a group of mammals whose identity and nomenclature had become so confused as to be a byword and reproach to American mammalogy.

Specimens—Roan Mt., Carter Co., 2.

Order CHIROPTERA.

Family VESPERTILIONIDÆ.

Genus ATALAPHA Rafinesque.

49. **Atalapha borealis** (Mull.). Red Bat.

A few of these bats were noted in the mountains of East Tennessee. None were found in the caves nor in Mammoth Cave. Specimens from Tyree Springs and Knoxville are recorded in the catalogue of the National Museum.

Not having any records of the presence of the Hoary Bat, *Atalapha cinerea*, in the State, it may be mentioned that it is likely to occur either as a migrant or resident anywhere east of the Cumberland plateau.

Genus VESPERTILIO Linnæus.

50. **Vespertilio lucifugus** (Le C.). Little Brown Bat.

I am informed by Messrs. Brimley of Raleigh, N. C., that they received four specimens of this bat collected by J. T. Park at Warner, Hickman Co., Tennessee. One was taken in April, another in July, the rest in September.

As Dr. H. Allen has adopted it,[17] this name is subspecifically ap-

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[16] N. Amer. Fauna, No. 10, pp. 38 and 50.

[17] Mon. N. Amer. Bats, 1893, p. 78.

plicable to the little brown bat which he had previously called *subulatus* in the first monograph and to which he now applies (p. 75) the name *gryphus* of F. Cuvier. Taking for granted that his identification and choice of names is correct, we will have to alter their order to accord with sequence of publication, *V. lucifugus* (1831) being the type and *V. lucifugus gryphus* (1832) the subspecies. But I fail to discover that Dr. Allen has indicated in what respect or to what geographical or faunal areas the subspecies in either case shall be distinguished or restricted. The doctor apparently accepts *gryphus* (p. 76, last par.) as "the name of the eastern species," but does not say whether he means *lucifugus* to represent the western form. It is difficult to come to any other conclusion than that he did so intend it, unless the trinomial was used merely to indicate a type of individual variation having no regard to faunal distribution. Cuvier's type of *gryphus* came from New York, Leconte's type of *lucifugus* appears to have come from Georgia. Granting with Dr. Allen that these names were applied to the same species of eastern bat, it is impossible to use either name for any of its geographic subspecies, and hence, Leconte's having priority, Cuvier's name is merely a synonym.

Genus **ADELONYCTERIS** H. Allen.

51. Adelonycteris fusca (Beauv.). Brown Bat.

I found this bat abundant in the lowlands. None were seen on the summit of Roan Mountain. Specimens from Hickman County, are recorded by the Messrs. Brimley. It is found on the Cumberland plateau.

Genus **VESPERUGO** Keyserling & Blasius.

52. Vesperugo carolinensis (Geoff.). Carolina Bat.

This is a common form in the caves of Kentucky and Tennessee but is not as abundant there as *Vespertilio lucifugus*. Mr. Park took three specimens in Hickman County.

Specimens—Vaughan's Cave, Bellevue, 3.

Genus **NYCTICEJUS** Rafinesque.

53. Nycticejus humeralis (Raf.). Rafinesque's Bat.

Five specimens of this animal, taken in Hickman County by Mr. Park in August and September, have been identified by the Messrs. Brimley.

Genus LASIONYCTERIS Peters.

54. ?Lasionycteris noctivagans (Le C.). Silvery Bat.

On two occasions it was my opinion that I had seen the Silvery Bat in Tennessee, viz. at Sawyer's Springs and on Roan Mountain. The fluttering, moth-like flight of some of these mountain bats was characteristic of the peculiar movements of *noctivagans*, and on this identification I admit it here with a query. From our knowledge of the wide distribution of this species in North America there is little doubt that it is to be found over the greater part of the State.

Order PRIMATES.

Family HOMINIDÆ.

Genus HOMO Linnæus.

55. Homo sapiens americanus. North American Indian.

I shall make no apology for including aboriginal Man in a faunal list of the native and feral mammalia of Tennessee. The customary omission of the genus *Homo* from such lists finds no justification in nature or in science.

For accounts of the history, distribution and habits of the native Indian races of Tennessee, the reader is referred to Haywood's *Natural and Aboriginal History of Tennessee.* For the history of their extinction no references are necessary.

March 3.

The President, Samuel G. Dixon, M. D., in the Chair.

Two hundred and fifty-eight persons present.

Messrs Morris E. Leeds and J. S. Stokes of Messrs Queen & Co. gave a resumé of investigations relating to Roentgen photography and a demonstration of the processes employed. (No abstract).

March 10.

The President, Samuel G. Dixon, M. D., in the Chair.

Forty-nine persons present.

Papers under the following titles were presented for publication:—

"Summary of New Liberian Polydesmidæ," by O. F. Cook, was presented for publication.

"The Minerals of South Carolina," by J. G. Hartzell, Jr.

Two Supposed New Trap Dykes in Chester County, Pennsylvania.—The following communication was read from Dr. Persifor Frazer:—

In a paper read before the Academy, Feb. 1, 1896, Mr. Theo. D. Rand calls attention to two trap dykes which he thinks have thus far escaped notice. The writer is unable to ascertain by the localities to which Mr. Rand refers, the beginning of the one said to be in the northern half of the County, viz.: "Williams' Quarry, near Aldham." The trap is called "a peculiar porphyry * * containing the variety of silica Vetsan;" and it is said that "a rock which Mr. Goldsmith has pronounced identical occurs near Barneston Station on the Waynesburg branch of the Penna. R. R." In the working township map used by the writer in his field studies of the geology of Chester County, is found noted a porphyritic quartzose syenite. In Report of Progress, Second Geological Survey of Pennsylvania, Volume C 4, p. 248, 3d paragraph from bottom, a quartz porphyry is also noted as visible in place probably about half a mile south of Barneston Station.

The second dyke which begins in Downingtown is probably the same to which the following reference is made (same volume, p. 274). "At several points on the road leading south from the Downington R. R. station occur fragments of trap."

Again just south of the northernmost apex of West Marlboro' township and within a short distance of Doe Run the existence of trap is noted on the working field township map of the writer, as is also the case on his working township map of Caln about two miles west of Downingtown.

It is only fair to remark that, in the nature of things, much must be discovered as time goes on which was not observed by the last field geologist. New cuts are made, obscure outcrops are made distinct by continued weathering, etc.; yet it is also true that different observers may give different values and interpretations to the same phenomena.

The writer added many dykes of trap to those already recognized in geological maps before his work began, but he refrained in a great many instances from connecting together scattered localities where trap fragments occurred, on the assumption that these represented a dyke, because he was often unable to assure himself that these fragments were anywhere near the place of their origin, or uncertain which of the many scattered localities should be joined. In a country so much denuded as that of Chester Co., Pennsylvania, and where collections of surface fragments of trap occur so frequently, it is generally hazardous to indicate their relations to each other without more substantial grounds than mere geographical position.

As a matter of fact, a very large number of such indications which appear on the writer's field maps were never transferred to his final geological map, and in some cases not alluded to in the text, because of the difficulty of ascertaining whether or not they possessed real importance.

March 17.

The President, Samuel G. Dixon, M. D., in the Chair.

Twenty-eight persons present.

March 24.

The President, Samuel G. Dixon, M. D., in the Chair.

Twenty-nine persons present.

The death of Samuel H. Gilbert, a member, March 20, was announced.

March 31.

The President, Samuel G. Dixon, M. D., in the Chair.

Thirty-six persons present.

The death of Jean Gundlach, a correspondent, March, 1896, was announced.

A paper under the following title was presented for publication:—

"Dr. Collett on the morphology of the cranium and the auricular openings in the north European species of the Family Strigidæ; to which is added some recent opinions upon the systematic position of the Owls," by R. W. Shufeldt, M. D.

On the recommendation of the Council an invitation to the Academy from the University of Glasgow to participate in the celebration of the fiftieth year of the Right Honorable Lord Kelvin's tenure of office of the Chair of Natural Philosophy therein was accepted and General Isaac Jones Wistar was appointed to represent the Academy on the occasion.

On a Collection of Barnacles.—Mr. H. A. Pilsbry spoke of a collection of barnacles from the bottom of the iron ship "Puritan" of Glasgow, which had been dry docked in Cramp's shipyard after a voyage from San Francisco to Hong Kong, and to Philadelphia *via* Java and India. The forms represented were *Balanus tintinnabulum* L., *B. tintinnabulum zebra* Darwin, *B. tintinnabulum spinosus* Gm., *Tetraclita porosa patellaris* Darwin, *Lepas anatifera* L. and *L. Hillii* Leach. The forms ranked as varieties of *B. tintinnabulum* retain their individuality perfectly, although growing side by side under apparently identical external conditions, so that their differential characteristics can scarcely be attributed to unlike environmental factors. The variety of *Tetraclita porosa* seems to be a rare form, originally described by Darwin from three examples taken off a ship's bottom in Boston by Dr. A. A. Gould. It is very unlike the ordinary form of the species. Specimens of *Ostræa rivularis* Gld. are attached to some of the barnacles. As this is a species of east Asian seas, it is very probable that the load of barnacles was obtained in China; although the Balanidæ themselves have been so widely diffused by commerce that alone they afford but little evidence of their original *patria*. The specimens were procured and presented to the Academy by Master Lester Bernstein.

Pugnus parvus.—Mr. Pilsbry also spoke of a remarkable shell representing a new genus of Tectibranchiate mollusks, *Pugnus parvus* Hedley, of which a specimen from Middle Harbor, near Sydney, N. S. W., Australia, was exhibited. The shell is involute, like that of *Bulla*, *Haminea*, *Cylichna* and many other genera of Cephalaspidea; but it differs from all of these in the remarkable features of a thickened outer lip and thrice-folded columella. These characters caused Mr. Hedley, its describer, to consider *Pugnus* a "telescoped" *Ringicula*. All other Ringiculidæ, both fossil and recent, have the spire developed; so that *Pugnus* stands unique in that family in its depressed and concealed spire. The generic name is an allusion to the resemblance of the shell to a clenched hand.

The following were elected members:—

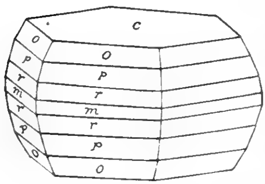
E. G. Conklin, Ph. D., Louis S. Amonson, Jacob Reese, A. Donaldson Smith, M. D., Charles L. Phillips, Walter P. Stokes and Mary T. S. Schaeffer.

The following were ordered to be printed:—

THE CRYSTALLIZATION OF MOLYBDENITE.

BY AMOS P. BROWN.

Although molybdenite, Mo S_2, has been known to mineralogists since crystallography was first studied, its crystalline form has never been satisfactorily determined. It has been provisionally assigned to the hexagonal and monoclinic systems by different authorities, the general opinion being that it is hexagonal. The crystals that have thus far been examined can be explained on a hexagonal basis, but they are not sufficiently lustrous to admit of very exact measurement, and the softness of the substance also militates against the exact determination of its angles. The locality at Frankford, Philadelphia, has long been known to mineralogists as affording well crystallized molybdenite, and I have for some years been collecting material from there with a view of making a crystallographic study of the mineral. Having in hand some crystals which are sufficiently lustrous for measurement on the reflecting goniometer I have examined them and obtained some positive results.



The crystals are hexagonal in habit, consisting of six sided prisms and barrel shaped crystals, the best of which are not more than 6 mm. in diameter. They strongly recall some mica crystals and seem often to show a twinning with the basal pinacoid as the composition face. A number of crystals were examined, the one giving the best results being a nearly perfect hexagonal plate of some 5 mm. diameter, which represents a broken crystal, only one termination being preserved. Nearly all of the faces gave fair images but the basal pinacoid was uneven, due to slight crumpling, and gave several images. By observations on a number of crystals these angles could be checked, however. The pyramid as a termination was not observed, all crystals examined showing the basal termination. The following crystallographic constants were observed:

Molybdenite. Hexagonal, axis c=1.908; $0001 \wedge 10\bar{1}1=65° 35'$

Forms observed: *c* (0001, *o P*), *o* ($10\bar{1}1$, *P*, *O*), *p* ($20\bar{2}1$, *2P*, *2*), *q* ($30\bar{3}1$, *3P*, *3*), *m* ($10\bar{1}0$, ∞*P*, *I*).

Angles:	Observed.	Calculated.
c p=	77° 15′	77° 13′
	(77° 17′)	
	(77° 7′)	
c q=	81° 31′	81° 23′
mm=	60° 2′	60°

Besides these, the angle *c m* was observed as 89° 48′ and several other angles near 90° on different crystals, but in general the images from *m* in this zone were imperfect. The angle *c o*=65° 35′ was obtained in the same crystal in adjacent zones, it was observed on several crystals. Oscillatory combination and probably vicinal planes render the measurements somewhat irregular but the above shows that the crystals may be explained on a hexagonal basis. The angle commonly observed is *c p*=77° 13′ and has been reported as 75°. This seems to show that the pyramid *2P*, ($20\bar{2}1$) is more common than the others. Many crystals only show two pyramids and the basal pinacoid, in others the prism is more prominent. While it is still possible that better crystals may show the mineral to be monoclinic, the above results are of sufficient value to place on record. It may be added that etching figures on the basal cleavage seem to indicate a hexagonal, perhaps rhombohedral crystallization.

THE COLORING MATTER OF THE ARIL OF CELASTRUS SCANDENS.

BY IDA A. KELLER.

The presence of different pigments manufactured by the vegetable organism has forced the plant world upon the attention of the human race from time immemorial. If we submit the colored parts to microscopical examination we are usually confronted by one of two distinct cases.

Firstly, we may find that the pigment, instead of pervading the entire cell, is found only in certain variously shaped bodies which are more or less regularly scattered through the cell contents. The best known illustration of this kind is to be found in ordinary leaves, the green color being confined to the chlorophyll granule. Secondly, if we examine other parts of plants we may find that the coloring matter is distributed uniformly throughout the cell sap. The blue flower of the Grape Hyacinth may serve as one of the many illustrations of the latter case. Wherever fixed and definite portions of protoplasm subserve a special function within the plant cell, these may be considered as parts of a unit and they may be termed organs of the cell. In addition, then, to the nucleus we may find various other organs as, for example, the colored bodies just referred to. A distinction must be made between such differentiated portions of the protoplasm and the products which are the result of their activity, between the colorless protoplasmic matrix and the colored product which makes it conspicuous. If we observe e. g., a living cell of a leaf of *Elodea Canadensis* we find as organs of the protoplasmic contents the nucleus and the chlorophyll granules ; as a product of the latter, chlorophyll and finally starch as a result of the action of the chlorophyll in response to satisfactory external conditions. Such conditions are a certain amount of heat, light, moisture and the absence of any injurious factors which might impede the various operations manifested in life activity.

In dealing with the products of this activity we come to a problem of great complexity. It is true that certain phenomena as witnessed in the vegetable cell can be explained by known principles of physics and chemistry, and that many substances for which mankind was formerly dependent on the vegetable organism are now manufactured in the chemical laboratory. I need only recall the synthetic preparation of alizarin, alcohol, indigo, oxalic, citric, tartaric and salicylic acids, vanillin and finally sugars, to call to mind a host of further illustrations. On the other hand it must be admitted that this victory, great as it is, has sometimes been overrated and has tended to make the scientist overbearing as shown by his attempts to resolve the phenomena of life into a simple operation of chemical and physical forces, without taking duly into consideration the highly organized structure of the protoplasmic mass, whose harmonious operation with a set of external conditions is manifested by what we call life. It is because of the exceedingly intricate mechanism of the protoplasmic structure, of whose operations we know very little, that our knowledge of the products of its activity is still extremely incomplete. Only in such cases, when we can obtain products capable of crystallizing, can we with any certainty state that we have to deal with chemical individuals whose formulas may be ascertained. If amorphous we cannot be sure but that we have instead of one, a mixture of substances more or less closely allied.

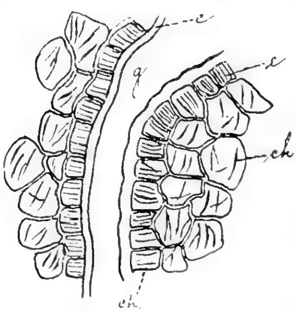
Before going further in the discussion of these plant products a few more words should be said in regard to the organs which bear the colors. The protoplasmic corpuscles have been appropriately designated chromatophores, which name is now generally accepted. It has been observed that as a rule, yellow, orange and brown (sometimes blue) coloring matters are deposited in such chromatophores, while white, violet, blue and red (sometimes yellow) are usually caused by a solution of the pigment in the cell sap. It has been found desirable to make a distinction between the kinds of chromatophores. They are for convenience classified as follows: chloroplasts, chromoplasts and leucoplasts, the latter class, which are the colorless color bearers, being one of the contradictions in which the systems of human classification abound. The bond of sympathy is, however, their common origin, the fact that one may be converted into the other according to the conditions, and each one can originate only as a result of the division of pre-existing chromatophores.

Chloroplasts, as their name indicates, are the green bodies which impart the green color characteristic of leaves and stems. The pigment in this case can be readily extracted by means of such solvents as alcohol, ether and chloroform, while the matrix remains behind as a definitely shaped, colorless mass of protoplasm. The pigment itself may under the influence of various factors, external or internal, undergo modifications into chemically different substances, such as etiolin.

Chromoplasts include all colored chromatophores, not green. It may be seen from this that the distinction is quite an arbitrary one. Chromoplasts may originate from leucoplasts or chloroplasts. This latter case can be easily observed in the ripening of many fruits, as they change from green to red, for example, apples or the berries of the potato plant.

As indicated by the variety of colors found in plants we have to deal with a number of chemically different substances. The literature existing on these pigments is not very satisfactory. Although the metamorphosis of the chloroplasts into the chromoplasts may be readily observed the new substances resulting from this metamorphosis are not well known. This past summer I became somewhat interested in the red color of fruits and collecting among others those of *Ilex verticillata*, I found that they turn brown in 50 per cent alcohol, those of *Gaultheria procumbens* turn gray; those of *Magnolia glauca*, dark brown; those of *Lindera Benzoin*, almost black; those of *Berberis Thunbergii*, light brown; those of *Cratægus coccinea*, dark brown. It is a matter of general observation that in most cases when immersed in alcohol the red color disappears and changes to gray, black or intermediate tints and this no doubt is due to a process of oxidation of the pigment. In rare instances, however, the red color does not seem to be affected by alcohol as, for examples, the berry of *Arisæma triphyllum* and the aril of the seed of *Celastrus scandens*. The latter I determined to submit to microscopical and chemical examination and the following are the results of my observations.

The coloring matter in this case occurs in chromatophores. The figure reveals the following anatomical structure:—A very much thickened cuticle (*c*) of a lemon yellow color. This without a doubt affects to some extent the tint of the aril which has some yellow in it. Courchet[1] states that the color of certain fruits is entirely due to the impregnation of pigment in such epidermal thickenings and he cites as illustrations *Solanum macrocarpum* and *S. racemiflorum*. The epidermis (*e*) consists of a layer of smaller cells of a rather uniform size. The chromato-



[1] Courchet. Recherches sur les chromoleucites, Annales de Sc. Nat., Bot. VII, Ser. VII, 1888, p. 301.

phores (*ch*) within these are very conspicuous. They are rather closely packed together and lie parallel to each other. In color they are bright red, and in form very narrowly spindle-shaped. Below the epidermis, the cells constituting the rest of the pulp of the aril are of larger dimensions, and the chromatophores seem scattered irregularly through the cells. The drawing shows also the groove (*g*) between the arils of two adjoining seeds. Attention has been called to the fact that the study of chromatophores and pigments can be carried on with entire certainty only within the living cells on account of their ready decomposition. When I collected my material I had not the opportunity of careful examination, but the resistance which this tissue manifests to powerful reagents, leads me to conclude that in all probability the arrangement as above described is identical with that of the living material. I found further that sections from the dried seeds did not show any difference in appearance from that represented in the drawing.

According to Zimmermann[2] the pigments of chromatophores found in phanerogams, regarding which we have somewhat definite descriptions, are as follows:

1. Chlorophyll green.
2. Carotin including chlorophyll yellow.
3. Xanthin.
4. Coloring matter of Aloe flowers.

Although certain reactions are characteristic of each of these four pigments, and although an abundant literature exists, at least so far as the first of these, chlorophyll green, is concerned, we can not with any justification claim even such knowledge as the chemist has in reference to many organic compounds of the various complex series. A formula is attempted only for carotin which is said to be C_{26} H_{38}. The great difficulty in investigating these pigments lies in their unwillingness to crystallize. Carotin is the only one of these four which occurs within the vegetable cell in crystalline form, and which can be again crystallized when extracted from the plant. In regard to amorphous extractions complete certainty is always wanting as to the purity of the product, i. e., whether we have a chemical individual to deal with or with a mixture of more or less closely related compounds.

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[2] Zimmermann, Botanical Microtechnique. Translated by James Ellis Humphrey, N. Y., 1893.

In spite of these discouraging facts this field of research seems to me well worth especial labor and care and the only feasible method is to continue the careful investigations of Arnaud, Courchet, Immendorff and Zimmermann which will no doubt shed further light on this hitherto dark field, of interest alike to the botanist, chemist and physiologist.

I selected the aril of the seed of *Celastrus scandens*, since some of the peculiarities of the pigment are well marked and I desired to find if possible its place in Zimmermann's four pigments.

Carotin is found as a crystalline secretion in the root of *Daucus Carota* also in red flowers and fruits of other plants. It imparts a blood red color to carbon bisulphide in which it is readily soluble and from which it may be obtained in the form of a crystalline precipitate by the addition of alcohol. I found that the pigment of the aril of *Celastrus scandens* was soluble in carbon bisulphide forming a deep red solution, but no precipitate was visible in the addition of alcohol. After evaporation an amorphous sticky mass resulted and it will thus be seen that it differs from carotin in this respect.

In using various well known solvents I found their effects as follows:

1. Water, no visible effect.
2. Alcohol, 50 per cent no visible effect on chromatophores, but the solution was slightly tinged yellow.
3. Alcohol absolute, more soluble; the solution of a deeper tinge.
4. Ether, about like 50 per cent alcohol in color but a greater amount of yellow residue left on evaporation.[3]
5. Aceton, about like 50 per cent alcohol.
6. Chloroform, much more soluble, solution deep red.
7. Carbon bisulphide, similar to chloroform, solution deep red.

Carotin "according to Arnaud is insoluble in water, almost so in alcohol, very slightly soluble in ether, and most so in chloroform and carbon bisulphide. These solutions are colored yellow to orange yellow, according to their degree of concentration, while the solution of carotin in carbon bisulphide is always blood red." [4]

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[3] It is possible that the yellow matter with which the cuticle is impregnated influences to some extent the color imparted to the solvents. This requires further attention.

[4] Zimmermann, Microtechnique, p. 102.

John A Ryder

Comparing then this statement with what I have observed regarding the pigment under consideration we find that there is a close similarity as to its solubility and that of carotin.

With concentrated sulphuric acid the chromatophores changed first to a greenish color and then to a decidedly purple-blue. This same change of color was effected when concentrated sulphuric acid was added to the chloroform solution. With iodine (in potassium iodide) the chromatophores turned blue-green, like the color characteristic of the Cyanophyceæ.

According to Zimmermann[5] with a solution of iodine (e. g. aqueous solution of iodine and iodide of potassium) carotin is colored greenish or greenish-yellow; with concentrated sulphuric acid, first violet and then indigo blue.

There is evidently, therefore, also much resemblance between the effect of iodine and concentrated sulphuric acid upon carotin and the red pigment of *Celastrus scandens.*

Lacking, however, complete correspondence I next determined to discover if it approached xanthin more closely in its properties. It differs from this in its most conspicuous, although on that account by no means most important property, its color. "Xanthin occurs in yellow chromoplasts in amorphous form, and especially in small granules.[6] Its alcoholic solution leaves on evaporation a wholly amorphous resin-like mass. It is insoluble in water, little soluble in ether, chloroform and benzine but more so in alcohol. With concentrated sulphuric acid, the isolated pigment, as well as the chromoplast takes first a greenish then a blue color; with iodine best used in the form of potassium iodide it becomes green."[7]

It will be seen from this that while the red pigment of *Celastrus scandens* differs from xanthin in its solubility it agrees with it more closely as regards the effect of sulphuric acid than does carotin. Another striking resemblance with xanthin is the resin-like amorphous residue left when the solvents are evaporated.

The behavior of the coloring matter of the aril of the seed of *Celastrus scandens* with different solvents and other reagents leads

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[5] Ibid., p. 102.

[6] It appears to me of no great importance to distinguish between pigments occurring in solution or in granules so long as we know no more about solutions than we do at present. We consider pigments in solution if present in such a fine state of division that the individual particles can no longer be recognized. It must be admitted than such an distinction is purely arbitrary.

[7] Zimmermann, Microtechnique, p. 103.

us to conclude that in it we find a connecting link between the crystallizing carotin of red flowers and fruits and the amorphous resin-like xanthin of yellow flowers, and these observations tend to confirm Courchet's views that the pigments of yellow and red chromatophores having the property of turning blue or green with sulphuric acid, thus distinguished from all other pigments, represent a group of closely related compounds[8] whose composition certainly demands further investigation.[9]

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[8] Courchet, Recherches sur les chromoleucites. Annales de Sc. Nat., Bot. VII Ser. VII, 1888, p. 291.

[9] The coloring matter described in this paper is also remarkable for its resistance to the action of alkalies. Boiling with potassium hydroxide does not decompose it.

APRIL 7.

MR. THEODORE D. RAND in the Chair.

Twenty-five persons present.

The Serpentines of Eastern Pennsylvania.—THEODORE D. RAND called attention to the specimens of serpentine presented this evening. They had been collected from numerous localities in southeastern Pennsylvania. He regarded them, as stated in a paper read before the Academy, as belonging to at least two groups: one bordering the ancient gneiss; the other, which he believed to be much more recent, occurring in the mica schists and gneisses.

The former are altered igneous rocks, either pyroxenic or chrysolitic, the chief material being enstatite, found often but slightly altered; the latter of more doubtful and perhaps varied origin, determination of which will require much more study of thin sections under the microscope.

The bright yellow serpentine from Easttown Township, Chester Co., is probably altered chrysolite chiefly, while that from Fritz Island, near Reading, is an altered dolomite. That from Brinton's Quarry, near West Chester, contains bronzite, not entirely changed.

The Radnor serpentine is chiefly altered enstatite, but specimens presented show, also, a change from asbestus into serpentine.

No rock is better suited than serpentine to show that minerals have a life history, that they are not the unchangeable substances commonly supposed, for serpentine seems to be a stage in the life of many minerals of which magnesia is a large component, while serpentine, in its turn, decomposes into soil, or occasionally, indeed in this region frequently, into quartz.

Perido-Steatite and Diabase.—DR. FLORENCE BASCOM stated that she had recently made examination of thin sections from the serpentine of the belt running northeast and southwest from Chestnut Hill through the soapstone quarry to a point northeast of Bryn Mawr, and also of the trap of the Conshohocken dyke.

The serpentine was from the quarries on the Black Rock road, between Mill Creek and the Roberts road. The belt lies wholly within the mica schists on the southeast side of the Pre-Cambrian gneiss. The serpentine proved to be derived from a peridotite and not from a dolomite or from an enstatite rock, as in other cases mentioned. The thin sections show olivine grains with the characteristic alteration to serpentine on their peripheries; much talc or steatite is present. The rock is, therefore, a perido-steatite. The dark green crystals, conspicuous in the hand specimens, often twinned, are pseudomorphs after olivine, and not after staurolite, the forms of each resembling the other closely.

The rock of the Conshohocken dyke is medium-grained, compact, of a gray color on the fresh surface, a rusty green on the weathered surface. In thin sections it shows itself a typical diabase, with plagioclase, pyroxene, ilmenite and apatite, as primary constituents, and chlorite, serpentine, scanty biotite and calcite, as secondary constituents. The structure is characteristically ophitic: slender idiomorphic lath-shaped feldspars form a net work, while allotriomorphic pyroxene fills the angular spaces. The feldspar is twinned according to the albite law, and its optical properties indicate that it belongs to the labradorite-bytownite end of the series. The pyroxene is a colorless nonpleochroic monoclinic variety. The cleavages and low extinction angle point to diallage as the species. Apatite is the oldest constituent. Ilmenite shows slight alteration to leucoxene. The rock is very like the Pine Rock diabase described by Dana in Amer. Jour. Sci., Vol. 42, 1891, page 82.

APRIL 14.

The President, SAMUEL G. DIXON, M. D., in the Chair.

Twenty-seven persons present.

APRIL 21.

The President, SAMUEL G. DIXON, M. D., in the Chair

Thirty-six persons present.

A paper entitled "A Revision of the Polar Hares of America," by Samuel N. Rhoads, was presented for publication.

APRIL 28.

The President, SAMUEL G. DIXON, M. D., in the Chair.

Thirty-three persons present.

A paper entitled "A Remarkable Central American Melanian," by H. A. Pilsbry, was presented for publication.

The death of William Hunt, M. D., a member, April 19, 1896, was announced.

DR. PERSIFOR FRAZER was appointed to represent the Academy at the Seventh Session of the International Congress of Geologists to be held in St. Petersburg in 1897.

An invitation to participate in the Mining and Geological Millennial Congress, to be held at Budapest, September 25th and

26th, was accepted and PROF. ANGELO HEILPRIN was appointed to represent the Academy on the occasion.

The following were appointed to constitute the Hayden Geological Memorial Committee for 1896:—Dr. Persifor Frazer, Prof. Angelo Heilprin, Mr. Benjamin Smith Lyman, Prof. J. P. Lesley and Mr. Theodore D. Rand.

Mr. William H. Roberts was elected a member.

The following were ordered to be printed:—

A BIOGRAPHICAL SKETCH OF JOHN ADAM RYDER.

BY HARRISON ALLEN, M. D.

I.

John Adam Ryder,[1] the first child of his parents, was born February 29, 1852, near Loudon, Franklin County, Pennsylvania. His parents are Benjamin Longenecker Ryder and Anna Frick Ryder. On his father's side he was descended from Michael Ryder who was one of three sons whose father came from England and settled near Cape Cod, Massachusetts. Michael Ryder removed from Massachusetts to Pennsylvania where his descendents have since lived. His paternal grandmother, Elizabeth Longenecker, the wife of Adam Ryder, was of German origin. She was born in Lancaster County, Pennsylvania.

Anna Frick Ryder, the mother of John Ryder, was born in Maryland. She is in part of Swiss descent. The maternal grandmother Anna Kelso was of Scotch origin. Her great grandfather was William, Earl of Kelso. At the time of the persecution of the Presbyterians in Scotland during the reign of Charles II, the Earl of Kelso, together with his wife, infant son and brother James, were compelled to leave Scotland. They sought refuge in Ireland, where James Kelso was captured, taken to London and executed. The

[1] In the preparation of this sketch the list of questions prepared by Mr. Galton in his monograph on "Men of Science" was sent to the family of Dr. Ryder and the details in all respects are based upon the answers received. The expressions of opinion of the speakers at a meeting held at the Academy's Hall, April 10, 1895, have been frequently quoted. The words "Memorial Pamphlet," when following a quotation refers to a brochure entitled "In Memoriam," which comprises addresses delivered at that meeting in the following order: Dr. Harrison Allen, Dr. Bashford Dean, Prof. Horace Jayne, Prof. E. D. Cope, Mr. H. F. Moore and Prof. W. P. Wilson. The brochure was printed for private distribution by a few admirers of Dr. Ryder in the fall of 1895. The writer desires to express his acknowledgments to many of Dr. Ryder's associates for information, especially to Rev. Jesse Y. Burk, Secretary of Board of Trustees University of Pennsylvania, Mr. W. C. Seal of Philadelphia, Prof. J. S. Kingsley of Tuft's College, Massachusetts, Mr. Edward Brooks, Superintendent of the Public Schools of Pennsylvania, and Mr. Herbert A. Gill, Secretary of the United States Fish Commission.

estates were confiscated. A grandson of William Kelso, above referred to, came to America.

It will be thus seen that Dr. Ryder was twice removed from ancestors who combined English, Scotch, German and Swiss traits.

Dr. Ryder's father was by training a farmer. He became interested in horticulture and at one time conducted a large nursery. His talents for invention are of an exceptional order; he has improved mechanical devices for preserving and curing fruits, vegetable and animal products, and has become widely known in connection with their manufacture and introduction.

Dr. Ryder's inventive ability can be traced in great measure to his father and remotely to the Longenecker branch of the family. His mother, however, possesses inventive skill in no mean degree. Ryder had no taste for music; in this respect he resembled his mother, since the taste was well developed in the father. He had a natural facility for drawing, although he never cultivated it beyond what was necessary for the illustration of his papers and for the class room. This talent, also, is traceable to his father. His taste for natural history is a direct inheritance from his mother. While Dr. Ryder never became much interested in medicine, many phases of his researches are so closely allied to this science that he may be said to have inherited the taste from his father, who, although never having studied medicine systematically, had that turn of mind which is constantly tending to contemplate the nature of disease. A paternal aunt of Dr. Ryder studied medicine. She was never graduated. Her medical opinion was frequently sought for and valued in the community where she lived. She was also of an inventive turn of mind.

Dr. Ryder early exhibited a taste for natural history. When three years old he was constantly bringing into the house brightly colored stones, insects and other natural objects. At eight years he knew the botanical names of all the plants in his father's nursery. While very young he was noted for a habit which distinguished him throughout life, namely, of always having his mind occupied with something apart from the duties in hand; thus, while helping his father at pruning or grafting, he would recite aloud passages from a favorite author, a copy of which would be found in his pocket. On one occasion his father hearing hearty laughter asked him the cause of his mirth. The boy replied he wondered how Diogenes felt living in such a small place as a tub, and what fun he must have had searching for the honest man.

Every farmer in those days kept a few swarms of bees. While Mr. Ryder was not a professional apiculturist, he knew in common with his neighbors a good deal about the raising of bees. Ryder developed an interest and without being specially instructed became proficient in the care of bees, and throughout life often reverted to their habits for many points in the economy of insects.

At three years of age he began to receive instruction from his maternal grandmother from whom he early mastered the rudiments of German. He attributed his subsequent fluency in German (for he could speak it like a native) to this early impression. A little book entitled "Biblische Naturgeschichte für Kinder" bears his name on the cover with the date of 1860.

Ryder spent the life usual to a country boy. He possessed great energy of body and was fond of walking, rarely, if ever, using a horse to ride, although the stable was at his command. He attended the country school from the age of six or seven until his fifteenth year, when he ran away. Soon afterward he was sent to the Academy and then to the Normal School at Millersville from which he also ran away, and did not return home but lived the life of a tramp for some days before he was detected. He was severely punished for both these escapades. It appears that Ryder was always very sensitive and never associated with boys of his age in the sports customary to youth, but wandered about alone through the woods and meadows collecting insects and plants. He soon earned the nickname of "crazy John." In the end his father prudently interviewed the principal of the Academy and made special arrangements which enabled Ryder to live on more agreeable terms. But he was unhappy under restraint. Class work was distasteful to him and discipline of any kind resented. In order to secure his obedience it was sometimes necessary to give him directions adverse to those which it was intended for him to obey. Preferring to study in his own way, he spent the greater portion of his time in the library of one of the local literary societies. He read every book it contained. He was geatly influenced by Horace Mann's "Thoughts for a Young Man,"[2] a copy of which he procured. In 1875 in writing to his brother he said "be careful of this book, five dollars would not buy it, if I were unable to get another." In 1868 when in his sixteenth

[2] "A Few Thoughts for a Young Man: a Lecture delivered before the Boston Mercantile Library Association on its 29th Anniversary. By Horace Mann. Boston: Ticknor, Reed and Fields, 1850.

year, he wrote home asking for a microscope, books on natural history, chemical apparatus, etc. His restless spirit caused him to drop out of the school for good after a few months.

He taught school in the neighborhood of Loudon and afterward in the High School of the county for three years. He was quite successful and was much esteemed by all who were brought in contact with him.

We now find Ryder in his twenty-second year with the best equipment it was possible to secure for him in a rural district. His tastes were defined, and he at once made up his mind to devote himself to the study of science. This decision was quickened by the failure of his father in business, so that Ryder was thrown entirely upon his own resources. Of a proud disposition, he refused all assistance from his relatives, and learning that the Jessup Fund of the Academy of Natural Sciences of Philadelphia afforded assistance to young men who were desirous of devoting themselves to the study of natural history, he came to Philadelphia in the spring of 1874, and appealed to Mr. Thomas Meehan, an old friend of his father, for advice. Mr. Meehan states that Ryder visited him at his residence in Germantown. His funds were low, and to save money he had walked the entire distance, twelve miles, from Philadelphia. Mr. Meehan was interested in Ryder, who was, however, urged not to attempt to live on the small amount of five dollars a week permitted by the fund. But Ryder was not to be deterred. He felt confident that he could in some way manage, and accordingly, armed with a letter of introduction, he visited the Academy and made formal application. This was, at first, unsuccessful, but in the latter part of the year he was duly appointed. He remained in the Academy as a beneficiary of the Fund for six years.

Little is known of his private life during the greater part of this time. In 1879, Mr. J. S. Kingsley, now Professor of Biology in Tuft's College, Massachusetts, was his associate, and through him it is ascertained that Ryder lived on the top floor of No. 1113 Chestnut Street. His chamber and laboratory were one. Upper rooms in business blocks were then cheap, and food at moderate prices, offered for the use of employés of newspaper offices in the neighborhood, could be obtained day and night. The markets and restaurants of Philadelphia furnish plain, wholesome food at rates which compare favorably with those in any American city. Meals at fifteen cents each are important factors in solving a problem of living on seventy cents a day. It was the custom of the proprietor of the restaurant frequented by Ryder to put aside for him the oyster shells, which, after each meal, were inspected for organisms. In this way he discovered the sponge *Camaraphysema*. Doubtless the work on the habits and food of the oyster, on which Ryder's fame in a measure rests, began in these desultory studies.

It was a time of formative plans. Among these may be recalled—an educational scheme by which the teachers in the public schools were to be prepared for imparting the elements of biology to their pupils; a course of popular lectures at the Wagner Institute; and a series of papers on natural history for a Philadelphia paper. None of these came to anything.

Such a life in a region of stores and warehouses is well enough during the week. The days and nights are separated by the changes in light—but not by changes in habit. But on Sunday the business part of a city is but little better than a desert. Ryder was in the habit of spending this day, when the season favored his so doing, in the suburban districts, or in Fairmount Park. It was on such excursions he discovered *Scolopendrella* and *Eurypauropus*.

The previous education of Ryder was one inadequately qualifying him for the career of a naturalist. This, indeed, is not less than that required to equip a student for any intellectual career whatsoever. How immense the labor when one is compelled to equip himself! The naturalist must be a linguist (for there is scarcely a modern European language which may not possess a treasure for his needs); he is all the better for being a draughtsman; he should command a good literary style; he should be a mathematician and physicist. Ryder, in these preparatory years, attempted all these things but the last. His endeavors to acquire new languages and a good literary style were unending. One of his favorite pastimes was to read an essay of Addison twice and then write out the essay from memory. He would then compare his sketch with the original. His tastes in art were not formed, and he rarely alluded to the subjects embraced among the humanities.

Mr. W. P. Seal, the well-known aquarium expert, was of great value to Ryder at this time in bringing him all the unusual specimens he detected while making collections of fresh water fishes and plants in the neighborhood of Philadelphia. At the end of his service in the Academy, Ryder had contributed thirty-one papers, most of which were based upon studies made in the Museum or on low forms of life.

In 1880, the National Government was desirous of having investigations prosecuted in behalf of the United States Fish Commission on the life-history of the American food-fishes and other aquatic animals, especially their embryology and growth, the character of their food in the early as well as the later stages of life. In the judgment of Prof. Baird, who was at that time Commissioner, no one in the country possessed the qualifications to meet the provisions of such investigations in so high a degree as Dr. Ryder.

He was at once invited to undertake the work, which not only gave him an opportunity of systematizing his studies (these were already embracing the higher problems in biology), but had the advantage of placing him in a better paid position.

It is true that up to this date Ryder had given no special attention to fishes, but he had obtained a general knowledge of the subject at the Academy, his inherited talent for invention lent itself readily to the details of field-work, while his acquaintance with the lower forms of aquatic life fitted him for the study of the food of fishes, the study of their young stages, their parasites, etc.[3]

Dr. Ryder always referred to this period with interest. His first detail was to the field, but in 1882, Prof. Baird transferred him to the National Museum, occasionally only, assigning him to field-work. He was extraordinarily active during the six years he remained on the Commission. He contributed twenty-nine papers on the oyster and oyster-culture, and fifty papers on the development of fishes, their food material and methods of development. All his contributions were carefully prepared and showed extensive knowledge of the subjects treated. He discovered, in 1888, a byssus in a young stage of the long clam *Mya arenaria.* Prof. Baird, in commenting on this discovery in his report for that year, believed "it to be of economic importance since the young individuals now can be freely handled and transported." Mr. Bashford Dean remarks: "I have heard it said that Dr. Ryder had, in his scientific work, grown up with the Commission; it might, I think, be said even as justly that the Commission had, in a measure, grown up with him."[4] His personality and methods had stamped themselves upon every

[3] (1) The following papers, prior to 1880, related to Dr. Ryder's contribution to ichthyology: "On the Origin of Bilateral Symmetry and the Numerous Segments of the Soft Rays of Fishes;" "Phosphorescence of very Young Fishes;" "The Psorosperms found in *Aphredoderus sayanus.*"

[4] Memorial Pamphlet.

officer of the Commission to which he had been originally attached as an expert. He "merited the confidence and esteem of every one from the Commissioner to the humblest attendant."

On the occasion of his resignation, 1886, Prof. Baird expressed himself in a personal letter in these words: "In view of the many years of your connection with the Fish Commission, and the valuable services which you have rendered by the exercise of your professional skill and ability, I accept your resignation with very great regret." His work, however, on the Commission, did not at once cease. He was employed in May and June, 1888, to investigate the sturgeon fisheries in the Delaware River.[5] During the remainder of the summer of the same year, he had charge of the station at Wood's Hole.

His interest in the study of Cetacea began while on the Commission. Although his work on this subject was never extensive, perhaps no other group of observations better illustrate the higher characteristics of his mind.

In 1886, it was determined by the authorities of the University of Pennsylvania, at the suggestion of Prof. Horace Jayne, to found a chair of Comparative Histology and Embryology. As stated by Prof. Jayne, "It was seen that a course was needed which would give students a thorough knowledge of comparative microscopic anatomy, together with the development of the tissues and of the different kinds of animal forms."[6] The chair was offered to Dr. Ryder and accepted, though "he hesitated at first," to again quote Prof. Jayne, "because he mistrusted his power to teach and handle large classes of students, a mistrust which was never shared by his friends." In many respects, the change from the duties of a biological expert on the Fish Commission to those of a professorial position was beneficial. He was now enabled to systematize his time, and permitted to extend the range of his inquiries. By renewal of associations at the Academy of Natural Sciences, he was assisted also in keeping thoroughly in touch with the progress of his favorite science.

In illustration of the zeal with which he prepared himself for his new duties, the following extract is taken from a letter written to Mr. Seal, from Chambersburg. "I am embracing an opportunity for the collection of embryos of warm-blooded vertebrates, which I

[5] Report of Fish Commission, Bulletin, 1888, p. 231.

[6] Memorial Pamphlet.

have never enjoyed until this season, and, unless one can give his whole time to the work of opening hundreds of females with great care, and have the means and time to preserve the material obtained, it is but very little use to bother with the subject. I have eviscerated about five hundred rats, mice, field-mice, moles, bats and musk-rats. I have a fine lot of embryos of all stages nicely preserved. Besides this I have obtained two hundred and fifty sparrow's eggs in all stages of incubation, which I have also put in good condition."

After an experience of nine years, terminating only in his death, it can be said of him that all the expectations raised at the time of his appointment were more than realized. He proved himself to be a diligent teacher and an esteemed colleague. As matters appear to be arranged for men of Ryder's attainments, a university position is the best available. Speaking for the personal side of his career, it may be said of him, as I am sure he might have said for himself, that to receive the respectful admiration and affection of pupils and to influence for good the mental development of youth, is for any man a sufficient reward. A former pupil, Mr. H. F. Moore, says of him: "What he may have lacked in some of the usual attributes of a successful teacher was more than compensated for by his keen sympathy, his painstaking care and his skill with crayon and pencil. If he had found a point of interest in his work, he usually invited us to enter, and would unfold to us his hopes and aspirations with the enthusiasm and simplicity of youth." Yet, after all is said, one must agree with his friend, Mr. W. V. McKean, that "Ryder was essentially the kind of investigator that it would have been a public benefit to have established in an amply endowed university chair, so that he might be entirely free to pursue his researches unhindered by any mere task work."

Dr. Ryder enjoyed perfect health until 1882, when he contracted malaria while engaged in some researches in connection with his work on the Fish Commission, at Ridge, Maryland. He suffered from a recurrence in 1888, while residing in Philadelphia. About this time dyspepsia announced itself. He suffered greatly and became much emaciated. In the summer of 1890 he visited Europe, but returned scarcely at all improved. He had an attack of the prevailing influenza in 1894, and from this time more serious and obscure impairment of the general health ensued. He died March 26, 1895, after an acute illness of a few days, aged forty-three years.

Dr. Ryder's death was unexpected, and expressions of regret were universal. The daily papers published detailed accounts of his life and services. Immediately after the death, the Board of Trustees of the University held a meeting, at which Dr. S. Weir Mitchell made a feeling announcement. The Board then passed the following resolution: "The Trustees of the University of Pennsylvania deplore the loss sustained by it in the death of John A. Ryder, Ph. D., Professor of Comparative Histology and Embryology. Called to that Chair in 1886, he quitted for it a congenial field of labor under the United States Fish Commission, in which he had rendered great service to the Government, and acquired for himself a world-wide reputation. Thenceforth, he devoted himself equally, and with a fidelity and effectiveness that ended only with his life, to the work of a teacher and that of an investigator. His characteristic traits were modesty, unselfishness, and sincerity in the search for truth. To these were added a rare talent for investigation, strong intellectual capacity, and unremitting industry; and these inured not only to the benefit of the school in which he taught, but to the distinct advancement, both in theory and in application to the science of biology to which his life was consecrated."

The funeral services were conducted by Prof. George F. Fullerton, Vice-Provost, and the Rev. Dr. H. C. McCook. His body was cremated.

A memorial meeting, held in the hall of the Academy of Natural Sciences of Philadelphia, April 10th, was participated in by members of the faculty of the University of Pennsylvania, representatives of the American Philosophical Society, the United States Fish Commission, and the Academy.[7]

Dr. Ryder was elected a member of the Academy of Natural Sciences of Philadelphia, January 29, 1878, and of the Biological Section of that body November 15, 1886. He was Director of the Section from 1886 to 1888. He was elected a member of the American Philosophical Society, December 17, 1886. The University of Pennsylvania conferred upon him the degree of Doctor of Philosophy, 1886. He was also a member of the following societies: The Zoological Society of Philadelphia (life member); the American Morphological Society; the American Society of Naturalists; the American Association for the Advancement of Science; the Association of American Anatomists, and the Historical Society of Pennsylvania.

[7] See note on page 222.

II.

Dr. Ryder was a man of restless mental activity. Plan after plan was discussed in his early letters. No defence was offered for this eagerness of spirit. On the contrary, he says in one of his outbursts: "I see more worlds ahead of me to conquer, so that I have little time to attend to number one, that often restive and troublesome person who is always reaching for toys he ought not to have, greatly to the disadvantage of more serious matters." Circumstances annulled most of his numerous enterprises, but the ideas were, without exception, admirable, and some of them were afterward realized by others. In 1879, he proposed to establish in Philadelphia, in conjunction with Mr. W. C. Seal, a depot of material for biological laboratories and class-room demonstrations. It was intended that Mr. Seal would collect and preserve the specimens which Dr. Ryder would undertake to identify and to furnish all other information. It was designed to embrace marine and fresh-water, as well as terrestrial forms. In association with his friend, Mr. J. S. Kingsley, he at one time thought of writing a book on the infusoria, a work that yet remains a desideratum. Dr. Ryder had a ready knowledge of the group. In later years he constantly reverted to it for illustration in his studies of the movements of protoplasm. A third undertaking on the embryology of fishes was proposed. It never went further than the title-page. In 1887, he seriously contemplated a text-book on general embryology. It was to be "copiously illustrated and to set forth the principles from new points of view." To this task he intended devoting two or three years. In 1893, he published, under the auspices of the University of Pennsylvania, a pamphlet entitled "The Synthetical Museum of Comparative Anatomy as the Basis for a Comprehensive System of Research."

It is a remarkable fact that Dr. Ryder, in his active and versatile career, never wrote an extended memoir. Everything he prepared for the press was the direct outcome of the practical tasks upon which he was officially engaged.

His work in zoology[8] was not large. Reference to the bibliography shows that twelve papers may be so classified. He once

[8] Dr. Ryder made a few observations in physiological botany. Early in his career, viz., 1877, he noted the disposition of the tendrils of *Cocculus indicus* to twine. (Proc. A. N. S., 1877, 3). In 1879 he observed the honey-glands of the leaves of *Catalpa*, and the habits of bees respecting them. (Proc. A. N. S., 1879, 6; Pastime, 1881, II, 8; Am. Nat., 1878, 4.)

said, "The species makers are caviare to me." But he himself did not escape the fate of most biologists in the making of species.

I have given my impressions of his disinclination to study species elsewhere:[9] "In competent hands the elucidation of species is not, as it has opprobriously been said to be, a dullard's task of taking an inventory of nature, but the study of the ultimate forms which those organisms assume which breed true. The shifting of color schemes, the exhibition of the effects of food and climate on size in whole or in parts, and of other causes by which minute differentiations are started and maintained, are of unending interest, and worthy of the best powers of the naturalist. If Ryder had been more closely identified than he was with the careers of the great academicians who had preceded him, it would in no whit have detracted from the value of his philosophical labors. One cannot but regret, if for no other reason than for his health's sake, that he discontinued those fruitful excursions to our woods, ponds and rivers, by which he contributed so notably to our micro-fauna."

While Dr. Ryder did not identify himself with zoology, his reputation may be said to rest in great part upon his labors on the morphology of the early stages of the development of fishes. This work, for the most part, represents that accomplished by him as an expert on the Fish Commission. His interest in the subject of the nature of species was, however, a deep-seated one, and he was constantly reviewing masses of data which he had accumulated in attempting to explain the tenets of evolution. That these attempts should have been largely in the direction of dynamics was to be expected, since he was enabled to apply to the problems his talent for mechanics and invention. He also had at hand the conclusions of many contemporaries who were with him eagerly seeking for a hypothesis of evolution not embraced in that of natural selection.

As early as 1874, he wrote: "I think I have discovered a law which offers a way to the solution of the variation of forms in animal life. This law I propose to call the law of the dynamics of phylogeny. In reading over Herbert Spencer's brilliant essay on the circulation of sap in plants and the formation of wood, I saw the solution of the problem. Here is field enough for a Darwin. I almost shrink from the task when I consider its magnitude. Cleavage of muscular fibre; the processes of bone; the arrangement of the bony layers; the change of form and length and of position of bony pro-

[9] Memorial Pamphlet.

cesses; their relations as a whole; their relations to the muscles; their form, arrangements, etc., all proclaim a common law: while every abnormality, injury, reparative expedient, still further strengthens it in my mind, and is the only thing that will demonstrate to the world the truths of the doctrines of unity of law and universal evolution. It completes Darwin's work on a grander scale than Darwin ever dreamed of. It still further declares that there is one eternal ever-active cause, operating in lines of constant and mathematical precision. If Dr. Haughton, of Cambridge, can demonstrate the mathematics of the bones and muscles, surely some one else can study the dynamics that creates them."

His first work in speculative biology was an attempt to explain by such reasoning a law of reduction of digits in the mammalia.[10] In the same year he endeavored to establish a dynamical theory to account for the modifications in the forms of tooth structure and to correlate this structure with the shapes of the lower jaw and other parts of the skull. In the following year he discussed the mechanical genesis, degeneration and coalescence of vertebral centra in a gigantic extinct armadillo.

He developed a theory on the origin of the amnion in 1886, and his explanation of the different types of placentæ in 1887. In 1889 he defended the thesis "that the segmentation of the soft rays of the fins of fishes are simply fractures due to flexures, and that on the caudal fin they possess probably the same direction as the intermyomeric fissures."[11] Ryder's bibliography contains fourteen titles of papers which illustrate similar lines of reasoning.

In the same year we have evidence of additions to his methods, for, while keeping to the lines already indicated, he added others of a different character, and sustained by broadly contrasted methods of expression. Allusion is made especially to his studies of the contractility of protoplasm, which is first mentioned in his paper, "On the Fore and Aft Poles, the Axial Differentiation and a Possible Anterior Sensory Apparatus of *Volvox minor*" and in his paper on the "Origin and Meaning of Sex." These papers began a series which (included in the bibliography under numbers 174, 186, 190 and 191) dealt not so much with problems in dynamics as with the old vital doctrines, or, as would be expressed in modern phrase, metabolism. "The Origin and Meaning of Sex" appeared in the *Biological Bul-*

[10] Law of Digital Reduction, Proc. A. N. S., 1877.

[11] E. D. Cope, Memorial Pamphlet.

letin, Univ. of Penna., 1889. Extensions of opinion were printed in the *Proceedings* of the Academy, 1889, and in the *American Naturalist*, 1889, 501. He held that over-nutrition led to all forms of sexual reproduction ; that the male and female elements are contrasted in their tendency to undergo segmentation—the female element having lost the power to undergo such segmentation spontaneously (excepting in parthenogenesis),—while the male element is accompanied by an increase of segmental power, * * * * "Sex probably arose simultaneously and independently in both female and male as soon as certain cells of coherent groups became over nourished, and incapable of further segmentation unless brought into contact and fused with the minute male element, or one which is the product of an increase of segmentational power which is transferred to the female element in the act of fertilization." Important applications were made of the hypothesis to the study of variation, the evolution of sexual characters, and, as the author believed, a consistent and simple theory of inheritance which is in harmony with all the facts of reproduction. At this time he was in a state bordering on exaltation. "I sat up late last night after the whole thing flashed across my mind in an instant," he writes, "and did not sleep for two hours after I went to bed because my brain was going like a dynamo, thinking out detail after detail of my hypothesis. * * * * Wolfe and Schwann mark two eras in the history of hypothesis. I shall mark a third if I live to complete the sketch of the vast hypothesis. * * * * My disappointments vanish into the uttermost inane when I think of what it has been possible for me to achieve."

After such strong evidence of his belief in the value of this theory, it is hard to understand how he practically dropped the subject. Subsequent to the dates above given, I have come across no reference to it, nor is any mention made of the matter in the estimates of his work that have appeared since his death.

It is impossible to understand Ryder's attitude toward evolution, without regarding his disbelief in the "cult" usually known as Weismannism, which embraces the opinions that acquired characters cannot be transmitted, and that a portion of each organism is carried unchanged from parent to offspring. He said, in his paper on sex, "The hypothesis which assumes that the germ-plasma is precociously set aside in order to render it unmiscible with the somatic plasma, and therefore immortal, is based upon a fundamental error of interpretation of the facts of morphology." In another place, an address entitled "Dynamics in Evolution," 1893, he said, "experimental investigations in embryology will make no solid progress until the mischievous influence of such speculations have been eradicated from the minds of the present generation." These opinions remained unmodified to the day of his death. Perhaps the best expression of his views can be found in a lecture delivered at Wood's Hole, 1894, and a second lecture entitled "A Dynamical Hypothesis of Inheritance."

The last phase of his scientific life is the most instructive, namely, that relating to the application of geometry and the differential calculus to the study of organic forms. The idea that anatomy and mathematics can be of mutual assistance generally comes to savants too late for practical use. Against the example of Helmholtz we cite many failures. Mathematics came to John Goodsir too late for anatomy, and anatomy to Fechner too late for mathematics. When Ryder saw the necessity of preparing himself in these sciences (for his early training had excluded them), he set to work to supply the defect with characteristic energy. He studied geometry and the calculus in spare hours. He became enthusiastic for them. He declared geometry to be the noblest of the sciences. He read the writings of Lord Kelvin carefully; his admiration for them was unbounded. At the time of Ryder's death, two works lay on the bed, one was a text-book on the differential calculus, the other a volume of Lord Kelvin's works.

It is difficult to fix a time when the mathematical explanation of the mechanics of evolution occurred to him. We have seen that he was influenced by Haughton as early as 1874. If we can draw an inference from the reading of the paper entitled "The Fore and Aft Poles of *Volvox minor*," previously quoted, and again the essay "The Polar Differentiation of *Volvox minor*" and "Specialization of Possible Anterior Sense Organs" (No. 174, Bibliography), the idea apparently suggested itself by studies in the early Academy days on the infusoria and later on the development of simple organisms. The same conception occurs in his papers on "Energy in Biological Evolution;" "Of the Representation of the Relative Intensity of the Conflict Between Organisms;" "Energy as a Factor in Organic Evolution;" "Mechanical Genesis of the Form of the Fowl's Egg;" "The Adaptive Forms and Vortex Motions of the Substance of the Red Blood Corpuscles of Vertebrates;" "The Correlation of the

Volumes and Surfaces of Organisms."[12] One of the last demonstrations he made was at a meeting of the Bibliographical Club of the University of Pennsylvania, when he exhibited contractile films of gelatin in illustration of the mechanical conditions underlying the problem of the arrangement of the convolutions of the brain.

In January, 1890, he writes: "It is my hope to reduce the doctrine of evolution into a simple realization of Newtonian principles. The three great Newtonian laws of motion are at the bottom of the whole matter. Some day I shall be able to tell a great deal that I have kept to myself in order to test its truth. * * * * I am engaged—and will be hereafter almost entirely—in determining the factors and processes which have effected the evolution and divergence of species. * * * * I have at last worked out a new theory of inheritance which must ultimately replace those of Weismann and Darwin, or at least furnish the foundation by which the data and phenomena of variation and inheritance can be co-ordinated with the great universal principle of the doctrine of the conservation of energy. The speculations of Darwin, Haeckel, Weismann, Brooks, DeBries, Strassburger and Nageli looking to a theory of inheritance are irreconcilable with the fundamental postulates of physical science, and must be abandoned. This also renders the conflict between the hypothesis of Darwin and those of Lamarck one of primary importance, and sharply defines the line of battle between the thinkers who range themselves under the banner of one or the other of these prophets of transformism."

While it is impossible to say what Dr. Ryder would have accomplished in his attempt to use mathematics as a medium of expression of biological problems, this much can be said, not only for him, but for all others similarly placed, that a course of training in geometry and the higher mathematics should be a part of the equipment of the student in biology. It does, indeed, seem pitiable that, ascending the heights of knowledge, he finds, as he nears the top, that the key which he believes can alone open the temple erected there has been left behind.

III.

Dr. Ryder was five feet eleven inches high, of a slender, slightly-stooping figure. While spare he had a robust physique. He was

[12] See Bibliography, Nos. 182, 184, 186, 187, 189, and especially Nos. 190, 191, 192, 195, 199, 200, 204, 205, 206 and 207.

of nervous temperament. His complexion was light—the hair flaxen. He was plain—almost careless—in his dress. He had a habit of sitting cross-legged and swinging one foot when deeply engaged in thought or study. He was of a genial disposition and enjoyed gatherings with his students after class hours, or discussions with his colleagues and friends at the Academy and other places. His learning was great, especially in contemporary literature, and nothing appeared to give him so much pleasure as talking of the work of his co-laborers; but he disliked what are called "social functions," and toward the latter part of his life was rarely present at them. From the beginning of his scientific career to his later years he did not require much sleep, taking about six hours daily, though his habits in this resprct were never regular. He had great energy of mind, and power of accomplishing a large amount of brain work. His memory was remarkably retentive—he never forgot anything he once heard or read. In addition to his early attainment of German, he read for scientific purposes French, Italian, Spanish, Dutch, Danish, Swedish and Russian.

His sense of duty was highly developed. He believed that the power of the will over action was practically without limit. Yet the motive for the exercise of the will must be from within. Hence can be explained his apparent obstinacy of disposition as a child; his aversion to class work at school; and his independence of convention, both as to thought and action in mature life.

Sometime prior to his appointment on the Fish Commission, Mr. W. V. McKean invited him to write articles on natural history for the *Public Ledger*. But Ryder could not overcome a distrust that his essays would be too technical for popular favor. That he should have declined an offer apparently so advantageous to himself at a time when he needed money, is an evidence of the rigid scrutiny to which he subjected all his actions. None but his most intimate friends knew of the costs he often paid to maintain his freedom of mental action. They were met without a murmur. But in their payment he doubtless drew largely on that vital energy, without which long life is impossible. His dearest friend said of him, "his self-sacrificing devotion cost him his life."

But, under the stern repression lay a child-like, affectionate nature. He was not happy unless he had one or more of his family with him; he was continually writing to the absent ones. His domestic letters contain full accounts of how he lived, whom he met, and of his enthusiasm for his discoveries. Those who knew him only as a scientist, had but little conception of the spirit that actuated him. His work was not a series of merely intellectual achievements, but back of it all lay the feeling that he was bringing something bright and interesting from the outside world to adorn the home.

His affection for kin extended to his friends. His relations with Prof. Baird were almost those of a son. His anxiety and distress at Prof. Baird's last illness found expression in all the letters he wrote at that time. As is common with such natures, his sense of justice was keen, though no instance can be shown in which his indignation was not excited by the general sense of wrong implied in the situation rather than by any personal feeling.

Dr. Ryder's religious training was that of the strict orthodox Christian faith as expressed in the teachings of the Mennonites. His paternal grandmother who directed his education was a woman of deep piety. For the faith of his parents he always entertained the profoundest respect, and at least toward the latter part of his life was inclined to return to it. At the age of eighteen he studied the Bible closely; and, ever afterward, no matter how limited his travelling effects, a copy of the New Testament was always among them. Though, as shown by his letters, he departed from the tenets of his early education, one cannot doubt that he retained all the force of a severe mental and moral discipline that such teaching implies. He was faithful in friendship; singularly frank and sincere in disposition; and disliked violent language, dispute or criticism. He was always severe to himself, but sacrificing in spirit to those whom he loved.

While a Jessup Fund student he became a devoted listener to the Rev. Mr. Mangasarian, an Armenian preacher, who, at that time, held a pulpit in a Presbyterian church in Philadelphia, but who afterward became a leader in an independent organization allied to the Society of Ethical Culture. In speaking of Mangasarian in one of his letters, Dr. Ryder uses the following language: "He has all the charm of the finished orator combined with rationalism and advanced evolution." Ryder greatly admired Emerson. He spoke of him as "the sanest man of the nineteenth century." In writing to a friend who was in mental distress, he advised him to read Emerson. He carried his admiration even to matters of scientific import. In his last paper he quotes from this writer the saying: "To a sound judgment the most abstract truth is the most practical." He was much influenced by the teachings of the Stoics. "I would strongly advise you," said he to a friend, "to get hold of the thoughts of Marcus Aurelius, when you are most provoked or vexed in spirit, and take their lessons to heart. Epictetus will do equally well, only I think Marcus is calculated to humble and content a man." His letters contain many expressions of trust in an infinite beneficence, and he would have agreed with Epictetus as to " whither dost thou tend after death, that is to nothing dreadful, but to a place from whence thoŭ camest, to things friendly and akin to thee."

We admire Ryder not so much for what he accomplished as for the indomitable spirit that actuated him. With imperfect equipment, with engrossing occupation, and—for much of his intellectual life at least—with impaired health, he attempted the solution of the most difficult problems. It is not for us to consider in what degree he succeeded. Had Bacon, Franklin or Darwin died at forty-three, or had their days been absorbed as his had been, in cares and the routine of task work, how much less would have been their achievments! It is enough for us to know that we are studying in Ryder's life phenomena of a mind of the first order, and that we have lost by his death one of the brightest of the group of workers to which he belonged.

THE PUBLISHED SCIENTIFIC PAPERS OF JOHN A. RYDER.

BY H. F. MOORE, PH. D.

This bibliography was originally prepared for the Proceedings of the Ryder Memorial Meeting but the committee having that publication in charge pointed out that the importance of Dr. Ryder's work demanded for it greater publicity than that medium would afford. It was suggested that it would be most fitting to publish it with the preceding memoir.

The list of papers given is supposed to be complete, being prepared partly from memoranda left by Dr. Ryder and partly by research in the bibliographies of the *Zoological Record* and of the several journals as well as in the sources of original publication.

The citations, with one or two exceptions, have been verified, and the appended notes are partly from the *Zoological Record*, partly Dr. Ryder's and partly by the compiler. The list is given under three heads: Original Research, comprising 215 titles; Descriptions of New Scientific Apparatus, 4 titles; and Translations and Reviews, 59 titles; a grand total of 278 papers published between 1877 and 1895.

ORIGINAL RESEARCH.

1—On the laws of digital reduction. Amer. Nat., Oct., 1877, pp. 603–607. (Points out the modes of modification of the digits in response to the methods of use in the different forms of mammalia).

2—On the evolution and homologies of the incisors of the horse. Proc. Acad. Nat. Sci. Phila., 1877, pp. 152–154, 4 figs. in text. (Traces the history of the "pit" or "mark" in the incisors from the early equine forms to the existing domestic horse).

3—Note on the color variation in mammals. Proc. Acad. Nat. Sci. Phila., 1877, pp. 272–273. (Discusses the probable causes which lead to a disturbance of the symmetry of coloration observed in wild animals when brought under the influence of domestication, assigning as that cause the protection which they receive under the latter, as a result of which asymmetrical and parti-colored individuals are protected and preserved to perpetuate their peculiarities, wild individuals of that character the more readily becoming the prey of enemies).

4—On the growth of Cocculus indicus. Proc. Acad. Nat. Sci. Phila., 1877, pp. 284–285. (Points out the habit or tendency of the terminal part of the newer apical growth to twine).

5—The significance of the diameters of the incisors in rodents. Proc. Acad. Nat. Sci. Phila., 1877, pp. 314–318, 1 fig. in text. (Points out the fact that the greatest diameter is in the line of greatest stress and is correlated with increased use).

6—A dog with supernumerary toes. Proc. Acad. Nat. Sci., Phila., 1877, p. 321.

7—On the mechanical genesis of tooth forms. Proc. Acad. Nat. Sci. Phila., 1878, pp. 45–80, 11 figs. in text. (This paper points out for the first time the correlation existing between the forms of the crowns of the teeth in the various groups of mammalia and the manner and direction in which the jaws are used to bring stress upon the teeth).

8—On *Polyxenes fasciculatus*. Proc. Acad. Nat. Sci. Phila., 1878, p. 223.

9—Description of a new species of *Smynthurus*. Proc. Acad. Nat. Sci. Phila., 1878, p. 335, 1 fig. in text. *Smynthurus quadrimaculatus* sp. nov.

10—On the form of the stapes in *Dipodomys*. Amer. Nat., 1878, p. 125.

11—On like mechanical (structural) conditions as producing like morphological effects. Amer. Nat., 1878, pp. 157–160.

12—Discovery of two remarkable genera of minute myriapods in Fairmount Park (*Polyxenes* and *Pauropus*). Amer. Nat., 1878, pp. 557–558.

13—Bees gathering honey from the *Catalpa*. Amer. Nat., 1879, p. 648.

14—A monstrous frog. Amer. Nat., 1878, pp. 751–752.

15—The mechanical genesis of tooth forms. Dental Cosmos, XX, 1878, pp. 465–472. Abstract by Dr. C. N. Pierce of "On the mechanical genesis of tooth forms." Proceedings of the Academy of Natural Sciences of Philadelphia, 1878, pp. 45–80, 3 figs.

16—Addenda to etiological views expressed in a paper "On the mechanical genesis of tooth forms." Dental Cosmos, XX, 1878, pp. 472–474.

17—The gigantic extinct armadillos and their peculiarities, with a restoration. Popular Science Monthly, XIII, 1878, pp. 139–145, 4 figs. in text. (Discusses the mechanical genesis, degeneration and coalescence of vertebral centra).

18—Morphological notes on the limbs of the Amphiumidæ as indicating a possible synonymy of the supposed genera. Proc. Acad. Nat. Sci. Phila., 1879, pp. 14–15. (Points out the variation in the number of digits in the same specimen, rendering the genus *Murænopsis* untenable).

19—Further notes on the mechanical genesis of tooth forms. Proc. Acad. Nat. Sci. Phila., 1879, pp. 47–51, 1 fig. in text.

20—Notice of a new pauropod. Proc. Acad. Nat. Sci. Phila., 1879, p. 139.

21—Description of a new species of *Chirocephalus*. Proc. Acad. Nat. Sci. Phila., 1879, pp. 148–149, 3 figs. in text. (*Chirocephalus holmanii* sp. nov.).

22—Honey glands on *Catalpa* leaves. Proc. Acad. Nat. Sci. Phila., 1879, p. 161.

23—The larva of *Eurypauropus spinosus*. Proc. Acad. Nat. Sci., 1879, p. 164.

24—Description of a new branchipod. Proc. Acad. Nat. Sci. Phila., 1879, pp. 200–202, 1 fig. (*Streptocephalus sealii*, sp. nov.).

25—The gemmule vs. the plastidule as the ultimate physical unit of living matter. Amer. Nat., 1879, pp. 12–20.

26—On the origin of bilateral symmetry and the numerous segments of the soft rays of fishes. Amer. Nat., 1879, pp. 41–43.

27—Ryder on the mechanical genesis of tooth forms. Amer. Nat., 1879, pp. 446–449. (Abstract with comments by Prof. E. D. Cope, of "On the mechanical genesis of tooth forms." Proc. Acad. Nat. Sci. Phila., 1878, pp. 45–80. And "Further notes on the mechanical genesis of tooth forms." Loc. cit., 1879, pp. 47–51).

28—On the destructive nature of the boring sponge, with observations on its gemmules or eggs. Amer. Nat., 1879, pp. 279–283.

29—Strange habitat of a barnacle on a garpike. Amer. Nat., 1879, p. 453. (*Platylepas decorata* Darw. on *Lepidosteus*).

30—An account of a new genus of minute pauropod myriapods (*Eurypauropus spinosus*). Amer. Nat., 1879, pp. 603–612, 1 pl. and 2 figs. in text. (Eurypauropodidæ, fam. nob. *Eurypauropus spinosus* gen. et. sp. nov.).

31—Successive appearance of *Chirocephalus* and *Streptocephalus* in the same pond. Amer. Nat., 1879, p. 703.

32—A third locality for *Eurypauropus*. Amer. Nat., 1879, pp. 703–704.

33—A probable new species of *Phytoptus* or Gall-mite. Amer. Nat., 1879, pp. 704–705, 1 fig. in text.

34—The psorosperms found in *Aphredoderus sayanus*. Amer. Nat., 1880, pp. 211–212, 6 figs. in text.

35—*Scolopendrella* as the type of a new order of articulates. Amer. Nat., 1880, pp. 375–376 (Symphyla).

36—Note on a larval *Lithobius*-like myriapod. Amer. Nat., 1880, p 376.

37—*Trichopetalum*. Amer. Nat., 1880, p. 376.

38—*Ichthydium ocellatum*. Amer. Nat., 1880, p. 674.

39—On the course of the intestine in the oyster. Amer. Nat., 1880, pp. 674–675.

40—Phosphorescence of very young fishes. Amer. Nat., 1880, p. 675.

41—On the occurrence of *Freia producta* Wright in the Chesapeake Bay. Amer. Nat., 1880, pp. 810–811.

42—*Rhipidodendron splendidum*. Amer. Nat., 1880, p. 811. (The first notice of this monad in American fresh-waters).

43—A pale variety of *Polyxenes fasciculatus*. Amer. Nat., 1880, pp. 811–812.

44—On *Camaraphysema*, a new type of sponge. Proc. U. S. Nat. Mus., III, 1880, pp. 269–272, 1 pl. (*Camaraphysema obscura* gen. et sp. nov.).

45—List of the North American species of myriapods belonging to the family of the Lysiopetalidae, with a description of a blind form from Luray Cave, Virginia. Proc. U. S. Nat. Mus., III, 1880, pp. 524–529. (Describes *Zygonopus whitei*, gen. et sp. nov.).

46—The structure, affinities and species of *Scolopendrella*. Proc. Acad. Nat. Sci. Phila., 1881, pp. 79–86, 2 figs. in text. (*Scolopendrella gratiae* sp. nov.).

47—Occurrence of the same species of Protozoon on both sides of the Atlantic. Proc. Acad. Nat. Sci. Phila., 1881, pp. 442–443. (The first record of the occurrence of *Licnophora cohnii* Clap. on the west side of the Atlantic).

48—A valuable edible Mollusk of the West Coast. Bull. U. S. Fish Comm., 1, 1881, p. 21.

49—Preliminary notice of the more important scientific results obtained from a study of the embryology of Fishes. Bull. U. S. Fish Comm., 1, 1881, pp. 22–23.

50—Notes on the development, spinning habits and structure of the four-spined stickleback (*Apeltes quadracus*). Bull. U. S. Fish Comm., 1, 1881, p. 24–29. (Points out the existence of a pouch in the male which supplies a viscid material to be drawn out into threads which are wound around plants to form a nest. This paper gives the first intimation of the true source of the material of which nests of the Gasterosteidae are woven).

51—Development of the spanish mackerel (*Cybium maculatum*). Bull. U.S. Fish. Comm., 1, 1881, pp. 135–172, 4 pls.

52—On the retardation of the development of the ova of the shad (*Alosa sapidissima*), with observations on the egg fungus and bacteria. Bull. U. S. Fish Comm., 1, 1881, pp. 177–190. Including an appendix on the histological rationale of retardation, also in Rep. U. S. Comm. Fish and Fisheries, 1881, pp. 795–811. (2d ed. revised).

53—A contribution to the development and morphology of the lophibranchiates (*Hippocampus antiquorum*, the sea-horse). Bull. U. S. Fish Comm., 1, 1881, pp. 191–199, 1 pl.

54—The micropyle of the egg of the white perch. Bull. U. S. Fish Comm., 1, 1881, p. 282.

55—Development of the silver gar (*Belone longirostris*), with observations on the genesis of the blood in embryo fishes, and a comparison of fish ova with those of other vertebrates. Bull. U. S. Fish Comm., 1, 1881, pp. 283–301, 3 pls.

56—On the nuclear cleavage-figures developed during the segmentation of the germinal disk of the egg of the salmon. Bull. U. S. Fish Comm., 1, 1881, pp. 335–339, 1 pl.

57—Notes on the breeding, food and green color of the oyster. Bull. U. S. Fish Comm., 1, 1881, pp. 403–419.

58—Additional observations on the retardation of the development of the ova of the shad. Bull. U. S. Fish Comm., 1, 1881, pp. 422–424.

59—The protozoa and protophytes considered as the primary or indirect source of the food of fishes. Bull. U. S. Fish Comm., 1, 1881, pp. 236–251; and Rep. U. S. Comm. Fish and Fisheries, 1881, pp. 755–770. (2d ed. revised).

60—Notes on some of the early stages of development of the clam, or mannanose (*Mya arenaria* Linn.). Report of T. B. Ferguson, a Commissioner of Fisheries of Maryland, for 1881, pp. 81–91, 11 figs.

61—An account of experiments in oyster-culture and observations relating thereto, made at St. Jerome's Creek, Md., during the summer of 1880. Report of T. B. Ferguson, a Commissioner of Fisheries of Maryland for 1881, 15 figs. in text. Appendix A., pp. 1–64 and 76–80 (First Series).

62—Structure and ovarian incubation of the top minnow (*Zygonectes*). Forest and Stream, Aug. 18, 1881. (The species was afterwards determined to be *Gambusia patruelis*, and the subject was treated of more fully in No. 65 of this bibliography).

63—Incubation of shad eggs in brackish or sea-water. Sea-world, Fishing Gazette and Packer's Journal, Wednesday, Oct. 12, 1881.

64—Observations on the species of planarians parasitic on *Limulus*. Amer. Nat., 1882, pp. 48–51, 10 figs. in text, of egg-capsules, embryos and adult.

65—Structure and ovarian incubation of *Gambusia patruelis*, a top-minnow. Amer. Nat., 1882, pp. 109–118. (Describes the

mode of viviparous development of the species and points out the early absence of an egg membrane and the existence of an opening in the ovarian follicle comparable to a micropyle).

66—Additional note on the egg-cases of planarians ectoparasitic on *Limulus*. Amer. Nat., 1882, p. 142–143.

67—Synopsis of the Scolopendrellidae. Proc. U. S. Nat. Mus., V, 1882, p. 234. Old genus *Scolopendrella* subdivided into 1. *Scutigerella* gen. nov. sp. 1, *S. gratiae* Ryder; sp. 2, *S. immacalata* Newport. 2. *Scolopendrella* Gerv. sp. 1, *microcalpa* Muhr; sp. 2, *notacantha* Gerv.

68—A contribution to the embryography of osseous fishes, with special reference to the development of the cod, *Gadus morrhua*. Rep. of U. S. Comm. of Fish and Fisheries, 1882, pp. 455–605, 12 plates, 11 figs. in text.

69—Preliminary notice on some points in the minute anatomy of the oyster. Bull. U. S. Fish Comm., II, 1882, pp. 135–137. (Points out the almost complete absence of connective tissues in the body-mass of the young "spat").

70—Observations on the absorption of the yelk, the food, feeding and development of embryo fishes, comprising some investigations conducted at the Central Hatchery, Armory Building, Washington, D. C., in 1882. Bull. U. S. Fish Comm., II, 1882, pp. 179–205, 1 fig. in text.

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239—The development of *Patella*. Amer. Nat., 1886, pp. 563–564. (Review of paper by Dr. Wm. Patten).

240—Professor Selenka on the development of the opossum (*Didelphys virginiana*). Amer. Nat., 1886, pp. 394–396. (Translation from Biblog. Centralbl., V, No. 10, 1885, pp. 294–295).

241—The development of *Dentalium*. Amer. Nat., 1886, p. 565. (Review of paper by M. Kowalevsky).

242—The development of the Chitonidæ or Polyplacophora. Amer. Nat., 1886, pp. 565–567. (Review of paper by M. Kowalevsky).

243—The development of the gill in *Fasciolaria*. Amer. Nat., 1886, p. 567. (Review of paper by Dr. H. Leslie Osborn).

244—The early development of *Julus terrestris*. Amer. Nat., 1886, pp. 662–666. (Review of paper by F. G. Heathcoat, M. A.).

245—The development of *Agalena naevia*. Amer. Nat., 1886, pp. 666–667. (Review of paper by Wm. A. Locy).

246—Life-history of *Thalessema*. Amer. Nat., 1886, pp. 988–989. (Review of H. W. Conn's paper).

247—The formation of the eggs and development of rotifers. Amer. Nat., 1887, pp. 93–95. (Review of G. Tessin's paper).

248—The gestation of armadillos. Amer. Nat., 1887, pp. 95–96. (Review of von Ihering's paper).

249—The ventral suckers or sucking disks of the tadpoles of different genera of frogs and toads. Amer. Nat., 1887, pp. 263–264. (From Dr. Ryder's notes. Citation not found).

250—Haddon's "Introduction to the Study of Embryology." Amer. Nat., 1887, pp. 292–293.

251—Development of the carnivora. Amer. Nat., 1887, pp. 394–396. (Review of A. Fleischmann's work).

252—Suggestion respecting the epiblastic origin of the segmental duct. Amer. Nat., 1887, pp. 587–590. (Review of Prof. A. C. Haddon's paper).

253—The development of an eight-limbed vertebrate. Amer. Nat., 1887, pp. 862–863. (Review of S. Watase's paper.)

254—Spermatogenesis in mammalia. Amer. Nat., 1887, pp. 946–948. (Review of paper by Dr. Carl Benda).

255—Development of the Coecilians. Amer. Nat., 1887, pp. 1035–1036. (Review of work of Messrs. Sarasin).

256—The origin of the segmental duct in elasmobranchs. Amer. Nat., 1887, p. 1037. (Notice of Dr. Beard's work).

257—Rudiments of true calcified teeth in the young of *Ornithorhynchus*. Amer. Nat., 1888, pp. 368–369. (Review of paper by E. B. Poulton).

258—The ectoblastic origin of the Wolffian duct in the chelonia. Amer. Nat., 1888, p. 369. (Notice of paper by M. Mitsukuri).

259—Origin of the Wolffian duct in lacertilia. Amer. Nat., 1888, p. 369. (Notice of paper by J. von Perenyi).

260—The origin of the mammæ. Amer. Nat., 1888, p. 370. (Note upon investigations of W. Haacke).

261—The several functions of the enamel organ in the development of the teeth of mammals, and on the inheritance of mutilations. Amer. Nat., 1888, pp. 547–550. (Review of researches of von Brunn et al).

262—Researches upon the development of *Comatula*. Amer. Nat., 1888, pp. 657–659. (Review of paper by Barrois).

263—Observations on the development of cephalopods. Amer. Nat., 1888, pp. 754–755. (Review of S. Watase's paper).

264—On the development of the calcareous plates of *Asterias*. Amer. Nat., 1888, p. 755. (Note on J. Walter Fewkes' work).

265—The value in classification of the stages of growth and decline with proposals for a new nomenclature. Amer. Nat., 1888, p. 755. (Note on A. Hyatt's paper).

266—Development of the sea-bass (*Serranus atrarius*). Amer. Nat., 1888, p. 755. (Note).

267—On the primary segmentation of the germ-band of insects. Amer. Nat., 1888, pp. 941–942. (Review of Veit Graber's work).

268—Development of the peripheral nervous system of vertebrates. Amer. Nat., 1888, pp. 1132–1134. (Review of Dr. Beard's work).

269—A new atlas of embryology. Amer. Nat., 1888, p. 1134–1135. (Review of M. Duval's work).

270—New studies of the human embryo. Amer. Nat., 1889, pp. 171–172. (Review of work of M. C. Phisalix).

271—On the development and first traces of the anterior roots of the spinal nerves in selachians. Amer. Nat., 1889, pp. 172–173. (Review of Dohrn's paper).

272—The maturation and fertilization of the egg of *Petromyzon planeri*. Amer. Nat., 1889, p. 173. (Review of A. A. Böhm's paper).

273—The structure of the human spermatozoon. Amer. Nat., 1889, pp. 183–184 (Vol. irregularly paged). (Review of E. M. Nelson's paper).

274—Development of *Crangon vulgaris*. Amer. Nat., 1889, pp. 737–738. (Review of J. W. Kingsley's paper).

275—Development of *Sepia officinalis*. Amer. Nat., 1889, p. 738. (Review of M. L. Vialleton's paper).

276—Extra-ovarian primordial ova in the human embryo. Amer. Nat., 1889, p. 827. (Review of W. Nagel's paper).

277—Placentation of the hedgehog and the phylogeny of the placenta. Amer. Nat., 1890, pp. 376–378. (Review of Hubrecht's paper).

278—"A theory of development and heredity," by Henry D. Orr. Amer. Nat., 1894, pp. 154–156. (Review).

SUMMARY OF NEW LIBERIAN POLYDESMOIDEA.

BY O. F. COOK.

In a preceding paper[1] on the diplopod fauna of Liberia several new species and genera were referred to, of which a list is here given together with such additional diagnostic characters as may be necessary for the separation of the various forms from the territory explored. Extended descriptions and plates are in preparation.

Ammodesmus granum.

Locality, Mt. Coffee, a cluster of hills in western Liberia, reaching an altitude of about 300 feet, and covered with dense forest. A large part of the other forms were collected in the same vicinity, all except those of which other localities are specified.

Cenchrodesmus volutus.

Length about 2 mm., width .65 mm.

Campodesmus carbonarius.

Surface of head and segments covered with rough granules; first segment scarcely broader than the head, with three transverse rows of coarse tubercles; second segment broadest of all; segments with a cluster of three large tubercles on each side of the middle, five smaller scattered tubercles on each side of these, and three tubercles on each of the very broad, decurved carinæ; last segment not concealed, rounded at apex, with three broad, blunt, setigerous tubercles on each lateral edge; preanal scale with two long smooth setigerous papillæ. Length of male 29 mm., width 5.25 mm.; length of female 32 mm., width 6.5 mm.

Tropidesmus jugosus.

Generally similar to the preceding, except that the segments are dorsally ornamented with two transverse rows, each of six short longitudinal carinæ; also the tubercles of the preanal scale are short, not papilliform. Length 28 mm., width 5 mm.; locality Mt. Coffee and vicinity; much rarer than *Campodesmus,* and more inclined to burrow in the ground.

[1] A New Diplopod Fauna in Liberia. American Naturalist, xxx, pp. 413–420, 1896.

Comodesmus lanatus.

Antennæ distinctly clavate; last segment decurved, the immediate apex small, projecting, truncate; lateral carinæ present only as a longitudinal row of large tubercles, above which the tubercles are gradually smaller; length 8 mm., width 1 mm.

Thelydesmus dispar.

Antennæ distinctly clavate; first segment nearly as wide as the second, scarcely concealing the head in front; segments with four regular transverse rows of conic piliferous granules; carinæ moderately broad, somewhat narrowed toward the margin, coarsely dentate all around by reason of the prominent granules, the largest of which is located at posterior corner; last segment triangular in outline, the edges dentate with setiferous tubercles, the apex narrow, with a small tubercle; females nearly black above, 18 mm. long, 3.25 mm. broad; males quite black above, less convex and more slender than the female, and with proportionately broader carinæ; length of male 15 mm., width 2.75 mm.; locality, Mt. Coffee; females not rare.

Discodesmus senex.

Smaller and more slender than *Comodesmus;* dorsum densely granular-tuberculate, the prominences subequal in size and setiferous; lateral carinæ nearly wanting, the segments slightly thicker at the sides and with larger tubercles; repugnatorial pore located above the lateral row of tubercles; color white.

Prepodesmus tigrinus.

This and its congeners have the copulatory legs with a large needle-like straight or slightly curved spine from the ventral or median face. The present species has the anterior margin of the first segment, the anterior lateral apices of the second and third segments, and the carinæ, or at least the posterior part of the carinæ of poriferous segments bright yellow, with the remainder of the body black; legs and antennæ reddish-yellow; length of female 42 mm., width 5 mm.; antennæ and longest legs 9 mm.; males distinctly smaller.

Prepodesmus mimus.

Of the same form and size, but with the anterior margin of the first segment, the carinæ of the second and third, and the whole posterior subsegments of the poriferous segments bright red; legs and antennæ reddish; locality, Muhlenburg Mission.

Tylodesmus crassipes.

Color entirely black, legs and antennæ yellowish; copulatory legs without the spine present in *Prepodesmus*, and with the interior lamina broad and flabellate; anterior male legs slightly, though distinctly, crassate; length of male 40 mm., width 4.5 mm.; length of female 43 mm.; width 5.6 mm.

Tylodesmus amœbus.

Anterior half of first segment, the carinæ of the second and third, and the whole of the poriferous segments, except the last two or three, bright red; the remainder of the body is black; legs and antennæ pale; legs of both sexes distinctly more slender than in the preceding species; sexes not strikingly unequal, though the male is more slender and has somewhat longer legs; length 35 mm., width of male, 4 mm., of female, 4.5 mm.; locality, Muhlenburg Mission. The color of this species is almost exactly that of *Prepodesmus mimus.*

Lyrodesmus nigerrimus.

The genus is evidently related to the last, and has a closely similar copulatory foot; it is distinct in being more slender and depressed, and in having the first segment lenticular or fusiform in outline, rather than hemispheric-elliptical as in the two preceding genera. The species is deep, shining black, including the legs and antennæ; length of male 35 mm., width 4 mm., legs 6 mm., antennæ 8 mm. in length. Very rare, only two specimens found. A third, nearly white in color and somewhat different in form, may prove to be specifically distinct.

Cheirodesmus ater.

First segment as in *Lyrodesmus*, but the angles not so pointed; body more slender, narrower, dorsum flat; carinæ with square corners, so that the poriferous callus projects from a nearly straight edge; copulatory legs less complicated, the slender branch shorter; color uniform black, legs and antennæ yellowish; length 30 mm.; width 3.75 mm.

Cheirodesmus discolor.

Similar to the preceding in size and form, but distinct at least in color; an area around each pore, and a moderately broad median line, yellow; legs and antennæ reddish-yellow; rare, only one pair taken, near Muhlenburg Mission.

Anisodesmus cerasinus.

Perhaps doubtfully distinct from *A. erythropus* (Lucas) in the greater size and lighter color, all the specimens from the interior differing thus from individuals collected at Monrovia. Length 41 mm., width of male 5.5, of female 6.5 mm. The length of what I have identified as *erythropus* is about 35 mm. The species can, however, hardly be determined with confidence from Lucas' description. Both forms are very beautiful in life, deep wine-color, with bright cherry-pink legs.

Isodesmus immarginatus.

Resembles *Lyrodesmus* and *Cheirodesmus*, but is distinctly broader than either, and distinct from all the related forms in the absence of a distinct poriferous callus, the margin being sinuate. Legs and antennæ more slender than in *Anisodesmus*, but less so than in *Lyrodesmus* and *Cheirodesmus*. Color uniform black, the antennæ and apical joints of the legs also dark. Copulatory legs also very distinct in that the outer ramus is broad and bifid, while the inner is trifid, giving five distal divisions. Length 42 mm., width 5 mm.

Isodesmus interruptus.

Is somewhat larger than the above and has the carinæ of the poriferous segments pale yellow. It is known from a female specimen only.

Oxydesmus medius.

Black or very dark vinous; carinæ concolorous; legs and antennæ also dark; length 52–66 mm., width 10–12 mm.

Oxydesmus liber.

Dark chocolate-brown to black; ends of the carinæ, especially the submarginal ridge, yellow or orange; antennæ and legs light yellow or orange; length 68–80 mm., width 12–13 mm.

Bactrodesmus claviger.

Antennæ very long and slender, clavate, sixth joint longest, scarcely exceeding the third; dorsum much as in *Polydesmus*, with three rows of scattering tubercles, each with a large clubbed hair; pores dorsal, of the usual arrangement; penultimate segment toothed behind; first legs reduced, the second greatly enlarged, especially the penultimate joint; last joint curved; claw very short, broad; copulatory legs with the basal joint much enlarged, galeate, containing the apical joint when at rest; length 7 mm., width 1 mm.

Pterodesmus brownellii.

Last segment exceeded and included by the penultimate, the posterior sinus of which is nearly square, longer than broad; copulatory legs excised at apex, the posterior lobe longer, laterally excised, the anterior broad, with three or four short teeth; length 28 mm., width 7 mm.

Gypsodesmus pruinosus.

Dorsum very flat, the carinæ curved gently upward toward the posterior corners, and as high as the middle of the segments; last segment subequal to the penultimate in length, the sinus of the latter broader, the sides diverging; copulatory legs with the dorsal ramus long, strongly decurved and turned mesad; length 16 mm., width 4 mm.

Lampodesmus volvatus.

Dorsum distinctly convex, the carinæ slightly decurved, nearly in the direction of the dorsal arch; last segment and copulatory legs somewhat as in *Gypsodesmus;* male legs crassate, especially the anterior; two large and conspicuous processes from the sternum of the sixth legs of males; length 24 mm., width 5.7 mm.

Compsodesmus pulcher.

About as convex as the last, but the sides sloping more directly from the middle; no processes from the sixth segment; male legs scarcely crassate; copulatory legs very simple, apically somewhat cup-shaped; penultimate segment with sinus broader; length 24.5 mm., width 6.5 mm.

Choridesmus citus.

Last segment nearly or quite concealed under the penultimate; length 5.5 mm., width 1.5 mm.

Scolodesmus grallator.

Dark vinous, a narrow, poorly-defined median spot on each posterior subsegment, giving the effect of a pale median line; legs and antennæ pinkish or yellowish; length 28 mm., width 2.5 mm., the first segment as broad as any, the other anterior segments distinctly narrower; locality, Monrovia.

Habrodesmus lætus.

Length of male 27 mm., width 2 mm.; width of female 3 mm.

Stylodesmus horridus.

Length 10 mm., width 3.2 mm.; the processes of the seventeenth and eighteenth segments project far behind the nineteenth, which has neither process nor pores. The first and eighteenth segments have the processes united for more than half their length.

Udodesmus telluster.

Length 8.5 mm., width 1.25 mm.; penultimate segment projecting beyond the last, but not exceeded by the processes of the eighteenth, which are not coalesced; processes trituberculate at apex; first segment with two large processes, and four large lobes in front, the median notch large, deep, rounded.

Hercodesmus aureus.

Length 6.75 mm., width .75 mm.; last segment exceeded by the penultimate; processes replaced by longitudinal ridges; carinæ very narrow; first segment with margin very faintly lobed.

Stiodesmus stratus.

Length 10 mm., width 1.4 mm.; last segment not concealed; first segment not lobed, but, like the rest of the dorsal surface, beset with rounded granules or tubercles. The affinities of this form are somewhat obscure. The general appearance and sculpture suggest *Comodesmus*, but the form of the first and last segments and the structure and location of the pores are very different. It may prove to be one of the *Cryptodesmidæ*, in the sense of being more nearly related to *Cryptodesmus olfersii* than to the other species which have been described under that much over-worked generic name.

RELATED FORMS NOT FOUND IN LIBERIA.

Xyodesmus planus.

Related to *Thelydesmus*, but distinctly more depressed, especially the male. Last segment broad at apex and with a large, conic, marginal tubercle on each side nearly equalling the apex; dorsum densely beset with conic tubercles; carinæ broad, dentate, with numerous pointed-conic tubercles; antennæ scarcely clavate; head not concealed; first segment narrower than the second; sterna granulate, especially in the female; color nearly black; length 21 mm., width of male 3.75 mm.; of female 4 mm.; locality, Bismarckburg, Togo Colony, Dr. K. Büttner; Berlin Museum.

Helodesmus porosus.

Related to *Comodesmus* rather than to the other families, but with remarkable differences. First segment widest, concealing the head; body tapering caudad, subcylindric, not coiled into a spiral; dorsum very convex, rough with low granules, and incrusted with earth;

pores with distinct raised rims, located far above the slightly prominent carinæ of segments 5, 7–17; antennæ and legs very short and stout; copulatory legs of two simple, equal processes; segments of adult 19; color above black, below white; length of female 4 mm.; width .6 mm.; locality, mountains of Western Java, 8,000 feet. This species may be considered the type of a new family, *Helodesmidæ.*

Prepodesmus pictus.

Suggesting *P. tigrinus*, but the yellow areas of that species are here bright pink; legs and antennæ very dark reddish; length of male 45 mm., width 5.5 mm.; locality, Togo Colony; numerous specimens in the Berlin Museum.

Anisodesmus konakri.

Nearly black, margins of all carinæ yellowish; legs and antennæ pinkish, rather pale; dorsum less convex than in *A. cerasinus*, and the posterior corners of the carinæ less strongly dentate; copulatory legs not expanded at apex, but bent together at a right angle; locality Konakri, French Gambia, where I collected a pair of mature individuals, January, 1896.

Anisodesmus gracilis.

Very distinct from the Liberian species in the smaller and more slender body, and light pinkish color. Copulatory legs similar in form to the other species, but much more slender apically; length of male 27 mm., width 3.25 mm.; locality, Bismarckburg, Togo Colony, Dr. K. Büttner; Berlin Museum.

Lipodesmus sublævis.

Legs and antennæ moderately long; segments faintly granular or longitudinally rugulose toward the posterior margin; pores located on a distinct marginal callus projecting from about the middle of anterior and middle segments; in front of the callus is a distinct notch and tooth; posterior corner of anterior segments square, acute on posterior; copulatory legs rather robust, a spiniform process rising from each side of the ungual portion and curved cephalad (dorsad); length of male about 28 mm., width 3.8 mm.; locality, Karewia, East Africa, Stuhlmann; two male specimens in the Berlin Museum.

Scytodesmus kribi.

Dorsum roughened with five or six irregular rows of close-set distinct granules; submarginal ridge and last segment as in *Oxydesmus*; copulatory legs not flexed and inserted under the edge of the aperture, but constructed somewhat as in *Oxydesmus;* length 50 mm., width 9 mm.; locality, Kribi, German Colony of Kamerun; a male specimen collected by Morgen is in the Berlin Museum.

Mimodesmus parallelus.

Vertex and dorsal surface smooth or faintly coriaceous, with neither granules, tubercles nor areas; posterior subsegments without a transverse furrow or depression; pores situated in the outer slope of the submarginal ridge, as in *Oxydesmus;* last segment much as in *Oxydesmus*, but the tubercles obsolete; anterior male legs distinctly crassate; copulatory legs long and twisted, apically recurved against the ventral surface of the segment; color a dull brown, with the submarginal ridges and a large spot in the middle of each posterior subsegment, yellowish; length 46 mm., width 6.5 mm.; locality, Karewia, East Africa, Stuhlmann; Berlin Museum.

Plagiodesmus obliquus.

Probably allied to and perhaps identical with *Stenonia occidentalis* Karsch, described from Quango. Distinct from the species of *Oxydesmus* by the very oblique submarginal ridges, which are wide and not prominent about the pores; copulatory legs long and somewhat twisted, not inserted under the edge of the aperture as in *Oxydesmus;* color dark vinous, nearly black; length about 75 mm., width 13 mm.; locality, Congo Valley; a few specimens in the British Museum.

Compsodesmus perlatus.

Length about 20 mm., width 7.5 mm., without the carinæ 2.3 mm.; color dark brown, marked with transparent radiating lines as in the other species of the present family; copulatory legs distally cupulate, the posterior rim produced caudad into a strong curved spine; locality, Kamerun hinterland; a male specimen collected by Zenker is in the Berlin Museum.

Tanydesmus ordinatus.

This genus is related to *Lampodesmus* and the allied Liberian forms, as previously noted. Dorsal areas arranged in three distinct transverse rows; pores distinct, of the usual formula, near the anterior edge of the carinæ, remote from the lateral margin; penultimate segment subequal with the last, the sinus rather broad, the sides distinctly diverging caudad; color in alcohol uniform light reddish-brown; length of male 19 mm., width 4.5 mm.; female 22 mm. by 5 mm.; locality, Togo Colony; several specimens in the Berlin Museum.

Scolodesmus securis.

Smaller and more slender than *S. grallator;* of the same color, but without a lighter median line or row of spots; sternum of fourth pair of legs with a large process more deeply bilobed than *S. grallator;* copulatory legs longer and more slender, reaching to the fourth segment, in general form like those of *S. grallator;* above the middle a curved acicular process projects from each, and the apices of the two lie in contact; apical portion gently curved mesad and pointed, with a large process from the inner side with a straight inner edge, its corners produced proximad and distad, suggesting the blade of a Roman axe; length of male 18 mm., width 1.6 mm; locality, Togo Coast; a male and a female in the Berlin Museum.

Habrodesmus falx.

Closely resembling *H. lætus* in size and form, differing in that the copulatory legs end in a broad, obliquely truncate lamina with a small transparent process from near the middle of the apical edge. In *H. lætus* the distal extremity is slender and curved, with two small teeth below the apex, so that the apical sinus is shaped like the figure 3. Color in alcohol, brown or black; the margins of the first, the posterior margins of the other segments, the ventral surface and legs, whitish; antennæ dark; several specimens from Togo are in the Berlin Museum. A label states that the legs are (in life) pinkish-red; a female specimen is slightly larger and more robust than the female of *H. lætus.*

Napodesmus costatus.

Differing from *Udodesmus,* to which it is nearest related, in the more depressed body, the thin margins of the carinæ, and the four, fine, slightly elevated, dorsal longitudinal ridges or carinæ, scarcely separated into their component tubercles; surface rough, uneven, and finely setose, incrusted with earth, but without distinct tubercles; pores located at the posterior corners of segments 5, 7, 9, 10, 12, 13, 15–18, each surrounded by a frill of short, fine hairs; first segment with numerous large conic processes, anteriorly with four large subequal lobes, each of which is incised along the margin, the median with two incisions, the lateral with one; penultimate segment considerably exceeding and completely concealing the last; lobed at the sides, and slightly so at apex; length 6 mm., width 1.1 mm.; locality, the forests of Western Liberia, along creeks and rivers; rare.

Pelodesmus fossor.

Differing from *Udodesmus* in the more robust body, the squarer and broader dorsum, and the more prominent and stronger dorsal processes arranged in two rows; each process distinctly bifid, instead of indistinctly trifid, directed obliquely cephalad. The first segment lacks the inner pair of large lobes, which are apparently replaced by a pair of anteriorly directed large processes similar to those of the other segments; last segment much as in *Udodesmus.* Surface thickly incrusted with earth; length 7.5 mm., width 1.5 mm.; locality, Freetown, Sierra Leone, under stones in a moist, shaded place.

Stegodesmus leonis.

A recently discovered genus evidently related to *Udodesmus*, but distinct by remarkable characters. First segment nearly as broad as any, much broader than the second, about twice as broad as long, strongly decurved, the anterior margin transverse, entire, decurved, completely concealing the head; antennæ distinctly clavate, geniculate; dorsum strongly arched, the carinæ depressed; surface finely roughened, ornamented with four longitudinal ridges, of which the part on each segment is apparently composed of three coalesced tubercles or granules; a deep median longitudinal sulcus, giving a resemblance to the *Platydesmidæ;* last segment completely concealed by the greatly produced median pair of ridges of the nineteenth, which is canaliculate and deeply bifid when viewed from above; pores on very distinct special papillæ of segments 5, 7, 9, 10, 12, 13, 15, 16; color pale pinkish, concealed by the adhering soil; length 5.5, width 1.1 mm.; a single female specimen was found under a stone in a moist place in Freetown, Sierra Leone, January, 1896.

Pronodesmus melas.

First segment completely concealing the head, the anterior margin faintly lobed or scalloped, the upper surface with a few scattered conic tubercles; segments with two conspicuous longitudinal ridges, the prominences of each segment composed of two tubercles somewhat coalesced at base; below these ridges there is on each side a row of three small tubercles on each segment; pores located near the posterior corner of the carinæ, opening dorsad on inconspicuous rounded prominences of segments 5, 7, 9, 10, 12, 13, 15–18; eighteenth segment with processes coalesced in the median line, the resulting protuberance projecting as far caudad as the apex of the last segment; nineteenth segment with distinct carinæ, the processes much smaller than on the eighteenth; last segment not concealed, apex very broad and rounded, dorsally rough like the other segments, two distinct notches on each side; color black, legs, antennæ, and anal valves, white; length 7 mm.; width 1.5 mm.; locality, Gede, West Java, 9,000 feet.

Myxodesmus lobatus.

With general resemblance to *Pronodesmus* and *Napodesmus*. Dorsum with four equal longitudinal rows, each of three conic tubercles on each segment; pores located as in *Pronodesmus*; lateral carinæ with three deep, narrow incisions, one in the lateral margin, two in the posterior, dividing the carinæ into three distinct lobes; tubercles of the caudal segments not larger than those of the others; last segment apically broad, entire, exposed; color black above, antennæ, legs and anal valves white; length 4.5 mm., width .9 mm.; locality, Gœnœng Filœ, West Java, at an altitude of 8,000 feet.

Cynedesmus formicola.

First segment clypeate, concealing the head, the surface covered with rounded granules of different sizes, the anterior margin thin, flattened, forming a projecting horizontal rim; segments covered with rounded granules somewhat regularly arranged, and with four equal longitudinal rows of three larger granules on each segment; pores much as in *Stegodesmus*, on a special process from the poste-corner of the areate carinæ of segments 5, 7, 9, 10, 12, 13, 15, 16; last segment large, broad and rounded at apex, with six small lobes or scallops; color pinkish-brown, with fine black points; length 7 mm., width 1.25 mm.; locality, Grand Canary, in the nests of ants, at Telde and at Guia.

May 5.

The President, Samuel G. Dixon, M. D., in the Chair.

Forty-five persons present.

May 12.

The President, Samuel G. Dixon, M. D., in the Chair.

Thirty-three persons present.

A paper entitled "Remarks on Filaria," by Fred'k P. Henry, M.D., was presented for publication.

May 19.

The President, Samuel G. Dixon, M. D., in the Chair.

Ninety-eight persons present.

A paper entitled "The Planktonokrit, a Centrifugal Apparatus for the Volumetric Estimation of the Food-Supply of Oysters and other Aquatic Animals," by Charles S. Dolley, M. D., was presented for publication.

Specimens of mammals, birds, reptiles, fishes, insects and mollusks collected in western Somali Land and the Galla Country, northeastern Africa, by Dr. A. Donaldson Smith, were presented to the Academy and commented on by Messrs. A. E. Brown, A. Donaldson Smith, Samuel N. Rhoads, Witmer Stone, Henry Skinner, William J. Fox and H. A. Pilsbry. (No abstract).

May 26.

The President, Samuel G. Dixon, M. D., in the Chair.

Twenty-nine persons present.

A paper entitled "Catalogue of the Species of Cerion, with Descriptions of New Forms," by H. A. Pilsbry and E. G. Vanatta, was presented for publication.

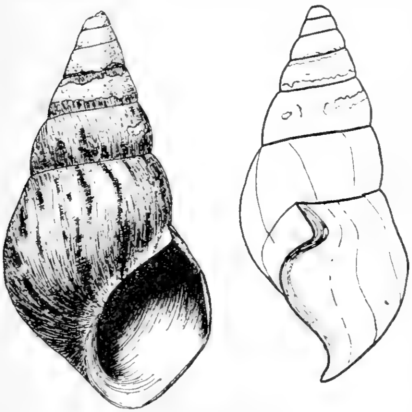
The death of Auguste Sallé, a correspondent, May 5, 1896, was announced.

The following were ordered to be printed :—

A REMARKABLE CENTRAL AMERICAN MELANIAN.

BY H. A. PILSBRY.

Some months ago Dr. Wm. H. Dall sent to the writer for comparison with the series in the collection of the Academy of Natural Sciences of Philadelphia, a peculiar *Pachycheilus* from Central America which he believed to be undescribed. The specimen proved to be totally different from anything yet made known, and may be briefly characterized as a species of the *Pachycheilus lævissimus* group, with the aperture characters resembling the genus *Melanatria* of Madagascar.



Pachycheilus Dalli.

It is about equally similar to *P. lævissimus* var. *indorum* Morelet and *P. chrysalis* Brot, having the short aperture of the former, and the color-tone and robust growth of the latter; but it is a stouter shell in figure than either, with the last whorl decidedly more convex. The operculum is like that of other species of *Pachycheilus.*

Pachycheilus Dalli n. sp.[1]

Shell ovate turreted, solid, dusky olivaceous-yellowish, with more or less distinct irregular and interrupted longitudinal black streaks. The surface is covered by a strong cuticle, beneath which the shell substance is white with livid stains; smooth to the naked eye, but showing fine, superficial growth-lines under the lens, cut by minutely wavy close spirals into a microscopic granulation, most noticeable near suture and base, but often almost obliterated on the body-whorl. Whorls numerous, but owing to erosion but 6 or 7 remain, the earlier ones nearly flat, last two or three convex.

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[1] See Science (n. ser.) III, p. 608, April 17, 1896. This is the species recorded as "*Pachycheilus walli*" in Zoologischer Anzeiger, No. 502, 4 Mai, 1896, foot of p. 223. It is an unfortunate typographical error, not traceable to the record as officially furnished by the Academy.

Aperture trapezoidal, white within, with livid brown or purplish tracts. Outer lip having a very deep rounded sinus a short distance below the suture, its outer portion then produced forward in a broad rounded lobe, retracted again on the lower outer portion, and produced in a more or less prominent narrow lobe at base. Columella concave; parietal wall covered by a transparent film, with a slight callus developed near the posterior angle of the aperture.

Alt. 52, diam. 25 mm. Alt. 54, diam. 27 mm. Alt. 53, diam. 28 mm.

Described from four adult and four young specimens in collection of the Academy of Natural Sciences of Philadelphia, and one adult in collection of the United States National Museum. The latter specimen, having suffered least erosion, is figured.

The peculiar sinuousity of the lip is strictly an adult character. In most specimens it is not perceptible a half whorl back from the lip-edge, although in the last of those measured above, the sigmoid contour is seen in the growth lines almost a full whorl back. Four young specimens examined have the lip hardly more bent than in the ordinary *Pachycheili.*

The altitude given above is, of course, measured on decollate specimens. A young shell 52 mm. high has 7 whorls left; one measuring 33 mm. high has 7½, and probably has lost about 1½.

Specimens subsequently received from Dall, collected by Dr. Spear in Tehuantepec, are dark chestnut colored, with traces of darker streaks, and the sinuation of the lip is somewhat less deep than in the types. The columella is brown. One very old specimen approaches a cylindrical form, measuring, in its truncated condition, alt. 51, diam. of last whorl 27, diam. of the truncated top 16 mm. Somewhat less than three whorls are left.

REMARKS ON FILARIA.

BY FREDERICK P. HENRY, M. D.

The case which is the basis of my remarks belongs to one of a group of diseases included under the generic term "filariasis," by which is understood an affection caused by one or other species of *Filaria.* This parasite is by no means rare in the lower animals, especially in the dog, but I will confine my remarks to those Filariæ which infest the blood of man. Of these, three species are universally recognized: (1) *Filaria sanguinis hominis nocturna*, (2) *Filaria sanguinis hominis diurna*, (3)*Filaria perstans.* This classification is based upon the habits of the filarial embryos, the first species being found in the superficial vessels solely or chiefly during the night; the second solely or chiefly during the day, while the third is constantly present in the cutaneous capillaries.

There is a fourth species recently discovered by Dr. Patrick Manson, formerly of Amoy, China, now of London, which he has modestly named *Filaria Demarquayi*, after Demarquay, the discoverer of *Filaria nocturna.*

Filaria diurna and *Filaria perstans* are confined thus far to the West of Africa and adjoining districts, while the *Filaria nocturna* is widely prevalent in the tropics and endemic in certain sections of the United States. The adults of *Filaria nocturna* have been frequently found; that of *Filaria perstans* never, so far as I have been able to ascertain. In the opinion of Manson the *Filaria loa* of the eye of the negro of Old Calabar is probably the adult form of the *Filaria diurna.* If it is not, he argues, then there must be another blood worm yet to be discovered, for the embryos of the *loa* must escape from the body of their host through the medium of the circulation. *Filaria perstans* has been practically proved by Manson to be the cause of the fatal "sleeping sickness" of the Congo region.

While engaged in the study of filariasis my attention was called by Dr. Charles A. Oliver of Philadelphia, to a remarkable case of *Filaria loa* recently reported by Dr. Argyll Robertson, the distinguished ophthalmologist of Edinburgh. The patient was a lady who had spent eight years in missionary work at Old Calabar on the West Coast of Africa. Without entering into the details of this most interesting case I will merely state that in two successive operations Dr. Robertson extracted two Filariæ (species *loa*) from the ocular tissues, the first a male the second a female. Both of these adult parasites are described by Manson in the course of Robertson's paper. The female was stuffed with embryos but repeated examinations of the blood failed to detect any embryonic Filariæ in that fluid. This fact seems to refute Dr. Manson's hypothesis that *Flaria loa* is the adult form of *Filaria diurna.*

The fact that the case on which my remarks are based is the first of the kind observed in Philadelphia justifies the publication of a life-history of the parasite, *Filaria nocturna*, which I found in the blood of my patient and of which living specimens are placed under the microscope. I wish, therefore, to emphasize the fact that Filariæ in the blood vessels are undeveloped, embryonic, and that they are the progeny of an adult, two or three inches long, which has its permanent abode in one of the lymphatic channels, probably the thoracic duct. Manson, observing the embryonic characters of the circulating Filariæ, came to the inevitable conclusion that they must reach a further stage of development outside of the body and, in all probability, in the interior of some blood-sucking animal. He naturally thought of the mosquito, an insect whose nocturnal blood-sucking habits seemed to render peculiarly fit to act the part of intermediary host. Without entering into details I will merely say that Manson's hypothesis was fully verified by experiment.

In the case of *Filaria diurna* it is conjectured that certain blood-sucking flies of Old Calabar known as Mangrove flies play the role of intermediary host.

The mode in which the embryos of *Filaria perstans* are supposed to escape from the human body is equally interesting, although it does not involve the agency of any blood-sucking insect. In the region in which *Filaria perstans* is endemic there prevails a skin disease called " craw-craw " attended with pustules, in the contents of which Filariæ have been found. It is supposed, with great probability, that the embryos escape with the rupture of the pustules and, in some as yet unexplained manner, although probably through the medium of drinking water, gain access to the human system in which one, or more, attain maturity. It must be confessed, however, that our knowledge of the life history of *Filaria perstans* and *Filaria diurna* is based more upon analogy than fact and that this will probably continue to be the case until some Manson takes residence in West Africa.

The presence of Filaria embryos in the blood does not necessarily give rise to disease, their transverse diameter ($\frac{1}{3500}$ inch) being as a rule such as to enable them to traverse the narrowest channels of the blood and lymph. Occasionally, however, they occlude these vessels and this is due to the fact that the embryos are prematurely born enclosed in a sac or sheath of globular form, the transverse diameter of which is about $\frac{1}{750}$ inch. Disease in man occasioned by the Filaria is, therefore, the result of disease in the Filaria itself. If the adult female Filaria produces the young in a physiological manner they are innocuous to their host; if, through disease or irritation, she brings them forth prematurely, they obstruct the lymph channels and produce one or more of the diseases grouped under the title of filariasis. According to Manson, " it is very certain that in the great majority of instances in which the blood is infested with Filariæ, no harm whatever accrues."

The principal diseases to which the Filaria gives rise are abscesses, lymphangitis, dermatitis and cellulitis, erysipelas, orchitis, chyluria, chylous dropsy of the peritoneum, chylous dropsy of the tunica vaginalis, varicose groin glands, lymph scrotum and elephantiasis.

The disease or rather the symptom that induced me to search for the Filaria was chyluria, which is not a common manifestation of filariasis even in the tropics.

It is an interesting fact that the diseases to which the Filariæ give rise are entirely due to mechanical interference with the circulation of lymph and blood; no toxines, or at least none inimical to man seem to be generated by this parasite and this fact is in marked contrast to what is observed in the ordinary infectious diseases. In the latter, as is well known, the products of bacterial activity are intensely toxic. I would venture to suggest, in explanation of this anomaly, that excretory products diminish in toxicity to man in direct ratio with the ascent in the scale of being of the organism that discharges them.

The most remarkable fact in connection with the habits of *Filaria nocturna* is that it is found in the superficial capillaries solely or chiefly during the evening and night. On several occasions I have examined the blood of my patient at noon or thereabouts and have found the parasites either absent altogether or very sparsely present; whereas at night they have always been abundant. This "filarial periodicity," as it is called, has been carefully studied by Manson who found that toward sunset the embryos "begin to enter the general circulation. Gradually, as the night wears on, their numbers increase. About midnight they are most numerous. As morning approaches they get fewer and fewer, and by 8 or 9 A. M. they have disappeared." This periodicity is wonderfully adapted to facilitate the escape and further development of the embryo through the medium of the mosquito. Various theories of the cause of "filarial periodicity" have been advanced but none of them is entirely satisfactory. The most satisfactory of them is that which correlates the habits of the parasite with the sleeping and waking habits of the host. This, however, is simply reiterating the fact without explaining it. That the approach of the embryos to the surface is not entirely due to the somnolent condition of the host is shown by the fact that it begins several hours before bedtime; while, on the other hand, the parasites begin to retire to the deeper vessels hours before the usual hour of rising. It cannot be denied, however, that the condition of sleep has something to do with the approach of the Filaria to the surface. This is proved by a celebrated experiment of Dr. Stephen Mackenzie who induced a patient who harbored the *Filaria nocturna* to reverse his usual habits as to sleeping and waking: *i. e.* to remain awake all night, and sleep during the day. While this experiment was in progress the Filaria was found in the surface vessels solely or chiefly during the day. The fact that the embryos begin to find their way to the surface several hours before bedtime would seem to indicate that the systemic condition which induces sleep is chiefly vascular and that it is of gradual development.

The refuge of the embryo of *Filaria nocturna* during the day has not, as yet, been discovered. The embryos of *Filaria immitis*, a parasite of the dog, observe a modified periodicity and when fewest in the surface vessels are found in enormous numbers in the blood vessels of the lung. This is not the case with *Filaria nocturna* for Manson has examined blood expectorated from the lungs of a Filaria patient by day without finding the embryos and Myers has examined blood withdrawn by aspiration from the spleen and liver during the day, with negative results.

I have elsewhere[1] discussed the question of the treatment of

[1] Medical News, May 2d, 1896.

filariasis and will, therefore, confine myself to the statement that there is no drug that will kill the adult parasite, and that even if such a drug were known it would be wisest to refrain from its employment. When the adult worm has its seat in one of the extremities and dies, an abscess usually results; or it is perhaps more correct to say that adult Filariæ have been found in such abscesses, the presumption being that the latter are caused by the former. If, however, the adult Filaria dies in the thoracic duct, with consequent abscess, the result would be of necessity fatal. The only treatment worthy of the name is prophylaxis. *Filaria nocturna* being introduced into the system through the medium of drinking water, it is of vital consequence, in the countries in which filariasis is endemic, to secure a pure water supply by filtration or other means.

As Manson remarks[2]; "the ultimate disappearance of the filarial diseases is entirely a matter of personal and municipal education"—in other words of "civilization . . . . and if any municipal or other body is in want of one more argument for a pure water supply, here is one ready made to their hands."

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[2] Davidson's Hygiene and Diseases of Warm Climates.

THE PLANKTONOKRIT, A CENTRIFUGAL APPARATUS FOR THE VOLUMETRIC ESTIMATION OF THE FOOD-SUPPLY OF OYSTERS AND OTHER AQUATIC ANIMALS.

BY CHARLES S. DOLLEY, M. D.

To Dr. Victor Hensen of Kiel is due the credit of being the first to insist upon the importance of a quantitative determination of the primitive food supply of marine animals.

In place of the terms "Auftrieb" and "pelagische Mulder" (pelagic tow-stuff) introduced by Johannes Müller, and commonly employed by zoologists for nearly half a century, Hensen substituted the more comprehensive term, plankton,[1] to include all those free-swimming, or drifting organisms which make up the fauna and flora of the sea. As the result of the initiative taken by Hensen and based largely upon the investigation conducted in the North Sea and Atlantic Ocean under his leadership, there has been developed in less than a decade, one of the most important departments of biological science, to which Haeckel has applied the term planktology. Biologists interested in the practical solution of the difficulties met with in the preservation and propagation of the food supply of Man, as found in ocean and lake, bay and river, were quick to recognize the importance of planktonic studies; and the broad considerations of the physiologist, concerning the cycle of matter in the sea, have led to narrower, but, nevertheless, exceedingly important studies regarding the source, character and quantity of the food supply of edible fishes and mollusks.

It is each year becoming more evident to the fish and oyster culturist that he has before him a problem of very considerable complexity. He is awakening to the fact that it is not sufficient that he should be able to hatch out and liberate millions of young fish fry, or plant thousands of bushels of oyster spat, but that he must base his culture experiments upon a thorough knowledge of the conditions affecting the survival and growth of the planted forms.

To the very imperfect knowledge of fish culturists and oyster planters, may be largely attributed the fact that American oysters have for

[1] πλαγκτός, wandering, roaming.

years steadily diminished in abundance, notwithstanding the enormous quantity of plants spread out on the oyster grounds of our seaboards, as well as that the fisheries of the Great Lakes have, in several instances, grown steadily less profitable, notwithstanding that millions of young fry have been liberated annually; for unless the transplanted organism can find suitable and abundant food, the time and money spent in rearing it, up to the period of its planting, is practically wasted.

As the result of the planktonic studies of Hensen, aquiculture is taking on a new phase which promises to mark a period in its history as important as has been seen in the very rapid development of scientific agriculture, directly attributable to the teachings and methods of Sir John Bennett Lawes of Rothamstead, England.

A glance at recent literature is sufficient to show the marked contrast between modern planktonic investigation and the empirical methods hitherto employed in aquiculture.

Prof. H. B. Ward, in his paper on the "Food Supply of the Fish in the Great Lakes," and Prof. J. E. Reighard, in his reports on the "Biological Examination of Lake St. Clair," indicate very clearly that the practical failure of fish culturists to replenish the rapidly diminishing supply of white fish in the Great Lakes may be directly attributed to a lack of knowledge on the part of those conducting the fish hatcheries, of the conditions affecting the primitive food supply of these waters. In the work conducted under the direction of Prof. Reighard, we find the first recognition in this country of the prime importance of a knowledge of the protophytes of the plankton, constituting as they do the primitive food supply upon which are dependent all other forms of the plankton, as well as all higher aquatic organisms.

John P. Lotsy, in a study of the food of the oyster, clam and ribbed mussel, confirms what has long been known, that these mollusks feed almost entirely upon diatoms, and that a knowledge of the life conditions of these latter must furnish the basis of intelligent oyster culture.

In reviewing the literature pertaining to oysters and the oyster industries, frequent mention is found of the food of oysters and the importance of an abundant and regular supply of the same, but nowhere in the numerous reports of expensive investigations of oyster grounds, carried on by the various governments, do we find any systematic study of the protophytic plankton of the waters examined.

Other and much less important factors, such as depth and density of the water, the character of the bottom, etc., have received exhaustive attention and are to be found displayed in lengthy tables and expensive charts, whereas, the most important factor of all, the conditions of the oyster's food supply, are relegated to brief paragraphs and have as yet received practically no consideration at the hands of those who have sought to awaken interest in scientific oyster culture.

In this connection I may be allowed to quote briefly from Prof. Haeckel: " The unicellular plants (Protophyta) have very great importance in the physiology of the plankton and the cycle of matter in the sea, for they furnish by far the greater part of the primitive food (Urnährung). The inconceivable amount of food which the countless myriads of swimming marine animals consume daily is chiefly derived, directly or indirectly, from the planktonic flora, and in this the unicellular protophytes are of much greater importance than the multicellular metaphytes.

" Nevertheless, the natural history of these small plants has thus far been very much neglected. As yet, no botanist has attempted to consider the planktonic flora in general, and its relations to the planktonic fauna. Only that single class so rich in forms, the diatoms, has been thoroughly investigated and systematically worked up; as regards the other groups, not a single attempt at systemization has been made; and many simple forms of great importance have lately been recognized for the first time as unicellular plants."

James I. Peck, in a recent article on " The Sources of Marine Food," adds testimony to the importance of primary food supply, showing, in a number of instances, the steps in the series from the microscopic plants of the sea to the voracious bluefish or squeteague; the higher organisms in the series being dependent on the lower. How essential, then, to the planktologist is a knowledge of the conditions affecting the development of the protophyta, since these minute plants form the primitive organic food, determining the welfare of a long series of higher forms, ending with man himself. Means should be devised for establishing planktonic standards based upon the ascertained conditions existing in waters known to be prolific in higher forms of life.

Knowing that the oysters, clams and mussels depend practically upon diatomaceous food, and that certain bays, coves or estuaries are noted for the abundance and quality of their molluscan fauna, let the average weight or bulk of diatoms for each cubic metre of such a region be determined and used as a standard of comparison, by means of which the culturist may estimate the value of neighboring waters.

Corporations such as are now rapidly securing control of the best oyster grounds of the coast, will not long be content to work under the rule-of-thumb methods of the unscientific oysterman. The experiments of laying out extensive oyster beds, or establishing fattening parks, are too costly to be undertaken on the basis of guess-work as to whether conditions are or are not favorable. The money invested in an oyster bed of one hundred thousand bushels is so great that a year's difference in the time required by the plants to reach marketable size means a very considerable profit or loss to the planters.

How to turn over the investment every two or three years, instead of every five years, is a question which affects very materially the dividends of a corporation engaged in oyster culture. In certain regions, the oysters grow rapidly in size, but do not become sufficiently fat to command the prices paid for oysters of a similar size from other beds. These thin oysters, for a few cents a bushel, can be transferred to parks or fattening ponds, where, by supplying them with waters rich in diatoms, they will become "primes" in the course of a few weeks.

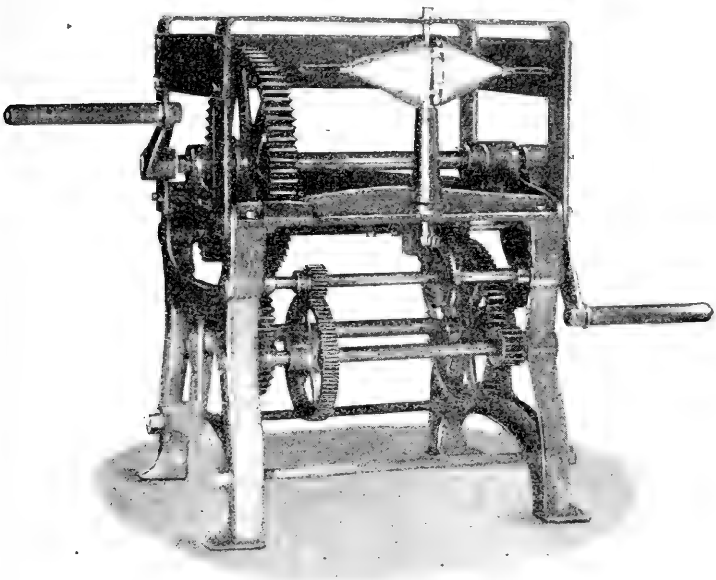
The advantage of such fattening is obvious, as is the fact that the time consumed in the process is a most important factor, the profit depending on whether the parks can be emptied of oysters and refilled every three weeks or every six weeks. To regulate conditions of this kind it is not enough to wait for results, to judge from day to day whether the oysters are fattening or not, and to judge the quality of the water of the park by the effects seen on the oysters. This method is unprofitable; it is either too slow, too uncertain or too wasteful. Variation in rainfall, in temperature, etc., will affect the relative number of food organisms in the water so materially that the best results can be secured only by a daily test of the supply.

Water rich in diatoms is too precious to be allowed to pass through the parks in quantities larger than necessary to bring the oysters to perfection in the shortest possible time. How now shall the ostreaculturist ascertain quickly and accurately the amount of plankton in the water of his parks and claires from day to day, or decide upon the best places for the location of new beds as regards food supply?

The methods adopted by Hensen and his followers in estimating the plankton content of any given area of water, are tedious in the extreme, and hold the same relation to practical fish and oyster culture as do the old fashioned methods of counting blood corpuscles and milk globules to the modern use of the hematocrit for the quantitative estimation of blood corpuscles; or of the various centrifugal machines and the Babcock system for the determination of the fat contents of milk. To the use of the pelagic tow-net we are indebted for practically all our present knowledge of minute aquatic organisms, and in so far as concerns the enumeration of the species constituting the plankton of any given region, no improvement can be suggested over the methods now employed. Prof. Haeckel has, however, very clearly pointed out the difficulties connected with Hensen's method of counting the individuals obtained in each haul of the net and that such counting "possesses only an approximate and relative value," and further, that "the only thorough method of determining the yield in planktology is the determination of the useful substance according to mass and weight, and subsequent chemical analysis." Without undervaluing in any way the counting methods at present employed by planktologists, I desire here to call attention to an apparatus which I have devised and by means of which one may make a large number of plankton estimations in a single day, in each case determining the volume and weight, rather than the number of individuals. By means of this apparatus one is enabled to judge of a given area of water at different times of the day, states of the tide, from various depths, in fact of the planktonic variations as regards depth, temperature, density, wind, tide, etc.

The method which I employ is that of the centrifuge, an apparatus which consists of a series of geared wheels driven by hand or belt, and so arranged as to cause an upright shaft to revolve to a speed of 8,000 revolutions per minute, corresponding to 50 revolutions per minute of the crank or pulley wheel. To this upright shaft is fastened an attachment by means of which two funnel-shaped receptacles of 1 litre capacity each may be secured and made to revolve with the shaft. The main portion of each of these receptacles is constructed of spun copper, tinned. To this is attached the stem of the funnel consisting of a heavy annealed glass tube of 15 mm. in outside diameter with a central bore of 2½ to 5 mm. These glasses are held in place and protected by a cover, such as is employed in mounting a water-gauge.

The receptacles having been filled with the water to be examined, are caused to revolve for one or two minutes, when the entire contents of suspended matter in the water is thrown down to the bottom of the tube, from which the volume may be read off by means of the



graduated scale on the outside of the tube. The plankton thus expeditiously secured can be transferred quickly to a vial or other receptacle, to be weighed or otherwise examined at leisure.

The apparatus is simple and efficient, covering, I think, some of the faults in the Hensen method, as pointed out by Haeckel, at any rate supplementing the counting method by one which makes it possible to secure a far greater number of estimations in a given time. It is free from many sources of error connected with the use of a net, and for the practical purposes of oyster and fish culture enables the scientist in charge to ascertain the diurnal variations of any given area of water, from planktonic standards previously established under the most favorable conditions. I have chosen the name planktonokrit for this apparatus, and I am confident that it will facilitate in many ways the solution of the œcological problems which confront the student of aquatic organisms, and at any rate free him, to a certain extent, from " the Danaides task " of counting the individuals.

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June 2.

The President, Samuel G. Dixon, M. D., in the Chair.

Seventy persons present.

June 9.

Harrison Allen, M. D., in the Chair.

Thirteen persons present.

Papers under the following titles were presented for publication :—

"Contributions to a Knowledge of the Hymenoptera of Brazil, No. 1. Scoliidæ," by William J. Fox.

"The Mesenteries of the Lacertilia," by Edward D. Cope.

"Revision of the Slugs of North America: Ariolimax and Aphallarion," by Henry A. Pilsbry and E. G. Vanatta.

June 16.

Mr. Charles Morris, in the Chair.

Nineteen persons present.

Papers under the following titles were presented for publication :—

"A Collection of Fishes obtained at Swatow, China, by Miss Adele M. Fielde," by Cloudsley Rutter.

"A Collection of Fishes made by the Rev. Joseph Seed Roberts in Kingston, Jamaica," by David Starr Jordan and Cloudsley Rutter.

June 23.

The President, Samuel G. Dixon, M. D., in the Chair.

Twenty-eight persons present.

June 30.

The President, Samuel G. Dixon, M. D., in the Chair.

Twenty-one persons present.

The Ulna of the Common Brown Bat.—Dr. HARRISON ALLEN called attention to the ulna in the common Brown Bat, *Adelonycteris fusca.* The ulna in the Vespertilionidae had been described by some authors (e. g. de Blainville) as ending free in the muscles of the forearm. Dr. Allen believed he had demonstrated this arrangement in *Adelonycteris* and *Vespertilio.* Others assert that in all the bats the ulna is anchylosed to the shaft of the radius. Dr. Allen wished to revise his former statement[1] on this subject. In a fully adult specimen of the bones of the forearm which he had subjected to prolonged boiling, Dr. Allen found that the ulna by gentle traction could be separated from the radius and be traced as a slender filament along the entire length of the forearm and to end at the wrist joint. The arrangement in the adult, in this species at least, is, therefore, not different from that found in the embryo.

The following were ordered to be printed :—

[1]Mon. N. A. Bats, 1894.

CONTRIBUTIONS TO A KNOWLEDGE OF THE HYMENOPTERA OF BRAZIL. No. 1, SCOLIIDÆ.

BY WILLIAM J. FOX.

The explorations of Herbert H. Smith have done more to extend our knowledge of the insect fauna of Tropical America than those of any other person, with the possible exception of the late Henry Walter Bates. His work in Mexico for the *Biologia Centrali Americana* and for the West India Committee has given him an extended reputation; but it remains for the classifying of his South American collections to show the real extent of his labors in the field and forest.

It has been my good fortune to have Mr. Smith's collection of fossorial hymenoptera placed in my hands for identification and study, and its size is indicated by the number of species contained in the present paper on the Scoliidæ, which includes no less than thirty species, besides some half dozen species of the genus *Tiphia*, which, in consequence of many faulty descriptions of South American forms, I have been obliged to leave undetermined.

In 1873–1875, Mr. Smith worked alone on the Amazons, and the Santarem material was then gathered. In 1881–1886, accompanied by his wife and two assistants, another journey was made. Going first to Pará he and his wife made a flying trip to Santarem, and then down the coast, stopping a week at Pernambuco and several months at Rio de Janeiro; from the latter place they went to Entre Rios. Six months were spent in Rio Grande do Sul; but there are no hymenoptera in the collection from that place. By steamer they proceeded up the Paraguay to Corumbá and Cuyabá. Headquarters were established at Chapada, and there four years were spent. Ad interim Mr. Smith returned to Rio de Janeiro for a year, leaving his wife and one assistant in the interior. After finally leaving Chapada they made a canoe journey on the Upper Paraguay to Pedra de Amolas, Pacoval, etc., but most of the time was here given to geological and ethnological work. Subsequently several weeks were spent at Corumbá and Piedra Blanca, before returning to the United States.

Mr. Smith has kindly furnished me with the following notes on localities visited as far as they relate to the hymenoptera.

Santarem. A town at the junction of the Tabajós with the Amazon. Its immediate vicinity is more or less open land, with scattered low trees and a thin grass growth: the type of vegetation called campo in Brazil. Most of the hymenoptera labeled Santarem, were, however, collected a few miles inland or down the Amazon, at the settlements of Panema, Marurú and Taperinha, where most of the land is covered with heavy forest broken by a few clearings. The soil both of campo and forest is sandy. The climate is moderately warm for a region so near the equator, and moist, though not extremely so.

Monte Alegre is in campo land very similar to Santarem; it is on the opposite or northern side of the Amazon.

Specimens marked Pernambuco are from the San Francisco plantation, some miles inland: a clearing in forest; land hilly, and soil clay.

Rio de Janeiro. Land originally forest. No specimens were collected above 2,500 ft. alt.

Entre Rios, in the State of Rio de Janeiro, is on the Parabyba do Sul River, back of the Organ Mountains. The soil is clay, covered with low and somewhat open forest; climate rather dry. Mr. Smith says: "The insects of Entre Rios, I have found, resemble those of Chapada and Corumbá rather than those of Rio."

Corumbá, in the State of Matto Grosso, on the western bank of the Paraguay, close to the confines of Bolivia. The climate dry and hot; the vegetation open; dry forest, full of cacti and other thorny plants. The opposite side of the Paraguay, where some collections were made (these are marked "lowland") is in the great flood-plain: a vast semi-swampy region, flooded every year during several months. This is the region known to geographers as Lake Xaraes, or, better, the Xaraes Marshes (also written Charaes or Jaraes).

Piedra Blanca (or Pedra Branca), a small settlement and custom-house just within the boundary of Bolivia, on a lake opening into the Paraguay, and only four miles from Corumbá. The land is low and damp and covered with heavy forest, very different from the region about Corumbá.

Pacoval and *Pedra de Amolas* are settlements on the Paraguay above Corumbá, on the edge of the flood-plain, but backed by rocky hills; land open or forest.

Cuyabá is the capital of Matto Grosso, on the River Cuyabá, a sub-branch of the Paraguay; soil dry and stony, with campo growth; climate dry and hot.

Cachoeira is just above Cuyabá, on low, semi-swampy land.

Chapada. Here the greater part of the collection was made. It is an Indian village, thirty miles northeast of Cuyabá, on the plateau stretching from the southern tributaries of the Amazon to the flood-plains of the Paraguay, and is about 2,700 ft. above sea level. The land in the immediate vicinity of the village is clayey or stony. Many of the specimens marked from here are from the neighboring settlements of Abrilonga, Gloria, etc., several hundred feet lower, and on sandy soil. All this region has a varied vegetation: stretches of open land or campo and semi-forest are interspersed with large patches of heavy forest. The climate is never very warm (mean at Chapada 72° F.) and there are cold snaps in June, July and August, when the thermometer frequently sinks to 40° or lower. These cold snaps are caused by southerly winds, which, as Mr. Smith states, he has proved are the same as the "pamperos," which are so destructive to shipping on the Rio de la Plata. The latitude of Chapada is about 14°8′. The hymenoptera from this place were largely collected on flowers about the open lands, and near the streams, where many specimens were gathered in muddy places.

To quote from a letter of June 16, 1896, from Mr. Smith: "I cannot say that the collection of fossorial hymenoptera is a particularly good one. The best work was done at Chapada; but even there most of our time was given to other branches, and I was much interrupted. In my opinion, the hymenoptera of Brazil are hardly touched. The rule in the tropics, with all orders of insects, is that a few species are common, while a great majority are rare, and require a long and patient collecting to amass a reasonably good representation. Probably the Scoliidæ are as well represented as any, because most of the species are large and conspicuous. They have a very peculiar and almost indescribable odor. I found them most common on flowers."

The Scoliidæ are as follows:

Myzine flavopicta Sm.

Rio de Janeiro (November); Corumbá (February and April); Chapada (March and November). Four female and seven male specimens. Burmeister's *M. duplicata* is a variety of this species.

Myzine emarginata n. sp.

♀.—Black; basal two-thirds of mandibles; tibiæ, tarsi and apex of femora reddish; a transverse, medially enlarged line across front, a narrower one across occiput; line on pronotum posteriorly and a spot on each side anteriorly, spot on dorsulum medially, small one near tegulæ, line on scutellum and metanotum, tegulæ at base, triangular spot on mesopleuræ, a large one on each postero-lateral angle of middle segment, and a small elongate one above in the middle, rarely absent, spot on fore femora beneath near apex, spot on medial and hind femora above near apex, this spot sometimes extending on the lower surface, fore tibiæ externally, broad transverse band on first dorsal segment, sometimes emarginate anteriorly in the middle, the second entirely except a narrow line at base and a transverse medial line, these lines united so as to form a low X, the medial one not extending to the sides, and apex of second, third and fifth with a narrow, thrice emarginate line at apex, yellow, that on the fifth irregular; body sparsely clothed with griseous pubescence; front with large separated punctures, smooth medially, those of the vertex and occiput very sparse; clypeus rather sharply carinated down the middle; pronotum and dorsulum much more sparsely, with large punctures, those of the scutellum and mesopleuræ closer; middle segment above finely punctured, in the middle somewhat roughened posterior face above and at the sides with coarse transverse wrinkles, at apex the wrinkles are longitudinal, sides very finely and obliquely striated; first dorsal segment punctured at the sides, the second with fine sparse punctures, strong at sides, punctures of segments 3 and 4 fine and closer, of the fifth stronger, second ventral with large sparse punctures, the remaining ventrals finely punctured at base, coarsely at apex; pygidial area covered with strong, longitudinally parallel striæ, the apex narrowly reddish; wings light fusco hyaline, with a broad fuscous streak running from stigma to apex of superiors. Length 16–17 mm.

Chapada (March to May). A series of males collected at Chapada and Corumbá (April), I place here with some doubt.

♂.—Black; abdomen iridescent; clypeus, mandibles except apex, inner orbits, spot on scape beneath, one over each antennæ, line on anterior and posterior margin of pronotum, that on anterior margin interrupted medially, dorsulum medially, spot on scutellum and metanotum, large spot on mesopleuræ anteriorly and a small one posteriorly, two parallel spots on upper surface of middle segment, postero-lateral angles of the latter, spot on all the coxæ beneath, and above on the posterior pairs, femora except base, remainder of legs except stripe on tibiæ beneath and a ring at apex of tarsal joints, a thrice emarginate fascia at apex of dorsals 1–6, the first broadest, the last interrupted medially, and a elongate spot on each side of ventrals 2–5, all yellow; wings hyaline, faintly dusky at apex, stigma testaceous; antennæ but little longer than the combined length of head and thorax; front rather strongly and closely punctured, the occiput much more finely so; middle segment above in the middle strongly punctured, the posterior face closely and transversely striato-punctate, on the sides obliquely and more finely so; abdomen above with rather strong, separated punctures, beneath the punctures a little finer and sparser. Length 15–17.

This sex is very like the ♂ of *flavopicta*, but is, as a rule, larger; spots on postero-lateral angles of the middle segment larger, abdominal fasciæ thrice emarginate, and the sculpture of the middle segment is less coarse. The spotted upper surface of middle segment is constant in all but two of the twenty-two specimens before me.

Myzine frontalis Burm.

One specimen. Corumbá (April).

Myzine radiata n. sp.

♀.—Black; abdomen iridescent; spot on each side of clypeus, at base of each antenna, inner orbits, two dots on metanotum, and a small spot on each side of the first dorsal segment, yellow; tibiæ, tarsi, mandibles and tegulæ in part obscurely rufo-testaceous; clypeus with fairly strong punctures on each side, in the middle longitudinally raised or carinated and impunctate; front and occiput with large separated punctures, which are finer along the occipital margin; region including the ocelli almost impunctate; scape distinctly punctured; pronotum and dorsulum with strong, though not very deep punctures, the posterior portion of dorsulum, however, and the scutellum are longitudinally rugoso-punctate; sides of prothorax strongly and obliquely striated; mesopleuræ with the punctures deeper and more even than on pronotum; upper surface of middle segment at base microscopically punctured, transversly strigose posteriorly, posterior face with unusually coarse wrinkles orf olds radiating rather evenly from apex and covering the entire surface, and running into less coarse oblique striæ on the sides; calcaria and spines of legs white; dorsal segments 1–4, rather finely and evenly punctured, the fifth more strongly, the base of 3 and 4 transversely smooth; ventrals with a series of strong punctures before apical margins, from which pale hairs project, otherwise sparsely punctured; pygidial area longitudinally and evenly striated; pubescence of body pale, a rather prominent bunch on each side of the first dorsal segment; wings subfuscous, the anterior portion of the anteriors deeply clouded, nervures black. Length 15 mm.

Chapada (March). One specimen. Seems to be very distinct as regards coloration and sculpture of middle segment.

Myzine iridescens n. sp.

♀.—Black; abdomen iridescent, especially the first dorsal segment; inner orbits, metanotum, and a dot on each side of the first dorsal segment of abdomen, yellow; pubescence pale; clypeus with fairly strong punctures, except in the middle, which is longitudinally smooth and raised or carinated; front with large, deep punctures closer than in *radiata;* occiput with large, rather sparse punctures, its posterior margin with finer and closer ones; ocellar region almost impunctate; scape distinctly punctured; pronotum with large, though not deep, somewhat confluent punctures; dorsulum with the punctures on anterior portion fine and closer, on the remainder stronger and sparser than those of the pronotum; scutellum with large, separated punctures, upper surface of middle segment at base finely and closely punctured, apically rugose, particularly in the middle; posterior face covered with fairly strong, close striæ which radiate from the apex, become coarser laterally, and extend on sides where they are finer and evener; sides of prothorax finely striated obliquely; mesopleuræ with large, deep punctures; calcaria and spines of the legs white; the tibiæ and tarsi obscurely rufo-testaceous; abdomen above rather finely punctured, most strongly on segments 4 and 5, and at the sides, base of 2–4 transversely smooth; ventral segments with large, sparse punctures, a transverse series before the apical margins of segments 2–5; pygidial area longitudinally striated; wings subfuscous, the anterior portion of anteriors deeply clouded, nervures and tegulæ in part testaceous. Length 12 mm.

Chapada (December). One specimen. This is very similar superficially to *radiata,* but differs in much finer sculpture of thorax, particularly the middle segment.

Tiphia parallela Sm.

Chapada (December and January); Santarem (February); Villeta (May). Seven specimens.

Tiphia solitaria Sm.

Chapada (May and November); Santarem. Four specimens. Smith doubtfully referred *solitaria* to *parallela* as the latter's male, in which he was probably correct.

In addition to the two species of *Tiphia* above noted the collection contains, perhaps, five others, which I have not been able to place in consequence of the many incomplete descriptions that exist of neotropical forms. Smith's descriptions of *Tiphia* are almost useless.

Epomidiopteron Julii Rom.

Chapada (December and February); Santarem. Four specimens, all females.

Scolia (Discolia) nigrescens n. sp.

Deep black, shining; mandibles red; wings black, with a strong blue reflection; tibiæ and tarsi reddish; base of second ventral segment with two small tubercles.

♀.—Head with deep, sparse punctures, closest at base of antennæ and on occiput; anterior margin of clypeus truncate; scape sparsely punctured; thorax coarsely punctured, tolerably closely so on prothorax and mesopleuræ, dorsulum and scutellum impunctate medially, upper segment of middle segment in middle strongly punctured, posteriorly depressed, and sparsely punctured; legs more or less reddish, their amount of black and red variable, the spines black, longer spur of hind tibiæ equal to about one-third the length of the first hind tarsal joint; abdomen strongly punctured, particularly on the first and second dorsals, dorsals 3–5 almost impunctate except at base, where the punctures are close and small, dorsal segment six with cribrose punctures and coarsely hirsute, ventrally the abdomen has large, sparse punctures, out of which project black hairs; pilosity of the body black and sparse; base of second ventral with two small, transverse tubercles. Length 22–24 mm.

♂.—Similar to ♀ in coloration except that the legs are usually entirely black; antennæ scarcely as long as head and thorax, stout; abdomen with all the segments punctured alike, the punctures being well separated, but not sparse; joints of medial and hind tarsi within, at apex, with a small bunch of grayish hairs. Length 16–20 mm.

Chapada (November, December and March). Fourteen specimens. Near *monticola* Cam., from Mexico, but is distinct in the tuberculate second ventral segment, the medially impunctate dorsulum and scutellum and differently colored legs.

Scolia (Discolia) versicolor Sauss.

Chapada (November and March.) Four ♀ and one ♂ specimen. Saussure in describing this species was in doubt whether its habitat was Brazil or Africa. The specimens before me agree very well with the description, and leave no doubt in my mind as to their identity. The color of thorax varies somewhat, the dorsulum, tegulæ and scutellum sometimes partaking of rufous.

The male has not before been recorded. It may be briefly diagnosed as follows:

♂.—Colored like the ♀, but with four apical segments reddish; antennæ stout, about as long as head and thorax; thorax strongly punctured, sparsely so on dorsulum, scutellum, metanotum and middle segment, medially; abdomen with strong punctures, fairly close, on dorsal segments 4–6 in the middle somewhat sparsely, the ventrals much more sparsely so; second ventral at base strongly bituberculate; longer spur of hind tibiæ about half as long as the first hind tarsal joint; wings black, with a strong bluish-purple reflection; pilosity of body black, rather sparse. Length 20 mm.

Scolia (Discolia) Drewseni Sauss.

Chapada (March and April). Eighteen ♀ and fifteen ♂ specimens. The wings have a bronzy-purple reflection, not violaceous as described by Saussure.

The ♂, heretofore unknown, may be described as follows:

♂.—Similar to ♀ as to coloration, the black or under side of thorax more distinct; antennæ about as long as head and thorax; thorax strongly punctured, sparsely so on the middle of dorsulum, scutellum, metanotum and upper surface of middle segment; abdomen with strong punctures becoming closer toward apex, sparsest on first and second dorsal and on the ventral segments; longer spur of hind tibiæ nearly half as long as the first hind tarsal joint; second ventral segment at base indistinctly tuberculate; wings black, with a strong bronzy-purple reflection; pilosity of body reddish, rather dense on apical abdominal segments. Length 12–18 mm.

Scolia (Discolia) decepta n. sp.

Similar to *Drewseni,* but the wings are deeper blue, and not purplish; clypeus transverse, not produced in the middle as in *Drewseni.*

♀.—Head with deep, sparse punctures, almost impunctate above on the front, more closely at base of antennæ and on occiput; clypeus convex and impunctate medially, depressed and punctured on the sides, a small patch of pale hairs on each extreme side; thorax strongly punctured, very closely above on prothorax, elsewhere sparsely, the center of dorsulun, scutellum and metanotum impunctate or nearly so, the middle segment above in the middle with large, scattered punctures; longer spur of hind tibiæ less than half as long as the first hind tarsal joint; first and second dorsal segment strongly punctured, the punctures on second sparsest and feebler, dorsals 3–5 almost impunctate, the sixth with cribrose punctures, ventrals with large, much scattered punctures, the base of second segment bituberculate; venation about as in *Drewseni*, the second transverso-cubital nervure strongly curved outwardly. Body rufous; flagellum except first joint, occiput narrowly, thorax on sides and beneath, the middle segment entirely, and first and base of second abdominal segments, black; legs, including spines, rufous; pilosity black, except fringe of mandibles and two apical abdominal segments. Length 21 mm.

Chapada. One specimen. Superficially, *decepta* shows a striking resemblance to *Drewseni*, from which it differs in the bluer wings, shape of clypeus and color of pilosity.

Scolia (Discolia) bisignata n. sp.

Similar to *Drewseni* and *decepta* in coloration, the third dorsal abdominal segment with a small lateral yellow spot; clypeus transverse anteriorly; wings black, with a strong purplish reflection.

♀.—Head with deep, sparse punctures, those of the occiput, base of antennæ and on sides of clypeus, much closer; clypeus strongly convex and impunctate medially, its fore margin transverse, at the sides with a small bunch or fringe of pale hairs; thorax strongly punctured, closest on prothorax and dorsulum anteriorly, posteriorly on dorsulum the punctures are large and sparse, as are likewise those of the scutellum and metanotum, on the centre of upper surface of middle segment the punctures are more evenly spaced; mesopleuræ posteriorly, metapleuræ and posterior face of middle segment smooth, impunctate, or nearly so; longer spur of hind tibiæ not one-third as long as the first hind tarsal joint; dorsal segments 1, 2 and base of third with strong, separated, though not sparse punctures, those at base of second and third segments finest and closest, apical portion of dorsals 3–5 with large sparse punctures, sixth dorsal cribrose, ventrals very sparsely punctured, the punctures of the last segment finest, second ventral bituberculate at base. Body rufous; flagellum except basal joints, mandibles at tips, thorax on sides and beneath, and the dorsulum medially as a rule, and a narrow, somewhat indistinct line at apex of dorsal segments 1–3, black; pilosity reddish and rather sparse, that on the occiput pertaining to yellow; none of the abdominal segments fringed; tegulæ strongly punctured on anterior half. Length 16–21 mm.

♂.—Head strongly and evenly punctured throughout the front, shallowly so on the occiput; antennæ scarcely as long as the head and thorax united, first and second joints of flagellum about equal in length, the terminal joint rounded at apex (the antennæ are decidedly stouter than in the male of *Drewseni*); thorax strongly punctured but rather more closely than in the female, and the posterior face of middle segment with large punctures; abdomen closely punctured particularly above, the last dorsal hardly cribrose; second ventral bituberculate. A yellow spot in the emargination of the eyes, and the black on dorsulum and abdomen more generally distributed. Length 13–16 mm.

Chapada (January, March and April). Eleven female and six male specimens. The extent of black of abdomen and sides of thorax is subject to variation: in two females the dorsal segments are almost entirely black. The yellow spots on abdomen are constant in all specimens, and may be regarded as a good superficial character in distinguishing this species from *Drewseni* and allied species.

Elis vitripennis Sm.

Chapada (March). Four specimens.

Elis regina Sauss.

Chapada (January to April). Thirty-nine specimens, all females.

Elis nigra Sauss.

Chapada (October, February, March and April). Twenty-three female specimens.

Elis lucida Lep.

Two specimens from Chapada, collected in December and March respectively, I refer with some doubt to *E. lucida*. The larger specimen measures 27 mm. in length, whereas Saussure gives 38 mm. Should my specimens be correctly determined, there is no reason for considering this species as a variety of *costalis*, as suggested by Saussure and Sichel on p. 219 of their catalogue, as it is clearly distinct from that species.

Elis hyalina Lep.

Represented in the collection by numerous specimens of both sexes from Chapada (December, March and April). In addition to the clear wings, the male of *hyalina* is distinguished from those of *costalis* and *Wesmaeli* by the unusually prominent and pointed tubercle at base of second ventral abdominal segment.

Elis costalis Lep.

Chapada (March and April); Rio de Janeiro (November). Fourteen females and numerous male specimens. The latter show considerable variation in size and maculation, the spotted form, however, is apparently rare. This form is the *E. fallax* Saussure, referred by that author as a variety of *E. hyalina*. It should be placed with *costalis*, however, in consequence of its heavy form and darker wings and also by the shape of the ventral tubercle of abdomen.

Elis Wesmaeli Lep.

Chapada (December, February, March and April). Numerous specimens of both sexes.

Elis cineraria Sichel.

A large series, over one hundred specimens, is in the collection from Chapada (November, March and April). The specimens agree with the description of *cineraria*, except that there is no yellow on the fourth dorsal or on any of the ventral abdominal segments. Only males are represented; and the series shows considerable variation in size, specimens measuring 16–30 mm.

Elis variegata Fabr.

Chapada (March). Fourteen male specimens. These only vary in that two specimens have the spots on the second dorsal segment united.

Elis conspicua Sm.

Four males. Santarem; Chapada (March). These vary in length from 12–20 mm.; and in the smaller specimens the pronotum is partly yellowish, and in one the third dorsal abdominal segment is bimaculated with that color.

Elis (Dielis) angulata n. sp.

Close to *conspicua*, but dorsal segments 1–4 fasciate with yellowish, thorax less shining, and pubescence of pronotum entirely pale yellowish.

♀.—Black, mandibles medially, tegulæ and tibiæ and tarsi more or less reddish-testaceous; transverse spot on metanotum and a band on dorsal segments 1–4, yellowish, the bands on first and fourth segments narrow, those on second and third greatly dilated medially and emarginate anteriorly, at the sides narrowed; pubescence pale, that of the occiput and pronotum somewhat yellowish; apical margins of dorsal and ventral segments 2–5 distinctly fringed, the color of which fringe is white except on the dorsal segments medially and the fifth ventral (which have it golden-brown); the first dorsal is rather densely pubescent; clypeus punctured at the sides, bearing two longitudinally parallel carinæ down the middle; front strongly and closely punctured, the vertex and occiput, with exception of a few scattered punctures, impunctate; scape with scattered punctures; thorax subopaque, the dorsulum strongly punctured laterally and anteriorly, impunctate medially; scutellum and metanotum with scattered punctures; middle segment above with strong separated punctures, with a smooth, longitudinal, narrow space in the middle; posterior face concave, impunctate at extreme sides, the lateral margins somewhat sharply carinated; spines of the legs whitish-testaceous, calcaria darker; hind tibiæ beset with strong, black thorns externally, their longer spur more distinctly spatulate than in *conspicua*; wings subhyaline, subfuscous anteriorly and apically, with a purplish iridescence, nervures and stigma testaceous, apex of second submarginal cell very sharply angular in the middle; dorsal segments punctured toward the sides, rather opaque, ventrals shining, the second and third with two, and the fourth with one, transverse series of strong punctures; pygidium nude, sculptured in such a way as to appear shingled, its apical margin narrowly smooth and testaceous. Length 17 mm.

Santarem. One specimen. The strongly angulated apex of second submarginal cell and the maculation distinguish this species from *conspicua* and *auripilis*.

Elis (Dielis) auripilis n. sp.

Likely to be confused with *angulata*, but differs in its golden pubescence of front and dorsulum, the semi-yellowish wings and strongly punctured occiput.

♀.—Black; mandibles reddish; transverse spot on metanotum, and a fascia on dorsal abdominal segments 1–4, or 5, yellow, those on the second and third, or fourth broad, emarginate anteriorly and narrowly incised with black at the sides, else a small black spot is enclosed by the yellow on each side, on the first segment the fascia narrow and sometimes interrupted medially, on the fourth more or less variable, on the fifth narrow and inconstant; front, occiput, pronotum and dorsulum bearing golden pubescence, that of cheeks, clypeus, thorax beneath and legs griseous; dorsal segments 2–5 with a fringe of golden-brown pubescence at apex, ventrals 2–5 with a white fringe; clypeus furrowed down the middle, bearing some coarse folds anteriorly; front strongly and closely punctured, the vertex with a few large, scattered punctures; occiput coarsely punctured and posteriorly, in addition, bearing coarse folds or rugosities; scape with scattered punctures; pronotum except posterior margin, strongly and closely punctured, bearing near each antero-lateral angle a deep, oblique depression; dorsulum with very large, rather regularly placed punctures, which are but little sparser medially; scutellum smooth medially, strongly punctured at each side, the metanotum impunctate; middle segment above somewhat prominent in the middle at apex, the median division with large punctures smooth at base, however, the lateral ones more finely punctured, posterior face concave, smooth, at the sides crenulated, not carinate; spines of medial and hind tibiæ yellow, those of the tarsi and calcaria, whitish; wings fulvo-hyaline, iridescent, particularly on apical third, nervures and stigma fulvo-testaceous, apex of second submarginal cell angular medially, but not sharply, the second transverso-cubital vein being rather more sinuate than angulate; dorsal segments 1–4 sparsely punctured medially, rather strongly and closely at the sides, segment 5 strongly punctured throughout, ventrals shiny, segments 2–4 with two transverse series of punctures, segments 5 and 6 more generally punctured, sculpture of the pygidial area much as in *angulata*, but finer, and when held in certain lights the pygidium is clothed with a short appressed golden pubescence. Length 16–17 mm.

Three specimens. Chapada (March). This seems quite distinct from its allies in the color of the wings, which approaches that of Saussure and Sichels "stirps *Elidis vespiformis;*" those species have the abdomen immaculate, however.

Elis (Dielis) Smithii n. sp.

In maculation, similar to *confluenta*, but the thorax immaculate; wings faintly yellowish along costa.

♀.—Black; mandibles in part reddish; narrow transverse spot on first and a large spot on each side of the second dorsal segments orange, the spots on second segment almost united internally, thereby having the appearance of a band which is strongly emarginate in the middle anteriorly; otherwise the abdomen black; insect with pale pubescence, that on the vertex and dorsulum fuscous; dorsal segments 2–5 and fifth ventral with a fringe of black pubescence, ventrals 2–4 with a white fringe; clypeus furrowed down the middle, strongly punctured laterally and basally, in the middle and anteriorly smooth; front strongly and closely punctured, the punctures of vertex large and scattered; occiput with strong separated punctures, but not rugose; scape with scattered punctures; pronotum except posterior margin strongly and closely punctured, and with a depression on each side as in *auripilis*, but less strong; punctures of dorsulum coarse, close anteriorly, sparser at the sides, and in the middle absent; scutellum and metanotum strongly punctured except the apical portion which is smooth; middle segment with the median division strongly punctured laterally, smooth medially and a little produced at apex, on each side of this median division the middle segment is more finely and evenly punctured, the posterior surface of the median division only smooth and shining, sides of posterior surface crenulated; spines of the tibiæ and the middle tarsi black, calcaria and spines of hind tarsi whitish; wings subhyaline iridescent, faintly yellowish along the costa, costal vein black, the others testaceous, apex of second submarginal cell angulate in the middle; dorsal segments 1–3 with sparse, rather indistinct punctures, those on the following segments closer and more distinct, especially on segment 4, ventrals shining, segments 2 and 3 with two, 4 and 5 with one, series of transverse punctures, sixth sparsely punctured; pygidial area coarsely longitudinally striate, not pubescent. Length 17 mm.

One specimen. Corumbá (April). Distinguished from *conspicua* which it resembles, by the immaculate thorax, distinctly punctured occiput, etc.

Elis dorsata Fabr.

Rio de Janeiro (November); Chapada (January, March and April); Santarem (February); Corumbá (April). Nineteen specimens, all females.

Elis mutanda S. & S.

Santarem. One ♀ specimen. I refer this specimen here with hesitation. It measures but 17 mm., and the wings are bluish-purple; the second and third dorsals have a small, somewhat rounded, yellow spot on each side.

Elis (Dielis) aureohirta n. sp.

Belongs evidently to Saussure and Sichel's "Stirps *Elidis respiformis*," and differs from other species of that group (*respiformis*, *brasiliana* and *Gerstaeckeri*) by the dense fulvous pubescence with which the pronotum and dorsulum are clothed.

♀.—Black; mandibles reddish in part; head in front, occiput and thorax above with long golden yellow pubescence, particularly dense on the pronotum and anterior portion of dorsulum, the latter in the middle nude, as well as middle of scutellum, metanotum and upper surface of middle segment; thorax beneath, legs, first dorsal and the ventrals more or less with long griseous pubescence, dorsals 1–3 with sparse pale pubescence longest at sides, the fourth, fifth and sixth with black pubescence, dorsals 1–3 and ventrals 2–5 fringed with white pubescence at apex; clypeus strongly punctured basally, smooth medially, and bearing folds or rugæ on apical portion; front strongly punctured, transverse smooth space before the ocelli; vertex with larger scattered punctures, which become closer on the occiput; scape with a few scattered punctures; dorsulum strongly punctured laterally and anteriorly, perfectly smooth and polished medially; scutellum, metanotum and median divisions of middle segment with large separated punctures at the sides, impunctate medially; outer lobes or divisions of middle segment with finer, shallower punctures, their punctures stronger in the middle of their upper surfaces, the sides of which are sharply carinated, the carinæ not extending on the posterior surface; spines of the legs and the calcaria black; wings fulvous, slightly bluish on apical portion, the second transverso cubital nervure sinuated, pertaining to angular in some specimens; abdomen above with sparse, shallow punctures, strongest toward the sides and on the first, fourth and fifth segments, base of second, and sides of third, fourth and fifth ventrals with strong punctures, the lateral punctures of third segment, however, not reaching its base, the second and third with two, the fourth and fifth with one, series of transverse punctures, sixth with finer, scattered punctures; pygidial area longitudinally and irregularly rugose. Length 16–17 mm.

♂.—Colored like the female, but the abdomen bluish, the pubescence of the body denser throughout, is finer, less yellow on the thorax and is very dense in the middle segment; form slender, similar to *E. plumipes* ♂; antennæ fully as long as head, thorax and first segment of abdomen united, the first joint of flagellum distinctly shorter than the second; thorax on sides and beneath clothed with a silky pile in addition to the long pubescence; dorsulum and middle segment on upper and posterior surfaces punctured throughout; legs slender, the spines of hind and medial tarsi pale; dorsal segments 1–4 with shallow, separated punctures, those of fifth, sixth and base of seventh closer and deeper, the ventrals sparsely punctured; second ventral at base not at all tuberculate. Length 15–17 mm.

Chapada (March). Over one hundred specimens. Differs from its allies including *E. albofimbriata* Smith, by the color of the thoracic pubescence.

Elis plumipes Dr.

Chapada (November and March). Eight female specimens. I am uncertain whether a large series of male specimens contained in the collection from Chapada (March and October), Corumbá (April) and Santarem (November) belong to this species or to *E. dorsata*.

THE MESENTERIES OF THE SAURIA.[1]

BY E. D. COPE.

Examination of the literature shows that this subject has been nowhere adequately treated. The most considerable paper is one by Dr. F. E. Beddard in the Proceedings of the Zoological Society of London for 1888. This, however, includes an examination of a limited number of genera, (eight) only. The present paper is founded on a study of most of the genera of all the families, excepting in the cases of the Gecconidæ and Agamidæ, where my opportunities have been more restricted. I am indebted for this material to the U. S. National Museum, the collections of the Academy of Natural Sciences of Philadelphia and my own.

A fold suspends the alimentary canal from the median dorsal line, forming the dorsal or epigastric mesentery (E G). No other mesenteries bind the alimentary canal, except the stomach, and sometimes the adjacent portion of the small intestine, which have other connections. The liver, on the other hand, has several mesenteric connections, as follows: Its ventral face has usually a single sheet connecting it with the median ventral line, but in rare instances it is bifurcate posteriorly (Scincidæ generally), or even double (*Tiliqua*, LHV, RHV). This sheet, or one of them, is continued along to the anterior abdominal artery to the ventral wall, and sometimes along the gall-duct to the pyloric part of the small intestine. Each border of the liver is twice or thrice concave above, in adaptation to the stomach and lungs in the types where the latter extend so far posteriorly, which is the usual arrangement. From the left hand ridge thus produced, a sheet or mesentery extends to the stomach, forming the gastrohepatic mesentery (GH). It is sometimes median in position. From right hand superior angle a mesentery extends to the right dorsal body wall, forming the right hepatic mesentery. The four mesenteries now described are the only ones which are universally present, which bind the liver. The following sheets are present in various types. Frequently the right hepatic and the gastrohepatic give off sheets to the right

[1] Read before the American Association for the Advancement of Science, Springfield meeting, Aug. 30th, 1895.

and left lungs respectively, constituting the right hepatopulmonary and gastropulmonary mesenteries (RHP. and GP.). A sheet occasionally goes off from the gastrohepatic to the left body wall, forming the left gastroparietal mesentery. This is frequently represented by a narrow band, and occasionally, as in *Dipsosaurus*, it joins the small intestine just beyond the extremity of the gastrohepatic sheet. This is not represented on the accompanying diagram. In *Heloderma* a distinct sheet extends from each border of the liver to the body walls, forming the right and left lateral hepatic mesenteries (LLH, RLH). In *Chamæleon*, *Polychrus* and *Anolis*, the left lung besides being attached to the gastrohepatic mesentery, is attached by a sheet to the left border of the liver, forming the left hepatopulmonary mesentery, (LHP).

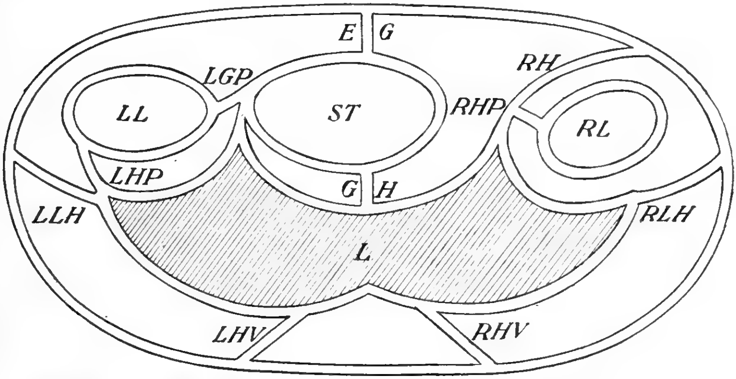

Diagram of peritoneum of Sauria, with all the folds displayed by a transverse section near the middle of the liver. L liver; St. stomach: RL right lung; LL left lung; EG epigastric peritoneal fold; LHV and RHV, left and right hepatoventral folds; RLH and LLH, right and left lateral hepatic folds; RH, right hepatic; GH, gastrohepatic; LHP and RHP left and right hepatopulmonary folds.

In *Varanus salvator* there is a short median gastrohepatic sheet (GH). In *Varanus*, owing to the anterior position of the lungs, they have no hepatic or gastric connections. In no Saurian have I observed a right hepatopulmonary sheet, as the right hepatic mesentery supports the right lung. The latter extends along the apical strip of the right lobe of the liver to the genital mesentery in many genera. In *Tupinambis*, *Dracæna*, and some others, the right hepatic extends as a strong sheet to the right body wall, forming with an equally strong gastroparietal of the left side, a kind of diaphragm. In many genera, the right hepatic sheet is connected with the stomach, especially at its proximal part.

Besides the hepatic and gastric mesenteries, there are those which enclose the internal genitalia, the urinary bladder, and the corpora adiposa. The genital mesentery is sometimes quite extensively free, and is always so anteriorly, especially where it supports the wide fontanelle of the oviduct. A mesenteric pouch encloses the corpora adiposa, only in those forms where those bodies project freely into the abdominal cavity, as is frequently the case. The cystic mesentery is a transverse fold of the peritoneum which lines the inferior wall of the pelvic cavity, which encloses the urinary bladder, when it is present.

Beddard has stated that in the genus *Varanus* there is a "horizontal sheet" of mesentery between the viscera and the abdominal peritoneum. This is an interpretation of the fact that the abdominal peritoneum is loosely attached to the abdominal muscular sheaths, and is readily separated from them. This sheet, however, presents the usual relation of the abdominal peritoneum to the viscera, as Beddard states, and appears to me to be homologous with it.[2] The same condition caused Günther[3] to state that in *Regenia ocellata* the corpora adiposa are enclosed in "a separate sac of the peritoneum," whereas the former are not enclosed in a special sac as in some other genera.

In the Chamæleonidæ the mesenteries include the usual hepatoventral, epigastric, gastrohepatic and right hepatic, the last including the right lung. The left lung is included in a left hepatogastric, a feature seen in few other groups, notably in the Anoline Iguanidæ. There is also a left hepatolateral, from the liver to the left body wall, having a direction diagonal to the long axis of the liver in *C. basiliscus.*

In the Nyctisaura I have been able to examine the mesenteries in relatively few genera of the superfamily. I find in both Gecconidæ and Eublepharidæ the structure to be of the type most frequent in the Sauria; *i. e.;* a simple hepatoventral; a single gastrohepatic; a left gastropulmonary; and a right hepatic which embraces the right lung.

In the Agamidæ the mesenteries present the usual sheets, hepatoventral, gastrohepatic, left gastropulmonary and right hepatic,

[2] Proc. Zool. Soc., London, 1888, p. 98.

[3] Loc. cit., 1861, March.

which includes the right lung. I have noted the following modifications: In *Agama colonorum* the left gastropulmonary has become a right gastrohepatic by its continuing to the liver, a character observed in *Chamæleon* and the Anolinæ. There is also in this species a left hepatomarginal. In *Megalochilus auritus* there is a right hepatoventral, as in *Phrynosoma.*

In the Iguanidæ the hepatic mesenteries conform to the general type, with certain exceptions to be mentioned. Thus there are no right or left lateral hepatic mesenteries, and but one ventral. The right hepatic supports the right lung. There is frequently a rudimental right lateral hepatic which connects the long right apex of the liver with the right body wall. There is a gastrohepatic which generally spreads over the space enclosed in the bend of the stomach. There is no left gastroparietal sheet or band. The most remarkable deviation from this type (which I have verified in twenty genera) is found in the Anolinæ. Here the left lung, besides its superolateral connection with the stomach, is connected by a special sheet with the left part of the inferior face of the liver. Thus the latter organ is suspended by two sheets to the left side of the middle line. In genera where this is the case the two sheets are sometimes difficult to distinguish owing to their easy adhesion together. They may be separated by inserting a probe from the free caudad extremity of the lung.

Another variation from the normal type is seen in the presence of a right lateral hepatic sheet in *Phrynosoma* and *Polychrus* (in *Polychrus gutturosus* it is wanting in the one specimen examined). A left lateral sheet is present on the cephalad half of the liver in *Cyclura cornuta* and *Polychrus marmoratus.* It is rudimental in *Polychrus acutirostris,* and wanting in *P. gutturosus.* There is a gastroparietal band in *Cyclura cornuta,* which is joined by the apex of the peritoneum of the corpus adiposum.

In the Anguidæ the viscera do not display any exceptional features, except as to the serpentiform genera. The mesenteries are of the typical character, modified in *Ophisaurus* by the reduction of the left lung. The hepatoventral sheet is very near the left margin of the liver in *Pseudopus apus,* and the gastrohepatic and right hepatic are near together when slack.

In the Helodermatidæ the mesenteries of *Heloderma* are characteristic. There is a single hepatoventral, and the gastrohepatic has the usual position. The right hepatic goes to the right side of the stomach, becoming a right gastrohepatic, and does not extend to the dorsal peritoneum, a character in which it is unique in the Sauria. Posterior to the middle of the liver they unite on the middle line, as in the Teidæ. The lungs are attached to the adjacent parts of the gastric peritoneum by separate sheets, the right and left gastropulmonary. Besides these there is a strong sheet on each side extending from the superior side of the liver near the border, to the body wall, forming the right and left hepatolateral. The right hepatolateral does not extend along the right border of the liver beyond the cephalad half. The right gastrohepatic continues along the elongate right process of the liver to the genital fold of the peritoneum, and the apex of this process of the liver sends a recurrent sheet backward, which forms with the former, a funnel-shaped passage. This recurrent sheet might be regarded as a caudad hepatolateral. Dr. Shufeldt states[4] that *Heloderma* possesses the free ventral peritoneum found in *Varanus*, but this is not the case, as this structure is the usual one.

The peritoneum forms a transverse fold at the posterior part of the corpora adiposa, supporting the urinary bladder, and forming the cystic mesentery. It is but loosely attached to the corpora adiposa, which do not project freely from the body wall and hence have no special peritoneal pouch. They are elongate and coarsely subdivided.

In the Zonuridæ the mesenteries in the genus *Zonurus* are of the usual type. There are one hepatoventral, a gastrohepatic, a left gastropulmonary, and a right hepatic which encloses the right lung.

The mesenteric attachments of the liver are very characteristic in the Teidæ. There is but one suspensor, a median gastrohepatic, but this bifurcates above the middle of the organ, and each half diverges, and adhering to the caudad margin, extends to the lateral inferior body wall on each side. In *Tupinambis* these sheets are united on the median line for a distance posterior to the liver. The lungs are each attached to the stomach by a separate sheet. The left hepatoparietal sheet is always present in this family, but the right one is feeble in some genera, and is easily ruptured, as for instance in *Cnemidophorus*. I have examined the genera *Dracæna, Tupinambis, Callopistes, Amiva, Cnemidophorus, Centropyx, Tejus, Anadia* and *Oreosaurus*.

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[4] Proceeds. Zool. Soc., London, 1890, pp. 193–4.

In the Scincidæ, as in other families, in the serpentiform types the liver and stomach occupy a position caudad to the lungs, and so the latter do not appear in the mesenteric connections of the former, *e. g. Siaphus.* The mesenteries are the usual ones, but one peculiarity is very frequent though not universal in the family. The hepatoventral sheet is generally divided into two, a right and left sheet next the liver, forming a pocket which opens caudad. In the *Tiliqua scincoides* the two sheets only unite at the cephalic end of the liver, remaining separate throughout.

In the Anniellidæ the viscera display the following characters. The left lung is much smaller than the right lung and is proximally fused with it, so that there is but a single lumen. Right lung much enlarged and covering the alimentary canal below (ventrad). Liver considerably posterior to heart, long and narrow, with a small left lobe and a long right lobe extending to the reproductive cells. Gall bladder enclosed by the liver and exposed inferiorly, *i. e.*, occupying a foramen as in the Diploglossa. Alimentary canal distinguished into stomach, and a small and large intestine, without distinct colon. Stomach without curvature; small intestine moderately plicated, with lacertiform mesentery. Reproductive cells anterior, symmetrical; kidneys symmetrical, posterior. There is a single gastrohepatic mesentery from the middle line of the liver, and no right hepatic or lateral hepatics. Hepatoventral simple; plates of epigastric very loosely attached together. No pulmonaries at middle of liver.

The fusion of the lungs is a peculiarity that I have not noticed elsewhere among the Sauria. The left lung is like a diverticulum of the right, and posterior to the point of divergence from the latter is bound to it by connective tissue to the extremity. This fusion is a step nearer to obliteration than occurs in any of the serpentiform genera of Teidæ, Scincidæ or Anguidæ, where, though of reduced size, it is distinct from the right except at its proximal extremity.

In the Amphisbænidæ, as the left lung only is present in this family, there is but one gastropulmonary mesentery. The liver has a crescentic cross-section, and it is supported by two gastrohepatic mesenteries (*Amphisbæna alba* and *A. fuliginosa*), or by only one, and a right hepatic or hepatolateral, as it may be: (*Rhineüra floridana*). There is but one hepatoventral. The last described structure also characterizes *Euchirotes diporus.*

Since the above was written a paper has been published in the Proceedings of the Zoological Society of London (1895, p. 702) by Mr. G. W. Butler on the lungs of snakes, Amphisbænidæ, etc. Here the fact of the suppression of the right lung in the Amphisbænia is pointed out.

CATALOGUE OF THE SPECIES OF CERION, WITH DESCRIPTIONS OF NEW FORMS.

BY HENRY A. PILSBRY AND E. G. VANATTA.

The genus *Cerion*, or as it is commonly known, *Strophia*, is one of the most characteristic forms of West Indian land-molluscan life. With two exceptions the species are all insular; *C. incanum* and *C. Antonii* only, the former from South Florida Keys, the latter reported to be from Guiana, are continental. The Greater Antilles—Cuba, Hayti and Porto Rico, with the Virgin Is. and the entire group of the Bahamas, are inhabited by numerous species, with a multitude of local races. South of the larger islands named, if we include with Cuba the faunally dependent Cayman group and Isle of Pines, but one single species is found, *C. uva* of Curaçoa, singularly isolated in characters as well as geographically. Jamaica is without a species; and the genus also fails in the Caribbean chain.

In the main, each species is confined to some single island, or to a series of adjacent keys or islets; but there are numerous exceptions, where forms unquestionably conspecific are found on several islands separated by considerable distances.

The species are subject to a remarkable range of individual and local variation. Thus, many species vary from strongly and conspicuously ribbed to entirely ribless and smooth. In fact this is a common variation, incontestably established by the series we have examined of *Cerion dimidiatum, C. columna, C. regina, C. uva, C. maritimum, C. Sagraianum* and many other species. Color is equally variable, pure white species varying to heavily brown-mottled, and this not in one, but in many of the species. Absolute size of adults is almost as mutable as in *Cypræa;* and occasional individuals are abnormally shortened by the premature assumption of the features of maturity, giving them a stunted appearance.

All of these considerations render the study of the species one of unusual difficulty; and the older authors, unacquainted with the protean nature of the species, as with the usually restricted range of each, often failed to properly discriminate them. Thus, the several volumes of Pfeiffer's *Monographia Heliceorum Viventium* are un-reliable in dealing with many species, especially in respect to geographic distribution.

An American writer on natural history, Mr. C. J. Maynard, some years ago begun the study of this genus, and to his earliest publication on the subject we owe the first clear statement of some facts of prime importance: that the Cerions are excessively plastic, and locally modified into a considerable number of species and subspecies; that the range of some of these forms is excessively limited; and that former authors had failed to discriminate many really distinct species, "lumping" them under a few old names; and finally, that the aperture-armature, or "teeth" of the Cerions are variously arranged, and furnish ground for the division of the genus into several subgenera. Mr. Maynard, moreover, has discovered and described a large number of most interesting species and varieties, especially the Cayman Island group; so that his work on this genus has been an important one. However, in our opinion he has unduly multiplied species and subspecies, basing them on characters we hold to be too slight and inconstant, and his work is marred by inaccuracies of all kinds "too numerous to mention."

Our object in preparing the present list has been primarily to place before students a moderate estimate of the species of the group, specific values being held neither in extremely narrow nor very wide limits, but practically in conformity with the views represented by the leading English and American conchological authors of to-day.

We have taken this occasion to place on record the results of a careful study of a very large collection of shells of the genus, a collection including numbers of shells which have been identified by Bland, Swift, Pfeiffer, Dohrn, Gruner and others, as well as accessions, considerable in the mass, from Messrs. H. D. Van Nostrand, S. Raymond Roberts, W. H. Dall, C. J. Maynard and others.

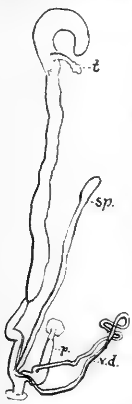
The soft anatomy of the Cerions is still but little known. Dr. Leidy, the Cuvier of American Zoology, has given figures of the the anatomy of *C. incanum* Binn.[1] W. G. Binney has figured jaw and teeth of the same species[2] and C. J. Maynard has more recently published figures of the jaws and soft anatomy of a species from the Cayman Is.[3] Leidy's figure unfortunately does not show the various systems of organs separately, and it is difficult to interpret

[1] Terrestrial Mollusks I, pl. xv, figs. ii-iv.
[2] Terr. Moll. V.
[3] Contributions to Science, Vol. I.

the confused masses and ducts of the generative and digestive tracts, shown crowded together. It appears, however, that the long spermatheca duct bears a diverticulum, and the vas deferens is of unusual length. Maynard does not seem to have been fortunate in his preparations, and his figures afford no data of assistance to us.

The only species seen by us in the flesh is *Cerion Yumaense* P. & V.;[4] the specimens examined being part of the type lot received from Mr. Henry Prime and corresponding to fig. 3 of pl. XI.

The penis (*p*) is a moderately stout sack from the termination of which the short retractor springs. Near the base of the penis the vas deferens (*v. d.*) enters; and this is of extraordinary length as shown in the figure. The spermatheca (*sp.*) has a long duct, without branch or diverticulum; and there is a large talon (*t*). Ovotestis not observed.



C. Yumaense P. & V.

A transverse section of penis-sack some distance above entrance of vas deferens shows a cavity with bipartite or dumb-bell shaped section, filled with a granular yellowish substance.

It will be seen that this differs from Leidy's figure in lacking the diverticulum of the spermatheca duct. It agrees with it in showing *an excessively long free portion of the vas deferens, inserted abnormally low on the penis;* and these will doubtless prove to be generic characters widely sundering *Cerion* from all other genera of which the genitalia are now known.

Subdivision of the Genus Cerion.

Four groups of subgeneric value may be distinguished by conchological characters. *Strophiops* only is known anatomically.

I. Axial and parietal folds wanting, EOSTROPHIA.

II. Axial fold in angle at root of columella; no parietal fold, CERION S. STR.

III. Axial and parietal folds present, the latter near middle of parietal wall, single and short, not over one-third of a whorl long, STROPHIOPS.

IV. Axial and parietal folds present, the latter very long and doubled, or short and interrupted, with an accessory denticle; rarely obsolete, DIACERION.

[4] The dissections and drawing are by Mr. Vanatta.

The first and second of these groups consist, at present, of one species each. *Strophiops* is by far the most numerous in species. We are unable to make any subgeneric division into long- and short-toothed forms; the various species present a perfectly graduated series. *Maynardia* Dall and *Longidens* Maynard are, therefore, in our opinion, merely subordinate divisions of *Strophiops*.

Genus **CERION** (Bolton, 1799.) Mörch, 1850.

Mörch, Catal. Yoldi, p. 63. Dall. Bull. M. C. Z. XXV, No. 9, p. 120
Strophia Albers, 1850, not of Meigen, 1832.

Subgenus **EOSTROPHIA** Dall, 1890.

1. **Cerion anodonta** Dall.*[5] Trans. Wagner Free Inst. Sci., III, p. 13, pl. 1, figs. 8c, 8d.

Miocene: Silex Beds, Ballast Point and Old Tampa Bay, West Florida.

1a. **Cerion anodonta floridanum** Dall.* *L. c.*, fig. 6.

Miocene: Ballast Point.

Subgenus **CERION** *s. str.*

Distribution, Curaçoa. This is the most distinct of the subordinate groups of the genus. The teeth of the inner whorls are frequently absent.

2. **Cerion uva** Linné.* Syst. Nat. (10), p. 765. Fér., Hist., pl. 153, f. 11–14.

Island of Curaçoa! The locality "Guadeloupe" is erroneous.

2a. **Cerion uva desculptum** P. & V.* Pl. XI, fig. 1.

Curaçoa.

Subgenus **STROPHIOPS** Dall, 1894.

Bull. Mus. Comp. Zool. Vol. XXV, p. 121 (October, 1894).
+*Maynardia* Dall, *l. c.* (type *S. neglecta* Mayn.).
+*Seniculus* Maynard, Contrib. to Sci., III, p. 17 (type *S. mumia* Brug.).
+*Umbonis* Maynard, Contrib to Sci., III, p. 28 (type *S. scalarina* Gundl).
+*Pinguitia* Maynard, Contrib to Sci., III, p. 30 (type *S.* "*dimidiatia*" Pfr.).
+*Longidens* Maynard. Contrib. to Sci., III, p. 39 (type *S. pannosa* Mayn.).
+*Multostrophia* Maynard, Contrib. to Sci., II, p. 177 (type *S. eximea* Mayn.).

Group of *C. pannosum* (Longidens Maynard).

Distribution, Cayman Islands. Maynard correctly separates this group of species from typical *Strophiops*.

3. **Cerion nanum** Maynard.* Contr. to Sci., i, p. 27.

Little Cayman.

[5] Species and varieties marked with an asterisk (*) are represented in the collection of the Academy of Natural Sciences of Philadelphia.

4. Cerion copium Maynard.* Contr. to Sci., i, p. 22.

Cayman Brac.

4a. Cerion copium parvum Maynard.* Contr. to Sci., i, p. 24.

Cayman Brac.

5. Cerion glaber Maynard.* Contr. to Sci., i, p. 25.

Cayman Brac.

5a. Cerion glaber perplexum Maynard.* Contr. to Sci., i, p. 71.

Cayman Brac.

6. Cerion levigatum Maynard.* Contr. to Sci., i, p. 12.

Little Cayman.

S. festiva Mayn.* *t. c.*, p. 17, is a more variegated form.

6a. Cerion levigatum acutum Maynard.* Contr. to Sci., i, p. 15.

S. nitela Mayn.,* *t. c.*, p. 73.
S. picta Mayn.,* *t. c.*, p. 18.

These seem to be very closely allied, differing from *acutum* merely in size and degree of mottling.

Little Cayman.

7. Cerion pannosum Maynard.* Contr. to Sci., i, p. 10.

S. fusca Mayn.* *t. c.*, p. 77. Seems to be the same thing differing only in color.
S. intermedia Mayn.* *t. c.*, p. 13. A smaller form.

Little Cayman.

8. Cerion lineotum Maynard.* Contr. to Sci., i, p. 20.

Little Cayman.

Group of *C. maritimum.*

9. Cerion dimidiatum Pfr. Zeitschr. f. Mal., 1847, p. 16.

P. proteus Gundlach mss., Pfr., Malak. Bl., VII, 1860, p. 19; Novit. Conch. t. 66, f. 13–22.

Gibara, Cuba.

An altogether ribless form occurs. The species varies toward the following.

10. Cerion incrassatum Sowb.* C. Icon., XX, pl. 1, f. 6.

Cuba, Gibara.

10a. Cerion incrassatum microdon P. & V.* Pl. XI, fig. 5.

Cuba.

11. Cerion multicostum Küster.* Conchyl. Cab., p. 77, t. 11, f. 6, 7.

Punta Maisi, Cuba.

12. **Cerion iostomum** Pfr.* Malak. Bl., 1854, p. 204.

Southern Cuba.

12a. **Cerion iostomum Arangoi** P. & V.* Pl. XI, fig. 12.

Cienfuegos, Cuba.

13. **Cerion Sagraianum** Pfr.* Zeitschr. f. Malak., 1847, p. 15.

S. marmorata Maynard, Contrib. to Sci., III, p. 12 (not of Pfr.!).
S marmorata polita Maynard, Contrib. to Sci., III, p. 14.
S. obscura Maynard,* Contrib. to Sci., III, p. 21.

Cuba, Cayo Galindo, Cayo Piedra del Norte, Cardenas.

There are two forms of *C. Sagraianum*, one smooth (typical), the other with fine riblets; but the distinction does not seem to be of subspecific value, being too variable in the series before us. The cone of the spire is always minutely sculptured. The intergradation of *S. obscura* Mayn. is established by specimens before us.

14. **Cerion maritimum** Pfr.* Archiv f. Naturg., 1839, I, p. 353; Conchyl. Cab., t. 9, f. 10, 11.

14a. **Cerion maritimum sublævigatum** P. & V.* Proc. A. N. S., May 4, 1895, p. 209; Conchyl. Cab., t. 9, f. 12, 13.

Matanzas, Cuba.

15. **Cerion incanum** Binn.* Terr. Moll., II, p. 318 (1851).

P. detrita Shutt., mss.

Florida Keys; Eastern Cuba.

16. **Cerion hyperlissum** P. & V.* Pl. XI, fig. 10.

Cuba.

Group of *C. regina*.

17. **Cerion Weinlandi** 'Kurr' Martens.* Malak. Bl., VI, 1859, p. 207, Novit. Conch., t. 84, f. 1, 2.

Crooked Id., Bahamas.

18. **Cerion nudum** Maynard.* Contr. to Sci., I, p. 29.

Long Island. Near to *C. Weinlandi*, but smaller.

19. **Cerion incanoides** P. & V.* Proc. A. N. S., May 4, 1895, p. 209. Pl. XI, fig. 15.

Turks Island.

20. **Cerion regina** P. & V.* Proc. A. N. S., 1895, May 4, 208. Pl. XI, figs. 23, 24.

Turks Island.

20a. **Cerion regina comes** P. & V.* Proc. A. N. S., 1895, May 4, 208.

Turks Island.

20b. Cerion regina eucosmium P. & V.* Proc. A. N. S., 1895, May 4, p. 208. Pl. XI, fig. 21.

Turks Island.

20c. Cerion regina percostatum P. & V.* Proc. A. N. S., 1895, May 4, p. 208. Pl. XI, fig. 22.

Turks Island.

20d. Cerion regina Swiftii P. & V.* Proc. A. N. S., 1895, May 4, p. 208.

Turks Island.

20e. Cerion regina brevispirum P. & V.* Proc. A. N. S., 1895, May 4, p. 209. Pl. XI, fig. 25.

Turks Island.

21. Cerion regium Benson.* Ann. and Mag. Nat. Hist. 2d. Ser., IV, p. 125; Conchyl. Cab., t. 17, f. 13, 14.

Pupa decumana of authors, not Fér.

22. Cerion columna P. & V.* Proc. A. N. S., 1895, May 4, p. 207. Pl. XI, fig. 17.

Inagua, Bahamas.

22a. Cerion columna validum P. & V.* Proc. Acad. Nat. Sci. Phila., 1895, p. 207. Pl. PI, fig. 18.

Inagua.

23. Cerion calcareum Pfr. Zeitschr. f. Malak., 1847, p. 83; Conchyl. Cab., *Pupa*, pl. 19, f. 4, 5.

Habitat unknown. Probably will be found in the Inagua group.

24. Cerion sarcostomum Pils. & Van.* Pl. XI, fig. 16.

Little Inagua.

25. Cerion infandum 'Shutt.' Poey.* Memor., II, p. 29–60; Malak. Bl., 1854, t. 3, f. 4, 5.

Punta Gorda en Matanzas, Cuba.

26. Cerion mumia Brug.* Encycl. Meth., I, p. 348, N. 87, Fér. Hist., t. 153, f. 5, 6.

S. fastigata Maynard, Contrib. to Sci., 1896, Vol. III, p. 6, 7.
S. eurystoma Maynard, Contrib. to Sci., 1896, Vol. III, p. 7–9.

Cuba.

26a. Cerion mumia chrysalis Fér.* Hist., t. 153, f. 1–4.

S. scripta Maynard, Contrib. to Sci., iii, p. 34.
S. scripta obliterata Mayn., Contrib. to Sci., iii, p. 5.
S. media Mayn., Contrib. to Sci., iii, p. 18.

Differs from *mumia* only in the insufficient character of being mottled in zig-zag pattern. The various forms described by Maynard are well represented in our series, with intermediate forms also. They have no racial characters worth naming.

26b. Cerion mumia magister P. & V.* Pl. XI, fig. 4.

Larger, stouter, more cylindrical, closely mottled and variegated; aperture large, with *the lip broadly flaring*, reflexed.

Matanzas and other localities in eastern Cuba. This is probably *S. mumia* Mayn., Contrib. to Sci., I, p. 190; not of Bruguière.

27. Cerion mumiola Pfr.* Archiv f. Naturg., 1839, I, p. 353; Malak. Bl., 1854, t. 3, f. 7, 8.

Matanzas; Bahia Honda, Cuba.

27a. Cerion mumiola major Pfr.* Malak. Bl., 1854, t. 3, f. 6.

Cuba.

28. Cerion sculptum Poey. Mémorias, II, p. 30, pl. 2, f. 22.

Cuba.

Group of *C. scalarinum.*

This is one of the most peculiar groups of the genus, unique in the sculpture of fine spiral lines crossed by very prominent ribs. Maynard proposes for it the subgeneric name *Umbonis*, but we would hardly accord the group so high a rank.

29. Cerion scalarinum 'Gundlach' Pfr. Novit. Conch., p. 367, pl. 84, f. 16, 17.

Gibara, Cuba.

30. Cerion Johnsoni Pils. & Van.* Proc. A. N. S., 1895, May 4, p. 207. Pl. XI, fig. 30.

S. faxoni Maynard, Contrib. to Sci., iii, p. 32.

Cuba.

31. Cerion felis P. & V.* Proc. A. N. S., 1895, May 4, p. 206. Pl. XI, fig. 29.

Cat Island, Bahamas.

Group of *C. glans.*

32. Cerion lentiginosum Mayn.* Contr. Sci., 1889, Vol. 1, p. 75, t. 7, f. 18.

Rum Key, Bahamas.

There is also a pure white form.

33. Cerion album Maynard.* Contr. Sci., 1889, Vol. 1, p. 74. t. 7, f. 17.

Rum Key. A closely allied form with liver-brown lip occurs on Eleuthera, but our specimens are only "crab shells," not suitable for exact comparisons.

33a. Cerion album Brownei Maynard.* Contr. to Sci., I, p. 196.

Rum Key.

34. Cerion Abacoense P. & V.* Proc. A. N. S., 1895, May 4, p. 209. Pl. XI, fig. 11.

Abaco, Bahamas.

34a. Cerion Abacoense Bendalli Pils. & Van.* Pl. XI, fig. 13.

Abaco.

35. Cerion Ritchiei Maynard.* Contr. Sci., 1894, Vol. 2, p. 135, f. 41 a. b.

Highburn Key.

35a. Cerion Ritchiei eburneum Maynard.* Contr. to Sci., 1894, Vol. 2, p. 144, f. 45 a. b. Costæ slightly closer.

U Key, Exuma group.

35b. Cerion Ritchiei elongatum Mayn. T. c. p. 148.

Same locality as preceding, with which it is probably identical.

35c. Cerion Ritchiei Grayi Maynard.* Contr. Sci., 1894. Vol. 2, p. 138, f. 42 a. b.

S. Grayi gigantea Mayn., *t. c.*, p. 141, f. 44 a., *Grayi pumilia* Mayn. *t. c.*, p. 143, f. 44 b.

Highburn Key, Bahamas.

35d. Cerion Ritchiei Vannostrandi P. & V.*

Similar to *C. Grayi giganteum* Mayn., but smooth and snow-white. Aperture small, built forward, its margins not reflexed. Alt. 40, diam. 16 mm.

36. Cerion Maynardi P. & V.* Proc. A. N. S., 1895, May 4, p. 210. Pl. XI, fig. 31.

Abaco, Bahamas.

37. Cerion griseum Maynard.* Contr. to Sci., 1894, Vol. 2, p. 159, f. 51.

S. glans Mayn.* *t. c.*, p. 15, f. 50. Fresh Creek, Andros.
S. bimarginata Mayn.* *t. c.*, p. 164, f. 53. Green Key.
S. bimarginata cera Mayn.* *t. c.*, p. 168, f. 54. Green Key.
S. Pilsbryi Mayn.* *t. c.*, p. 170, f. 53. Goat Key.
S. Pilsbryi evolva Mayn.* *t. c.*, p. 173, f. 57. Goat Key.
S. crassicostata Mayn.* mss. Andros.

Type from about one mile N. of Calabash Bay, Andros.

37a. Cerion griseum regulum Mayn.* Contr. to Sci., 1894, ii, p. 161, f. 52.

Fresh Creek, Andros.

37b. Cerion griseum restrictum Mayn.* Contr. to Sci., 1894, Vol. 2, p. 175, f. 58.

Goat Key.

38. Cerion glans Kuster.* Conchyl. Cab., p. 74, t. 11, f. 1, 2.

? *Pupa tumidula* Desh. in Fer. Hist., pl. 153, f. 8.
S. Curtissii Mayn.* Contrib. to Sci., 1894, Vol. 2. p. 107, f. 33. Waterloo, Nassau, N. P.
S. Curtissii nivea Mayn.* *t. c.*, p. 112, f. 34 a, Waterloo, Nassau, N. P.
S. cinerea Mayn.* and varieties *robusta*, *tracta* and *mutata*, *t. c.*, p. 119, f. 35–37. N. P.
S. neglecta and *var. agava* Mayn.* *t. c.*, p. 150, f. 47. N. P.
S. Carlotta Mayn.* *t. c.*, p. 156, f. 49. Fort Charlotte, N. P.
S. albea Mayn.* *t. c.*, p. 128, f. 28. Spruce Key.
S. Coryi Mayn.* *t. c.*, p. 129, f. 39. N. P.

Nassau, New Providence, may be considered type locality for *C. glans*.

38a. Cerion glans Thorndikei Maynard.* Contr. to Sci., 1894, Vol. 2, p. 116, f. 34, b, c, d.

Waterloo, Nassau, N. P.

This variety, like the next is not trenchantly defined.

38b. Cerion glans varium Bonnet.* Rev. et Mag. Zool., XVI, 1864, p. 71, t. 6.

P. zebra Weinland, Sowb., Conch. Icon , pl. 2, f. 12 a, b. (1875).

New Providence.

Under this head may be grouped the mottled and maculated forms with comparatively delicate, narrow riblets. Intergradation with the maculated forms with slightly stronger ribs, such as "cinerea mutata," "Curtisii," "cinerea tracta," etc., of Maynard, may be expected. Gods and men may well stand aghast at the splitting of *C. glans* recorded above.

C. griseum is doubtfully distinct from *glans*. We leave it separate, because in the average, the two are distinguishable, and they inhabit different islands.

39. Cerion martinianum Kuster.* Conchyl. Cab., p. 75, t. 11, f. 3, 4.

Habitat———— ?

40. Cerion Blandi Pils. & Van.* Pl. XI, fig. 7.

Turks Island.

Group of *C. Agassizii*.

41. Cerion Agassizii Dall.* Bul. Mus. Comp. Zool., 1894, Vol. XXV, p. 120.

Nassau Ridge, New Providence, fossil in the calcareous sand-rock.

42. Cerion Eleutheræ P. & V.* Pl. XI, figs. 19, 20.

Eleuthera.

43. Cerion gubernatorium Crosse.* Journ. Conch., 1869, p. 186; Journ. Conch., 1870, t. 2, f. 4, lower figure.

New Providence, Bahamas.

Group of *C. crassilabre*.

44. Cerion rude Pfr.* Malak. Bl., II, 1855, p. 102, t. 5, f. 1, 2.

St. Croix. A quaternary fossil.

45. Cerion Yumaense P. & V.* Proc. A. N. S., 1895, May 4, p. 210.

S. ferruginea Maynard, Contrib. to Sci., 1896, Vol. III, p. 19–21.

Yuma River, Hayti.

46. Cerion crassilabre Shuttlew.* Sowb., Conch. Icon., 20, t. 2, f. 14.

Porto Rico, Virgin Is.

The locality given by Sowerby, "India" is a mistake. Porto Rico may be considered the type locality, for here large specimens such as that figured by Sowerby occur. They are either maculated or unicolored. On Anagada a short, egg-shaped race is found. On Necker Island the shells are pure white, but white ones also occur at Ponce and Puna, Porto Rico.

46a. Cerion crassilabre Sallei P. & V.* Pl. XI, fig. 6.

Small and *cylindrical;* creamy, maculated on the terminal cone. Alt. 19, diam. 7·5 mill. San Domingo (Sallé).

47. Cerion Antonii Küster. Conchyl. Cab., *Pupa*, p. 92, pl. 10, f. 7, 8.

Berbice (British Guiana).

This species is unknown to us.

Group of *C. cyclostomum.*

48. Cerion cyclostomum Kuster.* Conch. Cab., II, p. 6, t. 1, f. 5, 6.

? *Pupa Kusteri* Pfr., Proc. Zool. Soc., 1852, p. 69.

Cuba.

49. Cerion pinerium Dall.* Proc. U. S. Nat. Mus. 1895, p. 6.

Isle of Pines.

50. Cerion tenuilabre Gundl.* Malak. Bl., XVIII, 1870, p. 91.

Barigua en Baracoa, Cuba.

50a. Cerion tenuilabre pygmæum Pils. & Van.* Pl. XI, fig. 9.

Gibara, Cuba.

51. Cerion microstomum Pfr.* Malak. Bl., 1854, p. 207, t. 3, f. 15, 16.

Punta Jiacos, Cayo Paredon Grande, Cuba.

52. Cerion Cumingianum Pfr.* Proc. Zool. Soc., 1852, p. 68.

Hab.———— ————?

53. Cerion Gundlachi Pfr.* Zeitschr. f. Malak., 1852, p. 175, t. 1, f. 39–42.

Punta de San Juan, Cuba.

Group of *C. Martensi.*

54. Cerion Milleri Pfr.* Malak. Bl. XIV, 1867, p. 129; Novit. Conch., t. 84, f. 6–13.

Duck Key, Exuma group.

55. Cerion Gruneri Pfr.* Zeitschr. f. Malak., 1847, p. 15.

Sagua de la Grande, Cuba.

56. Cerion venustum Poey. Memorias, II, p. 30.

Cuba. This species is unknown to us, and perhaps identical with *C. Gruneri.*

57. Cerion Martensi Weinl.* Malak. Bl., IX, 1862, p. 164; Novit. Conch., t. 84, f. 3–5.

Crooked Island, Bahamas.

58. Cerion eximeum Mayn.* Contr. to Sci., 1894, Vol. 2, p. 177, f. 59.

Cat Island. We have a small form; alt. 14½–18 mm. from San Salvador.

58a. Cerion eximeum agrestinum Mayn.* Contr. to Sci., 1894, Vol. 2, p. 179, f. 60.

New Providence. A pure white specimen was collected by Mr. W. Bendall, and kindly presented to the Academy, with others varying from sparsely to heavily marked. The claim of this variety to distinction rests solely on its locality. The shells of *eximeum* and *agrestinum* are often indistinguishable.

59. Cerion multistriatum Pils. & Van.* Pl. XI, fig. 8.

Crooked Island.

Group of *C. vulneratum.*

60. Cerion inflatum Mayn. Contr. to Sci., I, p. 126.

Galena Point, Auklin Is.

61. Cerion marmoratum Pfr.* Zeitschr. f. Mal., 1847, p. 83; Conch. Cat., t. 19, f. 10–12.

Cat Island, Bahamas (according to Bland.).

62. Cerion vulneratum Küster.* Conch. Cat., p. 161, t. 19, f. 16–18.

Gibara, Cuba.

Subgenus **DIACERION** Dall, 1894.

Bull. Mus. Comp. Zool. 1894, Vol. XXV, p. 122.

Group of *C. striatellum* (*Paracerion* Pils. & Van., 1895.)

See Proc. Acad. Nat. Sci. Phila., 1895, p. 206.

Distribution, Cuba. Maynard's name *Tridentistrophia* (Contrib. to Sci., III, p. 9, 1896) is a synonym. The group has much affinity with *Diacerion*, but the parietal folds are short.

63. Cerion tridentatum P. & V.* Proc. A. N. S., 1895, May 4, p. 206. Pl. XI, fig 27.

Cuba.

64. Cerion striatellum Fer.* Icon. Regne Animal, Moll., 1829–1843, p. 60, t. 6, f. 12.

Cabo Cruz, Cuba.

65. Cerion basistriatum P. & V.* Proc. A. N. S., May 4, 1895, p. 206.

Cabo Cruz, Cuba.

Group of *C. rubicundum* (*Diacerion* Dall).

Distribution, Inagua. The species or forms of this group form an excessively complex problem, which is far from being satisfactorily solved by the material yet studied. *C. Bryanti, rubicundum* and *Dalli* appear to be stages in a continuous or almost continuous series of variations. *C. Dalli* is the largest form, with the peculiar armature of the aperture most highly developed. *C. rubicundum* is more slender, often much smaller, with the armature less developed in many specimens. *C. Bryanti* is decidedly smaller, thinner, with the teeth reduced to a mere vestige in the typical form, although specimens occur which seem to establish its intergradation with *rubicundum* in tooth arrangement. *C. Bryanti* may be regarded as a stunted race of *Diacerion* which has re-assumed the characters of the group *Maynardia.*

C. Dalli varies from the fine-ribbed typical form with as many as 63 riblets on the last whorl, to a rather coarsely sculptured surface, 27 ribs on last whorl (40 specimens examined, including one of type lot).

C. rubicundum varies in the same way, Maynard's *S. ianthina* and *S. pallida* being coarse forms. Some examples before me are more elongated and coarse-ribbed than Maynard's types of *ianthina,* but the integradation effaces specific lines for these forms.

There is likewise a very stout variety of *C. Bryanti,* and as already mentioned, the specimens vary from almost toothless to the typical *Maynardia* dentition, and onward toward the condition of *C. rubicundum.* We are indebted to Mr. H. D. Van Nostrand for a large series of these species and varieties.

66. **Cerion Bryanti** Pfr.* Malak. Bl. XIV, 1867, p. 130; Novit. Conch., t. 84, f. 14, 15.

Inagua.

67. **Cerion rubicundum** Menke.* Catal. Malsb., p. 8; Conchyl. Cab., t. 9, f. 8, 9.

S. ianthina Mayn.* Contr. to Sci., 1889, Vol. 1, p. 69, t. 2, f. 13.
S. pallida Mayn.* Contr. to Sci., 1889, Vol. I, p. 70, t. 2, f. 14.

Great Inagua.

68. **Cerion Dalli** Mayn.* Contr. to Sci., Vol. 1, 1889, p. 128, t. 13, f. 23.

Great Inagua.

69. **Cerion cylindricum** Mayn. Contr. to Sci., 1896, p. 34–36, pl. 7, figs. 3, 4.

Great Inagua. We have not seen this form and know nothing of its status.

70. **Cerion duplodon** P. & V.* Pl. XI, fig. 26.

Bahamas.

UNDESCRIBED OR UNRECOGNIZED SPECIES.

S. orbicularis Maynard. Contr. to Sci., I, pl. 16, f. 6a, b. Undescribed; no locality assigned.

S. viola Maynard. Contr. to Sci., I, pl. 16, f. 5a, b. Undescribed; no locality assigned.

Pupa capillaris Beck. Index Molluscorum, p. 82. Undescribed. "I. Antill."

Pupa elegans Beck. Index Molluscorum, p. 82. Undescribed. "I. Antill."

Pupa conus Beck. Index Molluscorum, p. 82. Undescribed. "I. Antill."

Pupa strobilus Beck. Index Molluscorum, p. 82. Undescribed. "I. St. Domingo."

Helix (*Cochlodonta*) *decumanus* Fér., Prodr., p. 59 (undescribed) =*Pupa decumana* Gray, Ann. of Philos., N. ser., 1825, IX, p. 413, referring to Lister, pl. 588, f. 47, is unrecognizable with any reasonable degree of certainty, but *may* be *Pupa multicosta* Küster.

Turbo alvearia Dillwyn, Descript. Catal., II, p. 862,=*Bulimus fusus* Brug., Encycl. Méth., I, p. 348,=Lister, pl. 588, f. 49, is an unrecognizable form, similar to *Gibbus palanga*.

DESCRIPTIONS OF NEW AND LITTLE-KNOWN SPECIES AND VARIETIES.[6]

Cerion uva desculptum. Pl. XI, fig. 1.

Shell similar to *C. uva*, but differs in lacking the strong, regular ribs characteristic of that species, or in having them very few, weak and irregular.

Alt. 22, diam. 9; apert. alt. 7½, width 6½ mm.

Alt. 19, diam. 9; apert. alt. 7, width 6 mm.

Curaçoa.

A sectionized specimen shows no internal sets of laminæ, but these are frequently wanting in specimens of the typical *C. uva*. Of the latter a good many figures have been published.

Cerion incrassatum microdon Pilsbry & Vanatta. Pl. XI, fig. 5.

Shell varying from cylindric to stout oval, strong and solid; whitish with some inconspicuous gray flecks. Whorls 8½ to 9½, the first one smooth, next finely and regularly costellate, following whorls

[6] See also Proc. Acad. Nat. Sci., Phila., 1895, p. 206. Separate copies issued May, 4, 1895.

with coarser riblets becoming regular, curved, moderately coarse ribs on the cylindrical portion, on base of last whorl obsolete or subobsolete. Latter 3 to 4 whorls of about equal diameter, those above forming rather a long cone. Aperture rounded, truncate above, white within. Peristome white, narrowly expanded and reflexed, obtuse; parietal callus very thin or moderate. Axial fold inconspicuous from in front; parietal tooth extremely small, short.

Alt. 21½, diam. 10½; alt. of aperture 8½ mm.

Alt. 19½, diam. 9½; alt. of aperture 8 mm.

Alt. 18½, diam. 10; alt. of aperture 7 mm.

Cuba.

While this species is very much smaller than *C. incrassatum*, and has the parietal tooth extremely small or almost obsolete, still in figure and sculpture it resembles the larger shell, and may be considered a variety of it until further information is received.

C. incrassatum, like the very closely allied *C. dimidiatum*, has a smooth form which intergrades with the stoutly ribbed typical shells. The earlier whorls have the minute sculpture as in the type form, but to the unaided eye the surface appears smooth.

Cerion iostomum Pfeiffer. Pl. XI, fig. 14.

This species has not been figured. It was described from the south coast of Cuba living among Prickly Pears. Subsequently it was reported from Turk's Island and Great Inagua (see Bland, Ann. Lyc. Nat. Hist., N. Y., XI, p. 85), but having examined specimens from these localities, so labelled by Bland, we find them to be totally distinct species, having little save the purplish-brown color of the mouth, in common with the true *Pupa iostoma* of Pfeiffer's first description.

The specimen shown in our figure answers to the description of Pfeiffer in all respects save that the median whorls are only obsoletely ribbed, hardly "*distanter plicato-costata*"—more like the "*var. β.*" The post-nepionic whorls of the cone are "*conferte costulatum;*" the cone itself "*corneo-marmoratum*", suture conspicuously "*exserto-marginata,*" and the corrugation of last whorl and color of aperture ("*intus violacea*") are likewise in agreement. The specimen figured is 2 mm. shorter than Pfeiffer's. Alt. 30, diam. 12; alt. of aperture 12 mm.

Pfeiffer's type measured, alt. 32, diam. 12; alt. of aperture 13 mm.

Cerion iostomum Arangoi Pilsbry & Vanatta. Pl. XI, fig. 12.

Shell similar to the type in form, but smaller. Latter *two* whorls only of equal diameter, those above forming a rather long cone. Whorls $8\frac{1}{2}$ to 9. Surface *closely and regularly ribbed* throughout (except the smooth nepionic whorls), the ribs mainly white, interstices purplish-brown, mottled with white. Sutures without noticeably exserted margination. Aperture deep, rich purple within.

Alt. $23\frac{1}{2}$, diam. $10\frac{2}{3}$; alt. of aperture 9 mm.

Alt. $18\frac{2}{3}$, diam. 9; alt. of aperture 8 mm.

Alt. 24, diam. $10\frac{2}{3}$; alt. of aperture $9\frac{2}{3}$ mm.

Cienfuegos, Cuba (R. Arango).

Strikingly different from *iostomum* at first sight, but we believe it to be closely allied and probably a subspecies thereof.

Cerion hyperlissum Pilsbry & Vanatta. Pl. XI, fig. 10.

Shell moderately strong, much elongated, cylindrical, the latter four whorls of about equal diameter, those earlier gradually tapering, forming an obtuse cone with slightly convex outlines. Pinkish-brown (with more or less white maculation), the riblets white. Whorls $11\frac{1}{2}$, weakly convex, those of the cone smooth, the rest sculptured with rather fine riblets narrower than the intervals, about 36 in number on each of the several later whorls. Umbilicus a short rimation, compressed.

Aperture ovate, decidedly higher than wide, the throat flesh-tinted. Peristome white, well reflexed and revolute, thickened; parietal callus light, its edge hardly thickened; parietal fold median, very long, one-fourth to one-third of a whorl in length.

Alt. $32\frac{1}{2}$, diam. 10; alt. of aperture 12 mm.

Alt. $29\frac{1}{2}$, diam. 10; alt. of aperture 11 mm.

Cuba.

This species has the unusually long parietal tooth of the Cayman Island Cerions. For the rest, it does not differ remarkably from such Cuban forms as *C. maritimum.* The whorls of the cone are ribless.

A form also referable to this species is much striped and maculated with fleshy-brown and white, the riblets being finer.

Cerion regina Pilsbry & Vanatta. Pl. XI, figs. 23, 24.

Shell thick, subcylindrical, gradually tapering above, *the long terminal cone passing gradually into cylindrical portion;* lower 3 whorls of about equal diameter; apex obtuse; earlier whorls not striate; chalk-white and dull, the smoothness of the surface but little broken by slight growth-lines, *the basal whorl irregularly and rather distantly costate,* at least on its latter half. Whorls 10 to 10½, *flat, with superficial, seam-like sutures.* Last whorl suddenly ascending in front, much compressed and *pinched toward the base.* Umbilicus open or perforate, with the usual arcuate rimation, below which it is *broadly excavated and flattened.*

Aperture oblong-cordate, slightly less than one-third the length of shell, higher than wide, dark or light brown within, rarely purplish. Peristome expanded and reflexed, its face convex but not much thickened, whitish, parietal callus moderate, its outer edge not raised. Axial lamina situated high, narrow and inconspicuous from in front. Parietal tooth low, small, varying from moderately short to long, central in position.

Alt. 31½, diam. 11¾ mill.

Alt. 33, diam. 12½ mill. (average typical specimen).

Alt. 38, diam. 13 mill.

Turk's Island, Bahamas. (Gabb, Swift).

Cerion sarcostomum Pilsbry & Vanatta. Pl. XI, fig. 16.

Shell solid and strong, subcylindrical, but slightly wider below; whitish. Whorls 11 to 11½, slightly convex, the earlier 6 forming a convexly tapering cone with *extremely obtuse apex,* almost dome-shaped at top; passing gradually into the cylindrical portion of shell, which consists of 5 to 6 whorls. Sculpture, somewhat irregular and unequal, straight ribs, about as wide as the intervals, about 25–30 on last whorl. These ribs are strongly developed on the cylindrical portion of the shell, but the cone is very densely, finely and sharply striated, the earliest whorl only being smooth.

Aperture *small,* less than one-third the total length of shell, pinkish-flesh colored in the throat; peristome well reflexed, recurved, more or less thickened on the inner edge of the face; *parietal callus thick and heavy, its edge elevated.* Parietal tooth rather strong and moderately long; axial fold moderately conspicuous.

Alt. 34, diam. 11½; alt. of aperture 10 mm.

Little Inagua, Bahamas.

Some specimens are larger than the above dimensions; one worn and broken "crab-shell" before us would probably be not less than 40 mm. alt. if perfect. It is not unlikely that forms occur with the ribs obsolete, as in the allied *C. columna.*

C. sarcostomum clearly belongs to the immediate group of *C. cretaceum* and *C. columna.* The latter has a very dark aperture, broadly flanged lip and less obtuse apex. *C. cretaceum* lacks sculpture except on the basal whorl, is absolutely cylindrical, with light mouth and excessively short terminal cone, while the present species is more tapering, with the cone decidedly longer, gradually passing into the cylindrical portion.

This species is, we believe, the first one to be reported from Little Inagua. It is extremely likely that *C. cretaceum,* described without locality, will prove to inhabit some part of the Inagua group, when it is re-discovered.

Cerion Abacoense Pilsbry & Vanatta. Pl. XI, fig. 11.

Shell cylindrical, solid and strong, entirely white. Latter three whorls of about equal diameter, preceding one slightly smaller, those earlier rapidly tapering to form a short cone; apex obtuse. Sculptured with rather close, strong and nearly straight riblets, as wide as, or narrower than the interstices, numerous (31–38 on last whorl), part of the riblets generally splitting on the base; $1\frac{1}{2}$ to $1\frac{3}{4}$ nepionic whorls free from riblets, and those of the following several whorls very fine, though distinct. Whorls $9\frac{3}{4}$ to $11\frac{1}{2}$, slightly convex, the last ascending as usual. Sutures well-marked. Umbilicus a nearly straight rimation terminating in an almost closed axial chink; umbilical area (back of columellar lip) small, with a bounding furrow below.

Aperture vertical, brought forward almost to anterior level of the cylinder; rounded, nearly as wide as high, obliquely truncate above. Peristome well reflexed, recurved, its face thickened and convex; parietal callus heavy, but thinned at outer edge. Axial fold moderate, parietal fold deep seated, low, and rather long.

Alt. 34, diam. 13; alt. of aperture 12 mm. (largest specimen).

Alt. $27\frac{1}{2}$, diam. 13; alt. of aperture $11\frac{3}{4}$ mm. (shortest specimen).

Abaco, Bahamas.

This beautiful species differs from *C. album* Maynard and *C. Maynardi* Pils. & Van. in the characters of the umbilical region and lip, as stated in our former paper on Cerion.[7]

Cerion Abacoense Bendalli Pilsbry & Vanatta. Pl. XI, fig. 13.

A miniature *Abacoense* (*q. v.*) in shape and sculpture. Whorls 10 to $10\frac{1}{2}$. White, closely *mottled with brown*, the nepionic whorls

[7] Proc. Acad. Nat. Sci., Phila., 1895, p. 209.

corneous-brown. *Aperture dark brown within;* peristome white, less heavy; *parietal callus thin, translucent; parietal tooth very small,* short.

Alt. 19½, diam. 8⅓; alt. of aperture 7 mm.

Alt. 21½, diam. 8⅔; alt. of aperture 7 mm.

Abaco, Bahamas.

This form at first sight looks extremely different from *C. Abacoense,* and as we have seen no intermediate examples it may well prove to be a distinct species. However, we consider it best to rank *Bendalli* as a subspecies, thereby keeping in sight its genetic relationship with the larger form; this might otherwise be easily overlooked, on account of its maculated coloring, which would at first incline one to look to another group of forms for its allies.

It is named in recognition of the services to science of Mr. Wilfred Bendall, who has recently published a list of the land snails of the Bahamas.

Cerion Eleutheræ Pilsbry & Vanatta. Pl. XI, figs. 19, 20.

Shell solid and strong; smoothish above, ribbed below; color lusterless; white, with a bluish-purple tint, most obvious around the base, cylindric-tapering, terminating above in a rather long slightly convex-sided cone which passes gradually into the cylindrical portion. Apex obtuse; whorls 10½ to 12½; nepionic 2½ whorls nearly smooth, slightly convex; following *whorls of the cone smoothish* to the naked eye, showing rather irregularly spaced wrinkles under the lens, *flat,* with seam-like *sutures, not in the least impressed.* Latter 4 whorls approaching equality in diameter, subregularly and rather strongly costate (at least the lower two whorls), the last one with about 27 (22 to 30) ribs, which do not split or double on the base, although sometimes there are some riblets intercalated there.

Aperture about one-third the shell's length, oblong or rounded, obliquely truncate above, liver-brown within. Peristome white, reflexed, the outer edge sharp and somewhat recurved, *inner edge built far forward, especially below,* bevelled outwardly; parietal callus either very thin or thick. Axial fold variable in prominence; parietal tooth very strong, long. Axis perforate, with a rather short rimation.

Alt. 29, diam. 11½; alt. of aperture 11 mm.

Alt. 33, diam. 11; alt. of aperture 11 mm.

Alt. 23½, diam. 11; alt. of aperture 9 mm.

Eleuthera, Bahamas.

This species is closely allied to *C. Agassizi* Dall and *C. gubernatorium* Crosse, of the island of New Providence. It has more remote affinity with *C. sarcostomum* P. & V. of Little Inagua.

From *C. Agassizi* it differs in never having the parietal callus raised in a strong ridge making the peristome continuous; the ribs are less sharp and narrow, etc. *C. gubernatorium* has a proportionally very large mouth, less thickened lip, finer riblets or none, and a glossy surface; moreover, while nearly white examples occur, it is generally much variegated. There can be no doubt of the close relationship of the three species, but judging from a series of 25 examples of *C. Eleutheræ,* a good series of *C. gubernatorium* and author's examples of *C. Agassizi,* they are specifically distinct.

A pair of specimens of *C. Eleutheræ* before us (from Krebs) are considerably streaked with brown, otherwise typical. Another specimen, received from Mr. Van Nostrand, is very small, alt. 18⅔, diam. 8 mm., and somewhat maculated. The costulation extends further up, and the peristome is not thickened. This probably represents a subspecies.

Cerion Blandi Pilsbry & Vanatta. Pl. XI, fig. 7.

Shell solid and strong, cylindric-tapering, the latter 3 whorls approaching equality in diameter, those above slowly tapering to form a long cone, gradually passing into cylindrical portion. Light grayish, with inconspicuous white flecking. Whorls 10, the nepionic 2¼ corneous, smooth, the following 2½ weakly, distinctly ribbed, later 4½ to 5 whorls *very sharply and roughly, strongly ribbed,* ribs narrow and high, 19 to 22 on each of the two or three later whorls. Umbilicus compressed, rimate, the area behind columellar lip excavated, smooth.

Aperture ovate, white within; peristome reflexed and recurved, not thickened; parietal callus heavy, forming a strong bar across the space between lip ends. Parietal tooth median, moderately strong.

Alt. 27½, diam. 11; alt. of aperture 10½ mm.

Alt. 26¾, diam. 11; alt. of aperture 10 mm.

Turk's Island, Bahamas.

This species resembles *C. glans* in general figure and the stout parietal callus; but the ribs are conspicuously different, peculiarly rough and unfinished in appearance, somewhat like *C. felis.*

Cerion tenuilabre pygmæum Pilsbry & Vanatta. Pl. XI, fig. 9.

Shell small and rather thin, varying from cylindric to short oval. Whorls 7 to 8½, the latter 2 to 3 of subequal diameter, those above forming a stumpy (often *very* short) cone. Rusty brown. Surface regularly costellate; apical whorl smooth, next whorl finely and regularly striated. Last whorl ascending as usual in front, having a very short umbilical rimation below.

Aperture brownish within, rounded, obliquely truncate above. Peristome white, blunt, slightly expanded; parietal callus thin. Axial fold inconspicuous; parietal tooth deep within and extremely small.

Alt. 10, diam. $6\frac{1}{3}$; alt. of aperture 4 mm.
Alt. 12, diam. 7; alt. of aperture 5 mm.
Alt. $15\frac{2}{3}$, diam. $7\frac{1}{2}$; alt. of aperture 6 mm.
Alt. $14\frac{2}{3}$, diam. $6\frac{1}{3}$; alt. of aperture 5 mm.
Gibara, Cuba.

The short, typical form of this variety is extremely peculiar in shape, being shorter than any other *Cerion*. Longer examples are more like *C. tenuilabre*, of which we consider it a small variety. Many specimens are before us.

Cerion multistriatum Pilsbry & Vanatta. Pl. XI, fig. 8.

Shell small and rather thin, short cylindrical; white, longitudinally marbled with gray or chestnut-brown. Whorls 8 to $8\frac{1}{2}$, the latter 2 or 3 about equal in diameter, the rest rapidly tapering, apex obtuse. Sculptured with excessively fine, close, sharp thread-like striæ, apical 2 whorls smooth. Aperture rounded obliquely, truncate; peristome narrowly reflexed; parietal callus very thin; axial fold median, moderate; parietal tooth extremely small.

Alt. 17, diam. 7; alt. of aperture $6\frac{1}{2}$ mm.
Alt. 14, diam. 7; alt. of aperture 5 mm.
Crooked Island, Bahamas.

This is a small, extremely fine striated form with very small parietal tooth. It is represented in the collection of the Academy by only five specimens, given by Mr. H. D. Van Nostrand, and originally from Bland.

Cerion basistriatum Pilsbry & Vanatta. Pl. XI, fig. 28.

Shell rather thin, cylindrical, the latter three whorls of about equal diameter, those above tapering rapidly, forming a straight-sided cone about one-third the shell's length. Surface rather smooth and glossy. Two corneous nepionic whorls smooth; succeeding one or two turns densely and regularly striated; rest of the shell smooth except for slight irregular growth-wrinkles, down to the last whorl, which is finely costulate. Color white with irregular longitudinal streaks and blotches of brown. Whorls 9, hardly convex, the last ascending slowly in front, rounded below, with a short umbilical rimation. Aperture about four-tenths the shell's length, rounded-ovate, nearly as wide as high, brownish within. Peristome thickened, outer lip expanded but scarcely reflexed, columellar lip reflexed; the terminations connected across the parietal wall by a strong, elevated callous ledge. Axial lamina small as seen from the mouth; parietal lamina small, often double, moderately long; a small denticle to the left of, and an elongated lamina behind and to the right of its inner end.

Alt. 18, diam. 9; apert., alt. 7, width 6½ mm.

Alt. 16½, diam. 8; apert., alt. 6, width 5½ mm.

Cabo Cruz, Cuba.

This species differs from *C. tridentatum* in its round aperture with strong parietal callus, and the costulate basal volution; from *C. striatellum* it differs in the much smoother surface, thinner substance, etc. The arrangement of parietal plicæ is of the same type as found in the two species mentioned.

Cerion tridentatum Pilsbry & Vanatta. Pl. XI, fig. 27.

Shell moderately thick, strong, cylindrical, the latter three whorls of about equal diameter, those preceding tapering to form a long cone about one-third the total length of shell. Chalky-white, mottled with corneous, especially on the cone, rather polished, the surface smooth except for slight growth-wrinkles, but a few whorls following the two smooth, corneous nepionic ones are seen under a strong lens to be densely striated, and the base of the last whorl has irregular striæ. Whorls 10, with just perceptible convexity, sutures well marked below. Last whorl ascending as usual.

Aperture *ovate*, about four-tenths the total length, much higher than wide, light brown in the throat; peristome rather thin, narrowly reflexed, white; columellar margin well reflexed; parietal callus thin, its edge indistinct, axial lamina small or inconspicuous from front aspect. Parietal lamina small, short, central, with a still smaller accessory denticle to the left of and beyond its inner termination, and another slightly to the right and deeper within; all visible without cutting the shell. Umbilical rimation short and curved.

Alt. 27½, diam. 10; apert., alt. 11, width 8¾ mm.

Alt. 25, diam. 9; apert., alt. 10, width 7½ mm.

Cuba (Robert Swift colln., A. N. S. P.).

This species superficially resembles closely the *C. incanum* of Key West, but differs in the ovate form of the aperture, sculpture of the earlier whorls, and the teeth of the aperture.

Cerion diplodon Pilsbry & Vanatta. Pl. XI, fig, 26.

Shell rather thin, cylindrical, the latter three whorls of about equal diameter, those above slowly tapering to form a rather long, convex cone. White, variegated with gray-white. Whorls 10½, slightly convex, two nepionic smooth, those of the cone very finely, sharply striate, the latter four with coarser riblets, much narrower than their intervals. Umbilicus a short, compressed rimation.

Aperture ovate, large and open, white, higher than wide. Peristome expanded and recurved, rather thick; axial fold basal; parietal fold narrow, nearly a half whorl long; an acccessory fold ascends around the root of the columella, but at the apertural termination approaches close to the main parietal lamella.

Alt. 29, diam. 10½; alt. of aperture 11 mm.

Bahamas, exact locality unknown.

This is an albino form of the Diacerion group, differing from *C. rubicundum* and its immediate allies in the greater distance between the two parietal lamellæ within.

Plate XI.

Fig. 1. *Cerion uva desculptum* Pils. & Van.
Fig. 2, 3. *Cerion Yumaense* Pils. & Van.
Fig. 4. *Cerion mumia magister* Pils. & Van.
Fig. 5. *Cerion incrassatum microdon* Pils. & Van.
Fig. 6. *Cerion crassilabre Sallei* Pils. & Van.
Fig. 7. *Cerion Blandi* Pils. & Van.
Fig. 8. *Cerion multistriatum* Pils. & Van.
Fig. 9. *Cerion tenuilabre pygmæum* Pils. & Van.
Fig. 10. *Cerion hyperlissum* Pils. & Van.
Fig. 11. *Cerion Abacoense* Pils. & Van.
Fig. 12. *Cerion iostomum Arangoi* Pils. & Van.
Fig. 13. *Cerion Abacoense Bendalli* Pils. & Van.
Fig. 14. *Cerion iostomum* Pfr.
Fig. 15. *Cerion incanoides* Pils. & Van.
Fig. 16. *Cerion sarcostomum* Pils. & Van.
Fig. 17. *Cerion columna* Pils. & Van.
Fig. 18. *Cerion columna validum* Pils. & Van.
Fig. 19, 20. *Cerion Eleutheræ* Pils. & Van.

Fig. 21. *Cerion regina eucosmium* Pils. & Van.
Fig. 22. *Cerion regina percostatum* Pils. & Van.
Fig. 23, 24. *Cerion regina* Pils. & Van.
Fig. 25. *Cerion regina brevispirum* Pils. & Van.
Fig. 26. *Cerion duplodon* Pils. & Van.
Fig. 27. *Cerion tridentatum* Pils. & Van.
Fig. 28. *Cerion basistriatum* Pils. & Van.
Fig. 29. *Cerion felis* Pils. & Van.
Fig. 30. *Cerion Johnsoni* Pils. & Van.
Fig. 31. *Cerion Maynardi* Pils. & Van.

REVISION OF THE NORTH AMERICAN SLUGS: ARIOLIMAX AND APHALLARION.

BY HENRY A. PILSBRY AND E. G. VANATTA.

The genera of slugs inhabiting North America have hitherto been discriminated by *external* characters, and those of the jaw and teeth. We purpose to indicate, in a series of papers of which this is the first, some of the more important of their *internal* features, particularly the genitalia and alimentary canal.

The genitalia have been utilized by Mr. W. G. Binney and others for the discrimination of species; and we have already considerable knowledge of these organs from his descriptions and drawings; but, of late, quite a new stress has been laid upon certain characters of the organs of generation. By Dr. Simroth, in Germany, and the senior author of this paper in America, characters of generic, as well as of still higher value, have been found in the genitalia. It is, therefore, important to review our data upon the anatomy of American slugs, to correct the numerous misinterpretations of organs which have arisen from lack of good material or other causes, and to expose the true generic characters and affinities of these animals, so far as may be possible in the present state of our knowledge.

As the *species* of slugs also rest largely upon characters of internal anatomy, their revision will be attempted; a work now most timely, in view of the fact that such a multitude of insufficiently defined specific and varietal names have been proposed that he who attempts the identification of a West Coast slug to-day is not only a bold man but also one probably doomed to a miserable failure.

The largest slugs of America, *Ariolimax* and *Aphallarion*, are selected for the present essay.

No correct figures or descriptions of the genitalia of these animals have yet been published. The true structure of the male organs of *Ariolimax* is here for the first time made known; and the genus *Aphallarion* is proposed for a new species, perhaps the largest American slug, remarkable in lacking a penis.[1]

[1] We must acknowledge our indebtedness to P. B. Randolph, of Seattle, Washington, and to Fred L. Button, of Oakland, California, for large series of slugs used in preparing this paper.

EXTERNAL CHARACTERS.

The external characters of *Ariolimax* and *Aphallarion* are described below. *Arion* differs from these American groups in the rounded, not keeled, back, the anterior breathing pore and the more posterior genital orifice.

JAWS AND TEETH.

The jaw in *Ariolimax* and *Aphallarion* is of the ribbed type usual in *Arionidæ*, and does not differ materially from that of *Arion*. The teeth offer no characters of generic importance, being of the general type found throughout *Arionidæ*. Those of the median part of the radula are of the Helicid form; the marginal teeth develop long mesocones, simulating somewhat the teeth of *Zonitidæ*, precisely as those of some *Endodontidæ* do.

DIGESTIVE SYSTEM.

In *Arion*, *Ariolimax* and *Aphallarion* the alimentary canal is distinctly differentiated into fore-, mid- and hind-gut. The short œsophagus leads into a capacious crop, *which is separated by a decided constriction* from the stomach, which lies near the posterior end of body. At the termination of the stomach the bile duct enters, near the origin of the intestine. The latter presents, after coiling spirally once around the visceral mass, an *anterior loop*, lying to the right of the albumen gland. Passing backward it coils in a reverse direction around the visceral mass and forms a *posterior loop*, which, in the American forms (Pl. XIII, figs. 2, 4) lies behind, in the European (*Arion*, Pl. XIII, fig. 3) above and anterior to the main mass of the stomach. From this loop the intestine passes forward, describing a spiral coil again reversed in direction, and terminates near the respiratory orifice on the right side of the body anteriorly.

The digestive systems of the three genera *Arion*, *Ariolimax* and *Aphallarion* differ only in subordinate features. In *Arion*, the stomach, as mentioned above, lies behind the posterior loop of the hind-gut. In *Ariolimax* and *Aphallarion* the posterior loop lies behind the stomach. *Aphallarion* differs from the other two genera in having a spiral turn less of the intestine. As usual in slugs there are four lengthwise folds of the gut.

A very long and (for a slug) complexly disposed intestine, and a complete separation of crop and stomach, are the peculiar characteristics of these great slugs. This will become more apparent when we compare it with the simpler and very different digestive tract in *Prophysaon, Limax,* or the Helices.

The liver extends forward nearly as far as the anterior loop of the intestine, and backward to the tail (Pl. XIII, fig. 1), enveloping and partly concealing the convolutions of the intestine in all three genera.

The suboral gland (Pl. XIII, fig. 1) is about half as long as body, and lies free, not imbedded in the muscles of the foot.

GENITALIA.

In *Arion, Ariolimax* and *Aphallarion* the genitalia lie quite differently in the body-cavity from those organs in *Limax* or *Prophysaon*, the whole system being crowded forward. The albumen gland (Pl.XIII, figs. 1 and 2) lies to the left of the anterior loop of the intestine, almost entirely forward of the middle of the body-cavity. The distal end of the albumen gland turns down the left side and extends part way across the body beneath, often showing a longitudinal impression made by the suboral gland. (This is seen at *l. gr.* in fig. 14 of Plate XIV.) At the base of the albumen gland the ovotestis is closely packed (Pl. XIII, fig. 1) in *Ariolimax* and *Aphallarion*, and its duct is largely imbedded in the albumen gland; but in *Arion* the ovi-sperm duct follows the course of the mid-gut backward, and the ovotestis is situated at the tail, behind the stomach (Pl. XIII, fig. 3).

The penis in *Ariolimax* lies obliquely across the viscera, overlying salivary glands and crop. It is seen removed from its natural position in Pl. XIII, fig. 1.

In treating of *Arion* and allied forms, Dr. Simroth, the distinguished German malacologist, has discriminated between a true penis and that enlargement of the anterior end of the vas deferens seen in *Arion*, etc., which he has termed the *Patronenstrecke.*

The senior writer, in dealing with Helices, made the same distinction.[2] The penis is an evertable sack, provided with a retractor muscle. The "*Patronenstrecke*," or, as we have termed it, the *epiphallus*, is not evertable, and has no retractor muscle; its function being merely to gather the spermatozoa into packets or spermatophores; and it is strictly homologous with the lower portion of the vas deferens of ordinary snails. In the vast majority of snails in which the vas deferens is modified into an epiphallus, it occurs in connection with a normally developed penis, as in fig. 14, Pl. XIV. In *Arion, Aphallarion, Prophysaon*, and some other genera, the true

[2] Proc. Acad. Nat. Sci. Phila., 1892, p. 388.

penis has been lost, and the epiphallus directly enters the atrium. In these forms the vagina assumes the function of an evertable penis, an extraordinary but by no means unparalleled instance of change of function.

These matters are here dwelt upon somewhat fully, because in all former American work on slug anatomy, no discrimination whatever has been made between the penis and the epiphallus, the very real and important morphologic facts involved being, therefore, entirely ignored.

The most prominent general feature of the genitalia in the three genera is the crowding of the main mass forward into the anterior half of the body-cavity.

GENERIC CHARACTERS.

The three genera of *Arionidæ* mentioned above are seen by the foregoing general description to present many common features in their digestive and generative organs, showing them to be nearly allied. Their main differential characters are shown in the following analysis:

I. Respiratory pore anterior, the genital orifice below it. No caudal mucus pore. Back rounded in adults. Stomach extending back of posterior loop of intestine. No penis, an epiphallus replacing it; ovotestis widely separated from the albumen gland, situated in the cavity of tail, behind the stomach (see Pl. XIII, fig. 3, *A. hortensis*), Genus ARION Férussac.

II. Respiratory pore behind middle of shield. Genital orifice near right tentacle. A caudal mucus pore. Back keeled, at least toward the tail. Posterior loop of intestine behind stomach. Ovotestis packed close to the base of albumen gland.

a. No penis, a short epiphallus replacing it (see Pl., XIV. fig. 12); right eye retractor passing to the left of genitalia.
Genus APHALLARION Pilsbry and Vanatta.

aa. A well developed penis, with short, fleshy retractor muscle; epiphallus more or less introverted in penis (see Pl. XIV, figs. 7, 8, 9, 14); right eye retractor passing between ♂ and ♀ branches of genitalia, Genus ARIOLIMAX Mörch.

One species of the Palæarctic genus *Arion* has been introduced by commerce within our limits, *A. hortensis* Fér. It occurs at Boston and New Bedford, Mass.; Poughkeepsie, N. Y.; Seattle, Wash., etc.

Genus **ARIOLIMAX** Mörch.

EXTERNAL CHARACTERS.—Body limaciform, its posterior half more or less keeled on the back; foot margin defined by deep pedal grooves, deeper toward the more or less distinct caudal mucus gland. Mantle oval, about one-fourth as long as the entire body, finely granular, the respiratory orifice at its posterior third near the right edge. Genital orifice behind the right eye tentacle. Orifice cf the suboral gland very broad. Integument scored by numerous grooves, longitudinal behind, obliquely descending below the mantle and for some distance along the flanks.[3] Sole tripartite, the divisions rather indistinct; alcoholic specimens having the median band smooth, lateral bands finely transversely wrinkled.

The principal internal characters of the genus are mentioned above. The extraordinary modification of the penis is fully described below.

Key to species of Ariolimax.

a. Mantle free anteriorly for about one-third of its length. Penis with terminal retractor, and nearly filled for its entire length by the invaginated epiphallus; vas deferens not enlarged, *Columbianus.*

aa. Mantle free anteriorly about one-fourth of its length. Penis hollow, with very broad retractor, beyond which it is attenuated; vas deferens enlarged into an epiphallus external to the penis, the invaginated portion small. *Californicus.*

A. Columbianus Gould. Plate XII, fig. 2.

Limax Columbianus Gld. in Terrestrial Moll. U. S., II, p. 43, pl. 66, f. 1 (1851); U. S. Expl. Exped., Moll., p. 3, pl. 1, f. 1 (1852); Tryon, Amer. Jour. Conch., III, p. 315 (1868).

Ariolimax Columbianus Mörch, Malak. Blätter, VI, p. 110 (1859). W. G. Binney, Amer. Journ. Conch., I, p. 48, pl. 6, f. 11–13; Land and Fresh Water Sh. N. A., I, p. 279, f. 496–501, (1869); Proc. Acad. Nat. Sci., Phila., 1874, p. 33, pl. 2, f. B. to H; Terr. Moll., V, p. 231, pl. v, f. E (dentition), pl. xii, f. C (genitalia); Man. Amer. L. Shells, p. 98, f. 58, 59, 60, 61; Third Supplement to Terr. Moll., V (Bull. Mus. Comp. Zool., XIX, No. 4), p. 211, pl. vi, f. A (mottled form) and f. G (penis).

[3] Mr. Charles Hedley, the accomplished Australian student of mollusk morphology, considers the oblique surface grooves as characteristic of the *Aulacopoda* generally. I quote this passage from a recent letter: "Besides the pedal grooves, tail pore and horn, the typically developed Aulacopod has a keeled tail and oblique secondary grooves. The pore may be lost by degeneration, so, too, may the oblique grooves; and the keeled tail may become flattened. Nevertheless, both are typical characteristics, and deserve mention in the diagnosis. Again, the *Holopoda* have long tapering eye tentacles, with bulbous tips, but the *Aulacopoda* have shorter cylindrical tentacles, less bulbous at tip and set wider apart."

There can be no doubt that the features mentioned by my friend are of very frequent occurrence in the *Aulacopoda*, while they do not occur in *Holopoda*; but they are not invariable, the pedal grooves being, I believe, the only strictly diagnostic external character of the group.—H. A. P.

Ariolimax Columbianus forma typicus Cockerell, Nautilus, V, p. 31 (1891).

Ariolimax Columbianus forma maculatus Ckll., Nautilus, V, p. 31. Binney, Third Suppl. to Terr. Moll., V (Bull. Mus. Comp. Zool., XIX, No. 4), p. 211, pl. vi, f. A.

Ariolimax Columbianus forma niger Ckll., Nautilus, V, p. 32.

Ariolimax subsp. Californicus forma maculatus Ckll., Nautilus, V, p. 31 (foot note).

Ariolimary Columbianus var. *stramineus* Hemphill, Nautilus, IV, p. 130 (Feb., 1891).

Geographic Distribution.—British Columbia (J. H. Keen); Victoria (H. F. Wickham); Washington, at Tacoma, and North Bend, about 25 miles east of Seattle in the foot-hills of the Cascade Mts. (P. B. Randolph); Nesqually (Case); Discovery Bay, Puget Sound (Dyes); San Juan Island (Hemphill); California, at St. Helena, Napa Co. (Hemphill); Santa Cruz Island (Hemphill, var. *stramineus*).

Color of alcoholic examples a lighter or darker shade of reddish-brown, or sometimes ochraceous. Foot margin without dark vertical lines (see descriptions of varieties).

Melanistic form: Color of alcoholic specimens a slightly reddish-brown, marked with large, irregular scattered black spots along the sides, and with a rounded black spot on the mantle behind the middle. In some specimens the spots on each side coalesce into a large, irregular black area.

Anterior third of mantle free.

Jaw (Pl. XIV, fig. 10) with 13 to 17 ribs and riblets, which sometimes do not denticulate the basal margin; but there is variation in this respect. Teeth about as in *A. Californicus* (*q. v.*), but the outer laterals have less lengthened cusps, and there are rather fewer bicuspid outer marginals. The differences between the teeth of the species are too slight to be of any practical diagnostic value.

Shell oblong, convex above, calcified in the middle, but with a broad, yellow, uncalcified peripheral portion. Nucleus median, near the posterior end. Length 12, breadth 6¼, convexity 1½ mm.

The general internal structure (pl. XIII, fig. 1) and the digestive tract (pl. XIII, fig. 2)[4] have been sufficiently described above.

The genitalia (Pl. XIV, fig. 7, typical form, and figs. 8, 9, black-spotted form) present a rather long and stout penis, receiving the vas deferens and a very short retractor muscle at its apex; upon opening the penis longitudinally (fig. 9) it is seen to contain a large

[4] Compare Binney's figure of the digestive system in Proc. Acad. Nat. Sci., Phila., 1874, pl. II, f. D, F.

inner body, which extends to the external orifice, where it terminates in a penis-papilla (fig. 9, *P. papilla*). This internal body consists of a fleshy cylindrical tube (fig. 9, *epi.*) enveloped by a very thin-walled and minutely corrugated outer tube (fig. 9, *sheath of epi.*). This structure we can only interpret as an introverted epiphallus, which has extended entirely to the proximal opening of the penis, carrying the penis-papilla at its summit. This will be more clearly seen in the annexed diagram. The clearer, because less advanced, penial morphology of *A. Californicus* bears out this view of the structure in *A. Columbianus*, which is, moreover, more readily seen in our preparations than in the flat figures, necessarily còmplicated by lines to show the ducts and layers of tissue not visible from the outside[5]

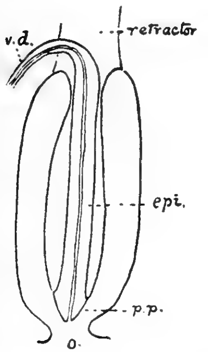


Diagram of the penis of Ariolimax. *v. d.* vas deferens; *epi.* invaginated epiphallus; *p. p.* perforated penis papilla, elevated on the epiphallus; *o.* external opening of penis.

The female side shows a rather long vagina, provided with a broad, split retractor muscle, inserted high. Spermatheca situated high, on a short duct. Other organs call for no special remark.

A. Columbianus is a dimorphic species in most, perhaps all, localities. There is a unicolored form, and one more or less heavily spotted or blotched with black. This maculated form has received the name "*forma maculatus*" Ckll. It is in no sense a true variety or subspecies but merely a "form," comparable to the *glaucus* form of the dimorphic *Papilio turnus*.

Cockerell's "*forma niger*" was described from one specimen in which the black blotches had coalesced, upper surface entirely black,

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[5] A similar penial structure has very recently been described and figured by Charles Hedley in the epiphallogonous genus *Xanthomelon* of the *Helicidæ*. In *X. fodinalis* Tate and *X. Adcockiana* Bednall, a tube occupies the penis cavity. "This," writes Hedley, "I interpret with some hesitation as an invaginated epiphallus, of which the distal end has grown to the atrium wall, and which has drawn after it into the penis sac both vas deferens and the retractor" (see Hedley's anatomical appendix to Professor Ralph Tate's report on the Mollusca of the Horn Expedition to Central Australia).

No such structure has been described before; and we are disposed to accept Hedley's ingenious interpretation of the morphologic problem. In *Xanthomelon* the invaginated epiphallus is attached at the proximal end of penis sac. This is not the case with *Ariolimax*, in which the invaginated structure is to that extent clearer.

from the humid British Columbian region, in which melanism is of common occurrence in snails, birds and mammals. In a series of several hundred examples we find great variation in the extent of the black marking.

We hazard little in assuming that "*A. Californicus forma maculatus*" Ckll. is identical with the spotted form of *Columbianus*, and has nothing whatever to do with the true *A. Californicus* Cooper. Like a good many "varieties" of slugs, this is "such stuff as dreams are made of."

We have opened numerous spotted Californian *Ariolimaces*, and found them invariably to have the extremely characteristic genitalia of *Columbianus*. Proof that a spotted form occurs in the other species is lacking.

A. Columbianus var. stramineus Hemphill. Pl. XII, fig. 1.

Alcoholic specimens clear, light buff. Length 59; greatest breadth (across shield) 19; greatest width of sole 15 mm. Genitalia as in typical *A. columbianus.*

Habitat: Santa Cruz Island, California.

The specimen figured is one of Hemphill's original lot.

A. Californicus Cooper. Pl. XIII, figs. 5, 6; Pl. XIV, figs. 14–16.

Ariolimax Californicus J. G. Cooper, Proc. Acad. Nat. Sci. Phila., 1872, p. 146, pl. 3, f. D, 1–3. W. G. Binney, Proc. Acad. Nat. Sci. Phila., 1874. p. 33; Am. Lyc., N. Y., X, 1873, p. 297; Terrest. Moll., V. p. 232, pl. v, fig. F (dentition), and pl. xii, f. D (genitalia); Man. Amer. Land Sh., p. 99 f. 62, 63; Third Suppl. Terr. Moll., V (Bull. M. C. Z., XIX, No. 4), p. 211, pl. v. f. E (living animal) and f. H (penis). Simroth, Nova Acta Acad. Caes. Leop. Carol. Germ. Nat. Cur., LVI, 1891, p. 365, pl. 7 [xv], f. 9–11; Malak. Blätter (n. F.) XI, pl. 1, f. 5. 6.

Distribution: We have seen this species from San Mateo Co., California, only.

Color of alcoholic specimens brownish ochraceous, sole gray; foot margin uniform with the upper surface, or dusky with vertical dark lines.

The free anterior portion of mantle is shorter than in *A. Columbianus*, less than one-fourth the entire length of the mantle.

Jaw (Pl. XIV, fig. 13) with about 9 ribs, denticulating both margins.

Radula (Pl. XIII, figs. 5, 6) with the formula 67.1.67. Rhachidian teeth with well developed side cutting-points; mesocone long, reaching to posterior edge of basal plate. Inner lateral teeth, without inner cusps, otherwise similar; outer laterals becoming oblique, with long mesocones, the ectocone gradually reduced to a slight sinuation.

The transition to marginals is extremely gradual; the latter being at first as described above (fig. 5, at 24, 25, 46), but about 20 at the outer edge of radula are of the form shown in fig. 6, with distinct ectocones, and the short, Helicid form of basal plates of other *Arionidæ*.

Genitalia (Pl. XIV, fig. 14) somewhat as in *A. Columbianus.* The ♂ and ♀ orifices are, as Binney has remarked, hardly united in an atrium (see figure). The penis is fleshy, with plicate inner walls, and its retractor is short and fleshy, as in *Columbianus*, but is extremely broad. The epiphallus (*epi.*) is very stout, nearly as large in calibre as the penis in sexually mature specimens. Further downward it becomes very small again, approaches the penis, follows it to its apex, turns in (fig. 15, enlarged view of apex of penis) and is introverted and invaginated therein for some distance, nearly as far as the insertion of retractor muscle (fig. 16, distal end of penis opened, showing the invaginated epiphallus).[6]

The female organs are as usual, except that there is a broad, stout, fleshy vaginal retractor muscle inserted near the base of vagina.[7]

It will be seen that this species shows a less advanced stage of penis structure than *A. Columbianus*, although of the same kind. The very stout, low, vaginal retractor is also a diagnostic feature.

INSUFFICIENTLY KNOWN ARIOLIMACES.

Ariolimax Columbiana var. *Hecoxi* Wetherby (Some Notes on American Land Shells, p. 6) from Santa Cruz, California, is stated by Wetherby to differ from *A. Columbianus* in the genitalia, but no characters whatever of the new form are mentioned. Binney (Manual American Land Sh., p. 103) apparently endorses the specific value of the form; but beyond stating that it has about 60.1.60 teeth (*Columbianus* varying from 56.1.56 to 67.1.67), with about 16 laterals, he gives no characters. The form has been mentioned in various lists, etc., by Cockerell and the senior author of this paper, but in the entire absence of diagnosis it can have no standing, and had better be dropped until described. We have not seen specimens, nor, in fact, any specimens of the genus from Santa Cruz.

Ariolimax Costaricensis Cockerell, Annals and Mag. Nat. Hist. (6), VI, 1890, p. 279, described as a sub-species of *A. Californicus*, from

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[6] The slender distal end of the penis has been erroneously described as a "flagellum" by Binney, "Blindschlauch" by Simroth; both overlooking the fact that the epiphallus runs up to its apex, as shown in our figure 15.

[7] Binney (Man. Amer. Land Sh., p. 100) calls the structure a "vaginal prostate," overlooking the easily ascertainable fact that it is composed of solid muscular tissue, similar to that of the penis retractor. All Ariolimaces have vaginal retractors, and at times invert and protrude the vagina, like a penis.

alcoholic specimens in Brit. Mus. The only diagnostic words of Cockerell's description are the locality, "Costa Rica." The other characters mentioned in the description are common to *Columbianus* and some *Californicus*. Measurements, etc., as given therein, look well on paper, but every practical limacologist knows them to be merely an empty form. We consider *Costaricensis* as probably a good species, on account of its locality (if correct), but a diagnosis is still wanting.

Genus **APHALLARION** P. & V. (n. g.).

External characters, jaw, radula and digestive tract, shell, and general internal topography, as well as female genitalia, as in *Ariolimax; penis (and its retractor) completely wanting*, a small and short epiphallus lying in its place; right eye retractor passing *to the left* of the genitalia.

We institute this new group for a large slug like *Arion* and *Prophysaon* in the total lack of a penis and its appendages, and like *Ariolimax* in the other essential features, internal and external, except the disposition of the eye-retractor mentioned above.

In view of the high development and complicated structure of the penis in *Ariolimax*, the strength of its retractor, the large size and extraordinary introverted character of the epiphallus, we can hardly refuse generic rank to a form differing so radically as this one. The anterior position of the genital foramen in *Aphallarion*, the posterior position of its breathing pore, and the anterior ovotestis, pressed against the base of the albumen gland, deny to our slug entrance into *Arion;* and in the genus *Prophysaon* the whole internal topography[8] as well as the type of digestive system is profoundly different.

A. Buttoni P. & V. (n. sp.). Pl. XII, figs. 3, 4, 5.

Color of alcoholic specimens light yellow-brown, the shield lighter, more yellowish, especially anteriorly. Foot-margin dusky, with close vertical black lines, alternately heavier, and seen under the lens to be impressed and pigmented wrinkles. Sole gray, more or less dusky. Anterior third of the mantle free. Length 82; length of mantle 34; greatest breadth of sole 21 mm.

Shell oblong, nearly flat, well calcified; white below, with a yellowish cuticle above, except toward the middle. Length 12½, width 6¾ mm.

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[8] By this we mean the positions of the organs in the body-cavity, both relative and actual. The relative positions of genitalia and digestive tract are greatly varied in different genera of slugs, and of considerable systematic value.

Mr. Button writes of the living animal as follows: "He has a way of occasionally raising up the mantle over the respiratory orifice, as shown in the sketch, which is characteristic. The following are some measurements of a very large specimen: Length, over all, when extended, 7 inches; width, $\frac{7}{8}$ in.; height, $\frac{7}{8}$ in.; length of tentacles, $\frac{3}{4}$ inch. The color is the same throughout, shield included, being an olive brown."

Figures 4 and 5 of Plate XII were drawn from sketches of the living animal furnished by Mr. Button. Fig. 3 represents an alcoholic specimen, dorsal view.

Jaw with 10 to 12 ribs (Pl. XIV, fig. 11). Teeth as in *Ariolimax Californicus*, but the outer laterals and marginals have the cusps shorter, less thorn-like, and there are rather fewer bicuspid outer marginals.

General characters of the digestive system (Pl. XIII, fig. 4) as in *Ariolimax Columbianus;* but the ascending gut from posterior loop passes under the stomach (instead of over it) and the descending gut from anterior to posterior loop makes one spiral turn less than in that species.

Genitalia (Pl. XIV, fig. 12) lying in the body-cavity like that of *Ariolimax.* Penis absent, the epiphallus (*epi.*) small and short. Vagina very long, strong, with plicate internal walls, and provided with a band of retractor fibers. Spermatheca large, of irregular shape, on a short duct.

Oakland, California (Fred L. Button!).

EXPLANATION OF PLATES.

Plate XII.

Fig. 1. *Ariolimax Columbianus stramineus* Hemph., lateral view of an alcoholic specimen.

Fig. 2. *Ariolimax Columbianus* Gld., lateral view of an alcoholic specimen of form *maculatus*, from Tacoma, Washington.

Fig. 3. *Aphallarion Buttoni* Pils. & Van., dorsal view of an alcoholic specimen of average size.

Fig. 4, 5. *Aphallarion Buttoni* Pils. & Van., lateral view and dorsal outline of a large living individual in motion, drawn from sketches by Fred. L. Button.

All figures natural size.

Plate XIII.

Fig. 1. *Ariolimax Columbianus* Gld. General view of viscera, the upper integument removed, viscera turned aside, and penis lifted from its normal position across salivary glands and crop.

Fig. 2. *A. Columbianus.* Digestive tract, the salivary glands and liver removed; albumen gland remaining in place.

Fig. 3. *Arion hortensis* Fér. (specimen from New Bedford, Mass.). Digestive tract, the liver removed; also showing position of the ovotestis.

Fig. 4. *Aphallarion Buttoni* P. & V. Digestive tract, the salivary glands and liver removed.

Figs. 5, 6. *Ariolimax Californicus* Cooper. Dentition.

Plate XIV.

Fig. 7. *Ariolimax Columbianus* Gld. Genitalia of an unicolored specimen.

Fig. 8. *Ariolimax Columbianus* Gld. Lower portion of the genitalia of a black-spotted specimen.

Fig. 9. *Ariolimax Columbianus* Gld. Vagina and penis opened, the latter showing invaginated epiphallus (*epi.*), its structure shown by dotted lines.

Fig. 10. *Ariolimax Columbianus* Gld. Jaw.

Fig. 11. *Aphallarion Buttoni* P. & V. Jaw.

Fig. 12. *Aphallarion Buttoni* P. & V. Genitalia, epiphallus shown at *epi.*

Fig. 13. *Ariolimax Californicus* Cooper. Jaw.

Fig. 14. *Ariolimax Californicus* Cooper. Genitalia.

Fig. 15. *Ariolimax Californicus* Cooper. Enlarged end of penis.

Fig. 16. *Ariolimax Californicus* Cooper. Enlarged distal portion of penis split to show the invaginated epiphallus.

SYNOPSIS OF THE POLAR HARES OF NORTH AMERICA.

BY SAMUEL N. RHOADS.

Owing to the extreme scarcity of specimens of skins and skulls, with reliable data, of our American Polar Hares in the museums of this country or of the Continent, no attempt has yet been made to study this group in a comprehensive way. To this fact, together with the prevailing opinion that the Arctic representatives of our land mammal fauna retain their specific constancy throughout the breadth of their habitat, the animals which form the subject of this paper owe the neglect and consequent misconception of their relationships which have so long existed.

Having occasion to identify a summer specimen of Polar Hare from Alaska, recently presented to the Academy of Natural Sciences of Philadelphia by Dr. Benjamin Sharp, I was led to a critical examination of the series in our museum. The subject proved of so much interest that I secured the loan of some specimens from the Smithsonian Institution, which finally led to a general correspondence with collectors in this country and in England, and the examination of a series of skins, skulls and alcoholic specimens of American Polar Hares, representing over thirty individuals, together with about fifteen specimens of Siberian and Swedish Polar Hares. Besides these, I secured data from correspondents, which covered the examination of nearly thirty more specimens, more than half of which were American species.

Especial mention is due to the courtesy of Messrs. Goode and True of the Smithsonian Institution, for their liberal assistance in the loan of their specimens and furnishing of data. To Mr. Outram Bangs I am indebted for a most valuable set of Newfoundland specimens and the use of a set of drawings of the type skull of *L. a. bangsi*, executed by Mr. Blake. Messrs. Walter Faxon of the Museum of Comparative Zoology, William De Winton, of the British Museum, and Ludwig Kumlien, of Milton College, Wisconsin, have also furnished me with timely aid in the loan and examination of specimens and the use of private field notes and references to literature. The illustrations on plates VI, VII and VIII, are reproductions of an exceptionally fine set of photographs made by H. Parker Rolfe, of

Philadelphia. Plates IX and X contain figures of the type skull of *L. a. bangsi* drawn by Mr. J. H. Blake of Boston. The remaining figures on Plate X were drawn by myself.

Although the series of specimens which I was enabled to bring together for study is much larger than any yet examined, it is very deficient in examples from certain parts of America, especially Baffin Land, the Arctic Archipelago and the interior of British America. On this account some of the opinions advanced in this paper may be found to need revision, but it is believed that sufficient material has been examined to establish the main conclusions arrived at, and also to indicate the direction in which our further investigations of these mammals should be turned.

HISTORY AND NOMENCLATURE.

Owing to the confusion of some authors as to the difference between the European and American Polar Hares, it will be necessary first to briefly outline the nomenclature of the former.

Linnæus, in the tenth edition of the *Systema Naturæ*,[1] was the first author to impose a tenable name upon the Polar or Arctic Hare of Europe, the *Lepus albus* of Brisson. He gave it the name *Lepus timidus*, including under that title both it and the Common Hare, *Lepus europæus* Pallas.[2] Pallas, in 1778, in distinguishing between the two, not only gave a new name to the Common Hare, but renamed the Polar Hare, *Lepus variabilis*,[3] and by this name it has since been known to most authors.

The description of Linnæus unmistakably refers in all particulars to the Polar Hare rather than to the Common Hare, which, however, he included under the name *timidus*. Pallas' name for the latter should be retained, while that of Linnæus continues to belong to the former.

No series of the Polar Hares of Russia, Siberia or the mountains of Central Europe being available for study in this country, attempt will not be made to give a synopsis of their status or nomenclature. While there is no doubt that the Old World is represented by at least three forms of the *timidus* group, for which there are available names in literature, it only concerns us, in this connection, to fix the type form and habitat of *L. timidus* for sake of comparisons be-

[1] Syst. Nat., 1758, p. 57.
[2] Nov. Sp. Glires, 1778, p. 30.
[3] Ibid, pp. 1, 30.

tween it and the hares of North America. A careful consideration of the question induces me to adopt the Scandinavian animal as the type of *L. timidus*, from the fact that Linnæus' conception of the Arctic Hare, when he wrote his original diagnosis, was based primarily on those frequenting the localities near his Swedish home.[4]

Captain John Ross was the first author to publish a description and new name for the American Polar Hare.[5] Owing to the fact that he gave this animal the name "*Lepus arcticus* Leach," and that Leach, a few pages further on, names and describes the same specimen as "*Lepus glacialis*,"[6] some confusion of synonymy has resulted. Owing to the scarcity of the work in which these descriptions occur, and to make the status of the case more clear, they are herewith given.[7]

Later authors recognized the American Hare as distinct from the European, but none of them, until Gray, in 1843, used the name *arcticus* for it, but adopted Leach's later name, *glacialis*.[8] In 1877, Dr. J. A. Allen revived Ross' name on account of the priority of

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[4] Linnæus' 1758 description refers to Fauna Suecica, 1746, No. 19, p. 8.

[5] Ross' Voy., 1819 (2d [octavo] ed.). Appx IV, p. 151 (Written by Ross).

[6] Ibid, p. 170 (Under caption: "Desc. N. Sp. Anim., Discov. * * * in Arc. Reg. by Dr. W. E. Leach").

[7] Ross' description (p. 151, l. c.) is as follows:

"Genus Lepus (*Hare*).

"Species *Lepus arcticus* Leach. The only one of this species was shot in lat. 73° 37′, on the west side of the Straits. It was nearly the same size as *Lepus timidus* (the common Hare); the body was white, except that a few solitary black hairs, longer than the rest, were dispersed over every part and which appeared to be rapidly coming away; the tips of the ears and the short hairs within the ears were black; tail short and white. It was shot on the first of September. Another, shot by a Master of a Whaler, in May, at Hare Island [Greenland?], differed very little from the above. Dr. Leach thinks it to be very distinct from the common White Hare of Scotland (*Lepus albus* Brisson) and equally so from the *Lepus variabilis* Pallas. See Appendix No. V."

Ross' reference to "Appendix No. V," is a mistake, as Leach's description comes in the latter part of appendix IV, page 170. It reads as follows:

"Genus Lepus of *Authors* (Hare).

"Species *Glacialis*. Albus, vertice et dorso pilis nigricante fuscis albo fasciatis sparsis, collo lateribus nigricante abloque mixtis, auribus apice extremo nigris.

"This animal, which will neither agree with the *Lepus albus* of Brisson nor the *Lepus variabilis* of Pallas, both of which are now before me, is of the size of the common Hare (*Lepus timidus* and of a white color. The back and top of the head are sprinkled with blackish-brown hair which is banded with white; the sides of the neck are covered with hairs of the same color, interspersed with white. The extreme tips of the ears are tipped with black, intermixed with white; the insides of the ears have a few black hairs mingled with the white.

"I am sorry that the skeleton (which would, in all probability, have furnished a good specific distinction) was not brought home."

[8] See Baird, Mam. N. Amer., 1857, p. 577 (foot note).

paging of his description of *arcticus*. Dr. Allen further gave Leach sole credit for this name and was induced, by the difficulty of specifically separating the American from the European Hare, to constitute the former a "variety" of the latter, so as to make it stand trinomially, *Lepus timidus arcticus* (Leach). As I have already attempted to show[9] our American forms are quite distinct from those of Europe, and the most proper formula for typical *arcticus* north of Baffin Land is *Lepus arcticus* "Leach" Ross. In the same paper I have described two new forms, *Lepus arcticus bangsi*, representing the dark southeastern race of *arcticus*, and *Lepus grœnlandicus*, a strongly characterized species which appears to be peculiar to Greenland and Grinnell Land. To these is now added a fourth, *Lepus tschuktschorum* (Nordquist), from the west coast of Alaska.

A skin, without skull, feet or limbs, from near Great Slave Lake, N. W. Territory, dated May, 1877 (No. 13,350, Sm. Inst.), and in full summer pelage, indicates the existence of an interior geographical race, so much lighter in color than *L. a. bangsi*, as to indicate that it should be separated under another name. The most diligent search in this country, however, has failed to reveal another summer skin from that region, and the condition of the one in hand does not warrant its use in this connection.

GEOGRAPHICAL DISTRIBUTION AND VARIATION.

The American Polar Hares confine their habitats very closely to the faunal areas designated by Dr. J. A. Allen[10] as the "Barren Ground" and "Alaskan Arctic." The most southern points of their distribution yet recorded, beginning in the east, are Bay St. George, Newfoundland (l. c.),[11] Solomon Island and Ungava, Labrador (l. c.); Fort Churchill,[12] Fort Rae (l. c.), Great Bear Lake,[13] Yukon Valley and mouth of Kuskoquim River,[14] Alaska. A line connecting these points runs northwest from latitude 47° in Newfoundland to latitude 57° in northern Labrador, thence directly west across Hudson Bay to Fort Churchill, and northwest along

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[9] Amer. Nat., 1896, pp. 251, 252.

[10] Bull. Amer. Mus. Nat. Hist., 1892, Pl. VIII

[11] Aud. & Bach., Quad. N. Amer, 1846, I, p. 248, state it is reported from Nova Scotia. This is not authenticated.

[12] Richardson, Faun. Bor. Amer, 1829, I, p. 221.

[13] Nelson, Rep. N. Hist. Alaska, 1887, p. 271.

[14] Richardson, l. c., p. 222.

the eastern drainage of the Mackenzie to its mouth in latitude 67°. The distribution between Great Bear Lake and Nulato is uncertain, but may be restricted to the Yukon drainage southwestward to Kuskoquim Bay, Behring Sea, in latitude 60°. North of this line, the Polar Hare is likely to be found in greater or less abundance, as far as explorations have reached. The Greenland Hare, according to Fabricius,[15] abounds throughout that country. His observations were probably restricted to the southern half of Greenland, but they equally apply to the northern sections. It is also found on the west side of Robeson Channel and Hall Basin in Grinnell Land,[16] and on the northeast coast of Greenland in latitude 75°.[17] The Baffin Land Hare, in its typical form, occupies the northern half of the Barren Ground Fauna of America, north of latitude 70°, exclusive of Alaska and the habitat of *grœnlandicus*. Its subspecies, *bangsi*, may be provisionally restricted to the country east of Hudson Bay, including south Baffin Land. The Polar Hares of the southern interior, west of Hudson Bay, as already stated, probably constitute another race of *arcticus*, while the Siberio-Alaskan species occupies the remaining portions of the "Alaskan Arctic" range of the Polar Hare in the northwest.

The causes of geographic variation in *arcticus* and its subspecies are nowadays so well understood, as far as they relate to color characters, as to need little comment. It is interesting to note, however, how they are correlated with the variations of some other animal forms inhabiting the same areas. In the extreme north, where it is never dissociated from snow-covered areas, *arcticus* practically retains its winter coat throughout the year. In those southern areas where snow largely disappears for a short summer season, we find an assumption of colors to correspond with the environment, blackest in rocky, fog-clouded Newfoundland, and hoary in the arid, gray wastes of the interior. On the verdant, humid shores of Alaska, a very distinct Old World species, in sooty-brown summer dress, takes the place of its eastern congener.

When we come, however, to inquire into the origin of the Greenland species, with the peculiar dental characters which seem to separate it, not only from its Polar allies, but from all other members of the genus, the problem is more difficult. It is not unlikely that

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[15] Faun. Grönl., 1780, p. 25.

[16] Feilden, in Nares' Voy., 1878, II, Appx., p 204.

[17] Zweite Deutsche Nordpolarf., II, 1874, pp. 165–167.

the character of the food procurable in extreme northern localities, as compared with that of the more southern, has been a factor in the development of the slender protruding incisors. In northern Greenland, plant-life is not only greatly reduced in size and number of species from that of Labrador, but the difficulty of procuring it is enhanced by the depth and long continuance of the snow in the former locality. For many months in the year the Greenland Hare must subsist entirely on dwarfed plants, which it uncovers and reaches by scratching away the snow,[18] while the Labrador animal is living without exertion on the twigs, leaves and branches of a large variety of bushes and shrubs. The character of the diet in each instance naturally accounts for the relatively weaker dentition of the northern animal and we may believe that the projecting form of incisor was the outcome of the needs of the animal in rooting among snow and stones for its scant repast. To insure such an armature the arc of the tooth must have a larger radius and hence the tooth itself a greater length, bringing its root farther back upon the maxillary than the sharply curved, perpendicular, massive form of the twig-eating animal. Again we see how the projecting form of incisor tooth, meeting its opposing member at a triturating angle of 45°, must, of necessity, have a greater relative vertical resistance than opposing pairs of teeth which meet on the same plane or at an angle scarcely appreciable. As a result, we have the narrow, deep incisors of *grœnlandicus* and the long, slender premaxillary and ramus enclosing them. By this means, the incisor sulcus is not only diminished but the weakness resulting from its possession is remedied by a special functional provision which fills it with the cementum-like scale as the animal approaches maturity.

It may be stated that the Polar Hares of America, contrary to the rule of specific stability in circumpolar animals have proved no exception to the protean character of the many members of the genus *Lepus* on this continent. On the other hand, they emphasize that fact, and form a group, apparently more sensitive to the minute alterations of a Polar environment than any other of the Arctic vertebrata.

Contrary to what we should expect, it does not appear that our Arctic Hares decrease in size as we go south. The average measurements of North Greenland Hares are less than those of the series taken in Newfoundland and it will be noted that the

[18] See Feilden, in Appx. Nares' Voy,, 1878, II, pp. 204, 205.

west Alaskan Hares are considerably larger than any others from either higher or lower latitudes. The length of ear, which the laws of variation lead us to suppose would increase southwardly, is actually less in Newfoundland than in Labrador, Baffin Land and Greenland, while the hind foot follows a reverse order, being longer in the south than in the north.

GENERAL OBSERVATIONS ON SEASONAL, SEXUAL AND JUVENILE PHASES OF COLOR.

The Polar Hares of all countries and latitudes undergo a double annual moult of the entire pelage, taking place during late spring and early autumn. Throughout their more southern distribution, the contrast between the perfect summer and winter coats, in color, texture and quantity is very marked. As their habitat nears the Pole, these seasonal differences diminish, so that it is difficult to distinguish at a distance the midsummer hares of North Greenland and the Arctic Archipelago from the same animals in their snowy winter dress. There is but one color character which remains constant to all members of the group at all ages and seasons the world over, namely, the black extreme tips of the ears. In winter this is the only exception to the prevailing whiteness which characterizes every American form of Polar Hare.

In Scotland, Ireland and parts of Europe and Asia, the autumnal change of color is incomplete in the Polar Hares which inhabit the more temperate parts of the range of *Lepus timidus* of the Old World. This peculiarity scarcely assumes the dignity of a racial or geographical character, owing to its inconstancy, some individuals in a given neighborhood changing to a pure white winter pelage while others acquire the grayish-brown or hoary dress which was named *canescens*, by Nilsson,[19] for the Swedish variety, and *hibernicus*, by Bell,[20] for the Irish animal.

In America I have found no instances which may be said to be analogous to this variation. The Newfoundland Polar Hare reaches a more southerly distribution than any of the Old World forms, but I have seen no specimens nor know of authentic instances of its failing to become pure white in winter, unless a few gray hairs on the fore part of the ears may be called an exception.

The number of skins showing intermediate stages of the molt, which would enable me to outline the process of change from winter

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[19] Ofver. Ved. Akad., 1844, p. 133.

[20] Brit. Quad., 1837, p. 341.

to summer and from summer to winter dress is very small in the series available, and those which I have seen appear to differ in the manner of molting from that outlined by Dr. J. A. Allen for the American Varying Hare, *Lepus americanus*.[21] An adult female, taken at Bay St. George, Newfoundland, October 16th, 1895 (No. 3,756, Col. of E. A. & O. Bangs), appears to be undergoing a bleaching process which affects, with remarkable uniformity, every part simultaneously. There is no ragged appearance, caused by the presence of patches of old hair, anywhere. The summer fur appears to have uniformly about half fallen, giving place to a growing, but still short, under-fur of white, which will speedily lengthen into the mature winter fur. The feet and hinder bases of ears are unmixed white. The leaden gray of inner flanks and lower head and neck and the ashy-gray head are little changed from midsummer shades, but the whole back, sides and ears are about two shades lighter throughout, owing to the disposition of the old over fur and the outgrowth of the new. There are no specimens in the series illustrating the style of spring molt.

In general terms, the spring change of more southern American examples consists in the acquisition of black ears, a tawny gray head and dark ashy-gray upper parts, including the chin, throat, neck and breast; the feet and belly are also more or less shaded with gray and leaden hues but the greater part of the belly and tail remain white. This diagnosis applies to the eastern subspecies, *L. arcticus bangsi*, and in great measure to the pallid form which frequents the southern Barren Grounds west of Hudson Bay. In species, *L. tschuktschorum* of Alaska and northeast Siberia, the ears are marbled blackish-brown and white, and the upper parts, head and neck are blackish-brown, resembling much more closely the colors of the Asiatic and European than the American type. In typical northern *arcticus* and *grœnlandicus* the summer coat never (?) attains a dark appearance except in the young, but close examination shows a greater or less admixture of clear gray hairs over the upper parts, most numerous on the head and ears, where it is generally accompanied by a tawny suffusion. In some instances these gray hairs are so sparse as to make the animal practically indistinguishable, save in texture and density of fur, from winter specimens.

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[21] Bull. Amer. Mus. N. Hist., 1894, pp. 107–128.

So far as I am able to determine, there are no secondary sexual color characters in the Polar Hares of America.

The young, at birth, as well as in the more advanced fœtal stage, are as dark or even darker colored than their parents in full summer pelage. In *grœnlandicus* they are fully and thickly haired some time before birth, and resemble in color and color pattern much faded summer skins of *arcticus* from Great Slave Lake. The inner posterior half of the ears is white, their tips and inner borders broadly marked with black, the remainder of the ear rusty gray. The pelage is remarkably long and well developed for an embryo. The soles of the hind feet are as dark as the back, their uppers white. The fore-feet and the tail are white throughout. With increasing age, the young of the northern forms assume a lighter colored pelage and it becomes nearly as white as that of their parents ere the winter fur begins to replace it. In the south the half-grown young are marked very similarly to their adult associates, but with a stronger fulvous or brownish tinge among the gray.

HABITS.

I find very few satisfactory accounts of the habits of any of our American species of Polar Hare. The literature on this subject mainly consists of brief allusions to the animal by Arctic explorers, and some of the most observing of these seem to have formed a very imperfect acquaintance with the animal. Richardson's account in the *Fauna Boreali Americana* is the best one relating to *Lepus arcticus* of the interior of British America. He says: "It is not found in wooded districts, hence it does not come further south on the line of the Mackenzie and Slave Lake, than latituds 64°. It was found in latitude 75°, on the North Georgian Islands. Although it does not frequent thick woods, it is often seen near the small and thin clumps of spruce fir, which are scattered on the confines of the Barren Grounds. It seeks the sides of the hills, where the wind prevents the snow from lodging deeply and where, even in the winter, it can procure the berries of the Alpine arbutus, the bark of some dwarf willows, or the evergreen leaves of the Labrador tea-plant (*ledum*). It does not dig burrows, but shelters itself amongst large stones or in the crevices of rocks, and in the winter time its form is generally found in a wreath of snow, at the base of a cliff. The Polar Hare is not a very shy animal, and on the approach of a hunter it merely runs to a little distance, and sits down, repeating this manœuvre as often as its pursuer comes nearly within gunshot. * * * According to Indian information, the Polar Hare brings forth once in the year and from two to four young at a time."

Respecting the Greenland Hare, Captain Koldewey of the German-Arctic Expedition of 1869–'70, writes:[22] "The European hare is remarkable for its long and rapid, hasty flight. The Greenland Hare, on the contrary, sits as if nailed down in its rocky refuge, however near the hunter may pass to him. Sometimes one sees the mountain slopes dotted with white spots, which, from their motionlessness, might be taken for snow; but they are only white hares. They are about the size of our own hares, but their flesh, like that of the Alpine Hare, is insipid. Hare hunting in Greenland often gives rise to the drollest scenes. Their hearing appears to be even weaker than their sight. Payer once stood near a hare which was startled by repeated firing, but had confined its flight to a few steps. The creature was nibbling the moss quietly. Payer took out his sketch book and drew it in all the different positions which, in its uneasiness at the conversation and laughter of his companions, it assumed."

This relates to the hares of northeastern Greenland. H. W. Feilden, in the Appendix to Nares' Voyage to the Polar Sea, thus describes the Hares of north Grinnell Land: "The Polar hare was found, though in scanty numbers, along the shores of Grinnell Land and its footprints were seen on the snow clad ice of the Polar Sea, by Captain Markham and Lieutenant Parr, in lat. 83° 10′ N., a distance of about 20 miles north of the nearest land. * * * * On February 14, two weeks before the sun reappeared at midday, the temperature minus 56°, I started one from its burrow, a hole about four feet in length, scraped horizontally into a snowdrift. I have no doubt the same burrow is regularly occupied, as this one was discolored by the feet of the animal and a quantity of the fur was sticking to the sides; all around, the hare had been scratching up the snow and feeding on *Saxifraga oppositifolia.* Even where exposed to the wind, this hardy plant had delicate green buds, showing on the brown, withered surface of last year's growth. The hare does not tear up this plant by the roots, but nibbles off the minute green shoots. The number of young that we found in gravid females varied from seven to eight, which is much in excess of that produced in Great Britain by *Lepus variabilis*, from which naturalists have found dif-

[22] Germ. Arc. Exp., Mercier's transl., 1874, p. 483.

ficulty in separating the Arctic species. * * * * We find *Lepus glacialis* inhabiting the most northern land yet visited, and attaining its normal weight, eight to ten pounds, under apparently very adverse circumstances. Still, I must say, it is sparsely diffused, and we found that after killing a pair or two out of each valley that afforded any vegetation, the race seemed to be extirpated in that district."

Referring to the Alaskan Polar Hare, *Lepus tschuktschorum*, Mr. E. W. Nelson says:[23] "The open country of the Yukon delta is their place of greatest abundance, so far as I was able to learn. There, in May, 1879, I found them very common. The snow was nearly gone, and while travelling along the small channels between the islands, in the pale twilight which marks the nights at that season, we saw many hares playing about on the banks. They were often in small parties of from three to five or six, and were not very shy. * * * While camped in this vicinity, at that time, I found them to be almost entirely nocturnal in their habits, rarely moving about in day-time, even during the gloomy days, when the sky was obscured by dense, low lying clouds. Although they are nocturnal in their habits, they see very well in the day, and it is extremely difficult to surprise one in its form. Usually it spies the hunter before he gets within gunshot and leaves the spot in great haste.

"During most of the year, these animals are essentially solitary, but during April and May they gather into small parties, and sometimes as many as a dozen or more may be found on a single hillside." After declaring that he is sure this hare voluntarily takes to the water, and crosses streams 30 yards in width in its wanderings, Mr. Nelson continues: "In severe winter weather they seek the shelter of willow or alder patches on the slopes of sheltered ravines, or in other comfortable situations, but as a rule they are characteristic of the open Arctic barrens, and on the wide expanse of desolate snow, their tracks are among the few evidences of life the traveller finds in crossing the Alaskan tundras in winter."

KEY TO SPECIES AND SUBSPECIES.

Cranial characters.

I. Upper and lower incisors strongly and regularly curved, meeting within the arc of a circle mutually described by their ex-

[23] Rep. Nat. Hist. Col. Alaska, 1887, pp. 271–273.

posed outer faces. Upper incisors rooted on the inferior bases of the premaxillaries. Diameter of upper incisor wider than deep, its face strongly and broadly grooved.

1a. Nasals compressed and narrowed anteriorly; bony palate longer than width of postpalatal fossa; narrow incisive foramina terminating opposite anterior alveolus of $\underline{\text{pm. 1}}$; narrow premaxillary process falling short of base of nasal; breadth of rostrum opposite bases of $\underline{\text{pm. 1}}$ shorter than distance from alveolus of $\underline{\text{pm. 1}}$ to alveolus of posterior incisor; total length of adult skull never exceeding 100 mm. (95 to 99 mm.), molars narrow, rounded— *arcticus.*

1b. Similar to 1a— *bangsi.*

1c. Nasals broad, equilateral, flattened; bony palate shorter than width of postpalatal fossa; the wide incisive foramina reaching nearly opposite base of $\underline{\text{pm. 2}}$; broad premaxillary process reaching to or beyond base of nasal; breadth of rostrum equal to or greater than distance between alveolus of $\underline{\text{pm. 1}}$ and the base of corresponding secondary incisor; total length of adult skull always exceeding 100 mm. (101 to 115 mm.); molars very broad and angular— *tschuktschorum.*

II. Jaws prognathous; upper and lower incisors meeting at angles of 35 to 50 degrees. Upper incisors rooted on the anterior floor of the maxillaries. Diameter of upper incisor deeper than wide, its slender sulcus filled with a functional, indurated, striate cementum approaching the consistency of enamelled dentine at the cutting edge.

2a. Nasals compressed and narrowed anteriorly; bony palate shorter than width of postpalatal fossa; incisive foramina reaching opposite anterior alveolus of $\underline{\text{pm. 1}}$; narrow premaxillary process falling short of base of nasal; breadth of rostrum opposite bases of $\underline{\text{pm. 1}}$ equal to or shorter than distance between the base of $\underline{\text{pm. 1}}$ and the apex of the incisive foramina; total length of adult skull exceeding 100 mm.; molars broad, angular, very massive as compared with slender incisors— *grœnlandicus.*

External characters.

I. Size medium, length of hind foot $1\frac{1}{2}$ times that of ear from crown. Tail always white. Upper body fur in summer, dark tawny gray to nearly pure white.

1a. Summer fur: ears black; back and sides dark gray; rump blackish— *bangsi.*

1b. Summer fur: ears grayish-black; back and sides hoary gray, belly and vent pure white—(Interior subspecies?)

1c. Summer fur: ears grayish-white; back, rump and sides. white, sprinkled with gray *arcticus.*

1d. Similar to 1c— *grœnlandicus.*

II. Size very large; hind foot 1¾ times as long as ear from crown. Tail dusky above in summer. Upper body fur in summer grayish or blackish-brown.

2a. Summer fur: ears sooty brownish-black and gray, their posterior margins, white; back blackish smoke-brown, becoming grayish-brown on sides, rump darker— *tschuktschorum.*

Genus **LEPUS** Linnæus.

Lepus Linnæus, Systema Naturæ, 1758, p. 57. (Type *L. timidus* L.)

1. Lepus arcticus "Leach" Ross. Baffin Land Polar Hare.

Lepus arcticus Ross, Ross' Voy., 8vo ed., II, 1819, appx. iv, p. 151. Type from lat. 73° 37′, Baffin Land, southeast of Cape Bowen.
Lepus glacialis Leach, Ibid (Under Chap. 'Descr. N. Sp. Anim. Disc. in Voy. to Arc. Reg.'), p. 170. (Same type).
Lepus timidus var. *arcticus*, J. A. Allen, Mon. N. Amer. Rod., 1877, p. 288 (in part).
Lepus arcticus "Leach" Ross, Rhoads, Amer. Nat., 1896, p. 252.

Geographic distribution.—Northern Baffin Land and the Arctic Archipelago; intergrading southeastward into subspecies *bangsi*, and south-centrally into a gray, pallid race.

Habitat.—Open rocky barrens and tundras, preferring in summer the borders of thickets; most abundant on rocky and hilly sea coasts; always avoiding the shelter of trees or bushes, but retreating to rock crevices for escape from an enemy.

Color.—Summer pelage white, interspersed over back more or less sparsely with long, gray-black and brown-pointed hairs, but not sufficiently to greatly alter the prevailing whiteness. Ears and face grayer, with a tawny shade, the former with black tips. Winter pelage pure white everywhere, except tips of ears, which are black. Summer pelage, in more southerly districts, darker, intergrading into subspecies *bangsi.*

Cranial characters.—Total length of skull twice the greatest breadth. Nasals broad and flattened posteriorly, narrowed and compressed anteriorly, their greatest breadth 2½ times greatest length, their bases reaching behind the superior prolongation of premaxillaries. Supraorbital frontal processes widely and deeply indented posteriorly, highly and broadly arched and upraised above the frontal plane. Posterior interorbital constriction tumid, arched high above anterior frontal plane and wider than alveolar length of molar series. Upper anterior incisors rooted at the inferior maxillo-premaxillary sutures, the termini of incisor roots marked by decided lateral osseous convexities of the rostrum. Incisors broader than deep (transverse exceeds the longitudinal diameter), the anterior upper pair each deeply and widely grooved by a single sulcus on the inner face. With the skull, minus mandibles, resting on a plane, horizontal surface, the chord of the arc described by the exposed incisors is vertical and the radius of this arc is about one-eighth ($\frac{12}{100}$) the basilar length of skull.[24] Lower incisors rooted anterior to $\overline{\text{pm. 1}}$. Incisive foramina reaching to $\underline{\text{pm. 1}}$, suddenly broadening and then contracting at base. Palatal bridge longer than width of incisive foramina. Palatal foramina opposite dividing alveolus of second and third premolars.

For measurements, see table, pages 374, 375.

General remarks.—As only one specimen of the Baffin Land Hare, and that consisting merely of head and neck skin with the skull of a young adult animal, has come to hand, it is impossible to furnish a description and measurements of typical adult *arcticus*, as compared with its southeastern subspecies, *bangsi*. The descriptions of older authors who have handled summer specimens, however, agrees substantially with the above diagnosis. The skull, which was taken from the above mentioned skin by myself, I have considered typical of the form described by Ross, and on this basis rests the separation of the Greenland Hare from *arcticus*.

Mr. Ludwig Kumlien, referring to the hares of south Baffin Land, states that "Many do not undergo any change of color during summer, and I doubt if it be more than a partial change with any. I have seen pure white specimens during all the summer months, and occasionally one about half gray."[25] In a communication dated Milton, Wis., March 4, 1896, Mr. Kumlien writes me: "I saw no gray hares at any season and I was told at Washington, by Dr. Emil Bessel, that Capt. Hall made [the same] observation

[24] For a comparison between the cranial and external characters of *arcticus* and *timidus*, see Amer. Nat., l. c., pp. 252, 253.

[25] Notes on Mam. of Cumb. Sd., Smiths. Misc. Coll., No. 15, 1879, p. 53.

as regards the hares of Baffin Land. This [statement] was included in my mss. of Bulletin No. 15 [l. c.] and crossed out by the final proof-reader, leaving my bare statement." Mr. Kumlien brought four specimens of Cumberland Gulf hares to the United States. One of these (No. 12,946, Sm. Inst.), a skin in white pelage, lacking head, is the only one remaining, the rest having been lost or accidentally destroyed by fire at the Wisconsin University.

No other Baffin Land specimens being discoverable, we are forced to rest our assumptions of the cranial characters of the hares of that region on the single skull which has come to hand. The apparent discrepancy between the dark color of this summer specimen and that reported by Mr. Kumlien in the above quotations is explainable. An examination of the itinerary of the Howgate Polar Expedition shows that Mr. Kumlien was absent from Baffin Land between the 6th of July and the 31st of August, which more than covers the short period in which the Polar Hares of that latitude retain their full summer pelage. The "gray" phase noted by him was the intermediate condition of molt. Captain Hall's statement may have related to the more northern form.

Lepus arcticus and its subspecies, *bangsi*, may be cranially distinguished from *timidus* of Sweden by the greater relative height and breadth of skull to its length, by the upraised anvil-shaped supraorbital processes and the relatively short, broad incisive foramina. Taking summer specimens of southern Sweden and Labrador, strictly comparable on account of latitude, the external characters separating *arcticus* from *timidus* are striking, the former being dark plumbeous-gray above, with black ears, and unicolor white tail, the latter rusty brownish-black, with darker ears of the same color, and bicolor gray and white tail. Typical *arcticus* undoubtedly resembles closely, in summer pelage, the hare of North Greenland, *L. grœnlandicus*.

Specimens examined.—Baffin Land, Niatilik, 1 head and neck skin, with skull. Interior form, N. W. Territory, 1 skin, 2 skulls.

Lepus arcticus bangsi Rhoads. Newfoundland Polar Hare. Pl. IX, figs. 1, 2 & 3. Pl. X, figs. 1 & 2.

Lepus arcticus bangsii Rhoads, Amer. Nat , 1896, p. 253. Type from Codry, Newfoundfound, No. 3,752, ad. ♀, Col. of E. A. & O. Bangs. Collected by Ernest Doane, Aug. 3, 1895.

Geographic distribution.—Newfoundland, northeastern Labrador and southern Baffin Land.

Habitat.—Hiding by day in rock piles on the coasts of Cumberland Gulf. Starting up out of range and running up the mountain sides to escape the hunter.—Kumlien. High rocky hills of Newfoundland, descending in severe winters to lower grassy levels, but never in woodland. Hiding by day among rocks or under a bush. —Doane.

Color.—Adult summer pelage: entire back and upper sides, including neck, shoulders and outer surfaces of thighs, uniform, dark, grizzled gray, faintly suffused with tawny. A pinch of hairs from near the middle of back shows the following color pattern: under fur fine, tawny-white basally, becoming tawny at distal end; overfur white or black at base in about equal proportions, the coarser black-based hairs black throughout, the finer white-based hairs with terminal half, black, interrupted by a subterminal band of white or pale tawny. Lower head (including chin), lower neck, nape, forebreast to forelegs, lower sides, edges of thighs and rump, dark, plumbeous gray, flecked with very long, slender, white hairs. Lower breast, belly, vent and tail white, bordered by a nearly clear plumbeous edging which separates the ventral from the abdominal regions and joins the dark rump along the inside of thighs. Inner anterior border of hams, sides of hind feet and toes, and lower surfaces of forelegs, white, thinly intermixed with leaden. Outer surfaces of fore and hind legs and superior surfaces of the feet, tawny gray. Ears and space between them, black, becoming grayish at base and with a narrow, whitish outer posterior margin from near base to tip. Upper head, including cheeks and nose, grizzled buffy gray, appreciably lighter than the gray shades of the back. Eyelids whitish, edged with black. Whiskers weak and sparse, white and black in equal proportions, the longer black hairs tipped with white.

Winter pelage: entire fur, exclusive of ears, white. Extreme tips of ears, black, the median anterior borders of ears, grayish; inside of ears, blackish.

Summer young, two-thirds grown, very similar to adults of same season but more fulvous above, the ears grayer, the basal half of back hairs leaden, their terminal half tawny brown with gray and black tips.

Cranial characters.—Not distinguishable from those already given for *arcticus*.

Measurements[26] (taken in flesh): average of four adults; total

[26] For measurements of type *bangsi* see table, pp. 374, 375.

length 600 millimeters, hind foot 164; ear, from crown, 84; tail vertebræ 60. Skull: total length 97; greatest breadth 49; greatest diagonal length of nasal 41; greatest length of mandible 76; greatest breadth of mandible 47; alveolar length of upper molar series 17.8.

General remarks.—This form has the most southern distribution of the Arctic Hares of America. It is found about eight degrees farther south than the most southerly locality inhabited by the *Lepus timidus* group of the Old World, and twelve degrees south of the southernmost habitat of our Alaskan representative. As already stated, it is quickly distinguishable from *timidus* by its clear, blackish-gray summer coat and black ears. It owes its separation from *arcticus* to the greater average temperature and humidity of its environment, intergrading with the parent stock across the barren grounds of Baffin Land. From *L. tschuktschorum* it is easily separable on account of smaller size, and its black ears and bluish, grizzled cast contrast decidedly with the sooty-brown shades of the Pacific coast animal. From the form inhabiting central British America the exact amount of difference is not determinable, owing to lack of specimens.

Specimens examined.—Newfoundland, 5 skins, 6 skulls; Labrador, 5 skins, 10 skulls.

Lepus grœnlandicus Rhoads. Greenland Polar Hare. Pls. VI, VII & VIII, figs. 1. Pl. X. figs. 5, 6 & 7·

Lepus glacialis Peters, Die Zweite Deutsch Nordpolarf., II, 1874, pp. 164–167, pl. 2.

Lepus grœnlandicus Rhoads, Amer. Nat., 1896, p. 254. Type from Robertson's Bay,* lat. 78°, Greenland. No. 1,486, ad. ♂ (?), Col. of Acad. Nat. Sci., Phila. Collected by C. E. Hite for the Peary Relief Exp., Aug. 2, 1892.

Geographic distribution.—Greenland and Grinnell Land. Iceland?

Habitat.—Everywhere quite numerous in southern Greenland, but preferring secluded places and the snowy mountains.—Fabricius. Rocky hillsides, keeping closely to snow patches in summer. —Heilprin. On the plains and mountains at all seasons, though never numerous.—Dr. Pansch (fide Peters l. c.).

Color.—Adult summer pelage (of type) white, suffused anteriorly with light tawny and sparingly sprinkled with gray over upper head and ears; back with scattering black, gray and tawny-tipped hairs. Tip of ears black. Tail, sides and lower surfaces, pure white. Whiskers black and white, Half-grown young in July

*Misspelled 'Robinson's Bay' in the original description.

and August, like adult, but darker, owing to greater abundance of gray and tawny hairs and the leaden under-fur. Appearance of young and old, at a distance, at all seasons, white. A pinch of hairs from near middle back presents the following color pattern: short under-fur very fine and silky white; over-fur silky white with rarely scattering black-pointed hairs and a few very long spinous hairs with the basal two-thirds black, and the terminal one-third white with a black tip.

Winter pelage (No. 1,047, A. N. S., Phila. Port Foulke, Greenland) pure white throughout, except the black ear tips, which are mixed with white hairs. Whiskers white.

Cranial characters.—Total length of skull twice the greatest breadth. Nasals narrow, compressed, their greatest breadth half their greatest (diagonal) length. Superior premaxillaries barely reaching bases of nasals. Supraorbital processes more greatly developed and widely flaring than in *arcticus*. Posterior interorbital constriction narrow, its width considerably less than alveolar length of upper molar series. Upper anterior incisors rooted on the maxillaries nearly half way from the inferior maxillo-premaxillary sutures to pm. 1, the termini of roots lying within the inferior lateral plane of the rostrum, but forming a marked interruption of the inferior rostral profile, viewed laterally. Incisors slender, prolonged, deeper than broad (transverse less than longitudinal diameter), the anterior upper pair in adults, multistriate, the normal sulcus of inner face, peculiar to all other members of the genus, being so filled with a calcareous process as to obliterate the depression, the face of the tooth presenting a more or less even, rounded and enamelled contour, marked where the groove normally belongs by irregular longitudinal striæ.[27] With the skull, minus mandibles, resting

[27] I have submitted teeth of *grœnlandicus* to my friend Dr. J. C. Curry, a dentist of Philadelphia, for examination of this character. He defines it in the following words: "The groove on the face of the tooth is filled with a grayish, opaque, homogeneous substance, which, on first examination, would appear to be continuous with the enamel. As it approaches the cutting edge its density increases and it is more striated in appearance. A continued maceration of the tooth, however, will enable the operator to separate this structure from the enamel groove with a clear line of cleavage, and with care the part may be removed entire. In the alveolus this structure is not continuous throughout the length of the root, but seems to have its beginning in a little triangular flap, about one quarter of an inch from the entrance of the tooth pulp into the base of the incisor. Like the tooth itself, this sulcus filling has a higher per cent of inorganic matter as it approaches the cutting edge, varying from about 40 per cent organic at base to 10 per cent at tip. At the incisive edge, its composition seems more closely allied to that of the cementum of the osse-

upright on a horizontal plane, the chord of the arc described by the exposed incisors forms an angle to the horizon of 45 to 50 degrees, and the radius of this arc is about one-fifth ($\frac{20}{100}$) the basilar length of the skull. Roots of lower incisors extending to base of $\overline{\text{pm. 2}}$. Incisive foramina terminating opposite $\underline{\text{pm. 1}}$; widest at or near base. Palatal bridge shorter than greatest width of incisive foramina. Palatine foramina opposite middle of $\underline{\text{pm. 3}}$.

Measurements.[28]—Average of four adults: hind foot 147 millimeters; ear, from crown, 98. Skull: total length 102; greatest breadth 48; greatest diagonal length of nasal 41; greatest length of mandible 75; greatest breadth of mandible, 49; alveolar length of upper molar series 19.

General remarks.—The peculiar incisor dentition of this species, so far as I have been able to compare it with other members of the genus *Lepus*, is quite unique, not only in the obliteration of the sulcus of the upper anterior pair but in the extension of the roots of both upper and lower incisors, the former being planted far behind the inferior anterior maxillary border and the latter reaching the bases of the second premolars.

Externally *grœnlandicus* will probably not be found to differ materially, even in its summer dress, from typical northern *arcticus*. Fabricius, whose experience was mainly confined to southern Greenland, twice asserts that its summer coat does not change in color from that of winter. Whether *grœnlandicus* will prove to be entirely distinct from the hares inhabiting Iceland and the extreme

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ous tooth than anything else."

While a formation analogous to this structure is seen in some adult specimens of all the species of Polar Hares I have examined, in no case does it assume the prominent and functional character which it invariably attains in adult *grœnlandicus*. In the others it manifests itself as a homogeneous deposit along the bottom of the sulcus; in the Greenland animal it is a laminate bistriate structure, having its inception near the base of the tooth in a honeycombed hastate flap which lies within, but does not touch the sides of the sulcus and which, as it extends toward the crown of the tooth, increases in density and calibre and is closely cemented within the groove. On the exposed surface of the incisor it often overtops the contour of the face of the tooth and widens up on the tooth face in the form of a protuberant lamina, with from one to three irregular longitudinal striæ upon its enamel-like surface.

In nearly mature fœtal specimens of *grœnlandicus* there is not the slightest indication of this incisor groove layer. In young *grœnlandicus*, one month old, the cementum has begun to form closely along the bottom of the groove and reaches along the median third of its length to the alveolar edge of the premaxillary. At this period its consistency is that of indurated cartilage. In specimens apparently but lately arrived at maturity, the sulcus is partly filled to the tip, and in very old skulls the groove is obliterated, as described above.

[28] For measurements of type *grœnlandicus*, see tables, pp. 374, 375.

North Polar regions westward, is an interesting problem, which lack of specimens prevents me from answering. That it is radically distinct from any American or Old World species represented in the collections at my disposal, is certain.

Through the courtesy of Mr. William De Winton, of the British Museum, I am in receipt of the following information about the hares of Grinnell Land: "The collection is rich in specimens of old and young from more northern localities, and those from Discovery Bay, Lincoln Bay, etc., have the characters [of *grœnlandicus*] mentioned [in your letter], viz.: the projecting, narrow, slightly grooved incisors." Accompanying this, Mr. De Winton sends a full length tracing of an upper incisor from a skull from Lincoln Bay, 82° 7′, Grinnell Land, which unmistakably belongs to the *grœnlandicus* type. He further says that these incisor "characters are not so marked in the small *brown* young," and that "Greenland specimens are more curved, so far as our collection shows, but they seem to me to get straighter with age, till the angle of meeting is considerably *less* than a right angle." In all particulars Mr. De Winton's examinations not only confirm but emphasize my own. Respecting the color of the young, which he incidentally mentions as "brown," it is of interest to note that while half-grown individuals are very light bluish-gray (nearly white), the newly born young and fully developed embryos collected by Dr. Hays at Port Foulke, Greenland, in the Academy's collection, are quite dark and resemble in color and color pattern miniature summer specimens of *L. timidus*, but are grayer. The embryos are densely clothed with long hair. The number of specimens in each litter above mentioned is four. Whether the full complement in each case was preserved, I am unable to state. The most satisfactory and reliable account of the Greenland Hare that I have seen is the one by H. W. Feilden, already referred to, in which he treats of these animals in Grinnell Land as observed by the Nares Expedition. The specimens secured by Mr. Feilden are those referred to above by Mr. De Winton, which I have identified as *grœnlandicus*. Feilden found the young of the year to have become nearly pure white by the end of July. The number of young in a litter was seven to eight. Tracks of this Hare were seen on the Polar Sea in lat. 83° 10′, twenty miles north of the nearest land.

Specimens examined.—Port Foulke, Greenland, 1 mounted skin and skull, 1 skull and 8 embryos in alcohol. Robertson's Bay, Greenland, 3 skins, 7 skulls.

Lepus tschuktschorum (Nordquist). Bering Sea Polar Hare. Pls. VI, VII & VIII figs. 3. Pl. X, figs. 3 & 4.

Lepus timidus var *tschuktschorum* Nordquist, Vega Exped., II, 1883, pp. 84–90; figs. 8, 9, 10, p. 88. Type locality, Pitlekaj, lat. 67°, lon. 173°, N. E. Siberia.

Geographic distribution.—Northwestern Alaska, from the mouth of the Kuskoquim River, northward.[29] (Northeast Siberia.)

Habitat.—Abounding in the open coast country and in the interior open barrens of the river valleys; seeking the shelter of ravines and willow scrub in severer weather but often found at such times in the open barrens.—Nelson.

Color.—Adult summer pelage (No. 3,780, A. N. S., Phila., Choris Peninsula, Alaska); upper surfaces of head and body, blackish smoke brown, becoming grayish-brown on the sides of body, neck and head. Median line of back smoky-black, sparsely tipped with dull tawny; rump purer black. Crown to nape like median line of back. Region around eyes, cheeks and nose dull rusty-black, grayer on lower jaws and with a white orbital ring. Chin and fore-throat, lower surfaces of limbs and feet, lower neck, chest, belly, vent and tail, white. Lower abdominal region clouded by a faint band of black hairs. Lower neck blackish-gray, suffused with tawny. Upper limbs and feet tawny gray, the hind feet nearly white. Median outer surface of ears sooty brownish-black, sprinkled with dull tawny, tawny gray and black on the inner surfaces, and white along the posterior borders; tips of ears black with brown and gray intermingled. Whiskers white. A few black hairs at upper base of tail. A pinch of hairs from near middle of back, about two inches from the vertebral line, shows the following color pattern: under-fur coarse, grayish-white at base, brown or sooty at distal end. Over-fur black, with or without a subterminal brown zone, intergrading into black spinous hairs, which form nearly twenty per cent of the dorsal pelage.

Winter pelage (No. 13,887, Col. Smiths. Inst.,, St. Michaels, Alaska), pure white, except extreme tips of ears, which are black, with rusty-based hairs. Whiskers white.

Cranial characters.—Total length of skull less than twice its greatest breadth. Nasals very wide, flattened, nearly as wide anteriorly as at base, their greatest breadth more than half their greatest (diagonal) length. Superior premaxillaries heavy, broad, reach-

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[29] See Nelson, Rep. Nat. Hist. Col. Alaska, 1887, p. 271.

ing behind bases of nasals. Supraorbital processes as in *bangsi*. Posterior interorbital constriction narrow, its relative width to alveolar length of upper molar series as in *grœnlandicus*. Upper anterior incisors rooted as in *arcticus*, their roots not forming decided maxillar convexities, owing to the great relative width of rostrum. Form and position of incisors as in *arcticus*, but heavier. Molars much heavier. Incisive foramina as in *arcticus*. Palatal bridge as in *grœnlandicus*. Palatine foramina as in *grœnlandicus*.

Measurements.—Average of three adults: hind foot, 176 millimeters; ear, from crown, 96. Skull: total length 103.5; greatest breadth 54; greatest (diagonal) length of nasal 42.5; greatest breadth of nasals 23; width, at tip, of upper incisors 66; alveolar width of upper incisors 9.8; alveolar length of upper molar series 20; greatest length of mandible 80; greatest width of mandible 51.

General remarks.—The Polar Hare of West Alaska, as will be seen by its measurements, represents the maximum development of the Arctic group in America. Added to great size we have in *tschuktschorum* several cranial and external characters which separate it from *arcticus* and its eastern subspecies so plainly that there is little doubt of their specific value. Among these we may note an approach in color to *timidus* of Sweden, but the uniformly broad flattened nasals, the great relative width of skull and large calibre of the dental armature and the anvil-shaped, upraised supraorbital processes induce me to specifically distinguish it. A skull from Plover Bay (Smith. Inst., No. 7,180) should be classed strictly as *tschuktschorum*. Reference to the table of measurements shows its dimensions to be of the largest. The relative zygomatic width is narrower, but in all other respects the Siberian skull is typical of the Alaskan as contrasted with the Scandinavian and Baffin Land animals. The researches of Radde[30] and Middendorff[31] show that the Polar Hares of east Siberia do not specifically differ from the European species either in color or in cranial characters, the latter mentioning the occurrence of this species in the Stanovoi Range which extends into the Tschuktschee country. Four skulls from Kamtchatka, in the collection of the Smithsonian Institution, show beyond question that the small *timidus* type of Polar Hare inhabiting that region is very different from the hare which frequents the

[30] Reisen im Ost-Sibirien, I, 1862, pp. 207–211.
[31] Sibirische Reise, II, 1853, p. 115.

Plover Bay territory. Brandt[32] says that "Wossenessenski observed the true form of *Lepus variabilis* in Kamtchatka and the coast provinces of Okotsk Sea, to be entirely white as far as the tips of the ears;" but the reference is of little value except in regard to the distribution and winter pelage of this hare in the maritime provinces of southeast Siberia. Schrenck[33] says the Amoor Land hares are not separable from the Polar Hare of Europe except that he regards the southern form as a variety of the northern, applying to it the name *canescens* of Nilsson, in which the normal change from the dark summer pelage to the white of winter presents an intermediate gray phase of coloration which is retained the whole winter season. As we would naturally expect, from the known character of the west Alaskan fauna, it furnishes us not only with the largest of our American Polar Hares, but with the darkest colored example of the whole group of Arctic *Leporidæ* I have yet seen.

Nordquist's description of the Tscuktschee Hare leaves no room for doubt as to its specific identity with the Alaskan animal. Owing to my lack of summer skins of this hare from Siberia it is impossible to say whether the Alaskan animal is separable as a darker race, though such a state of affairs is likely to exist.

The elaborate table of measurements given by Nordquist confirms my own conclusions regarding the great size of the Bering Sea Hare, the relative shortness of its ears, the great length of the hind foot and the strong peculiarities of the cranium.

I am informed that this hare, in common with some other species of the mammal fauna of these regions, is frequently known to cross Bering Strait on the ice in the winter.

Specimens examined.—Alaska, 3 skins, 4 skulls; Siberia, 2 skins (winter furs, without feet), 1 skull.

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[32] Reisen im Amur.-Lande, 1, 159, p. 1845.
[33] Bem. Wirbelth. Nord. Eur. Russl., p. 44.

MEASUREMENTS OF TWENTY-SEVEN SKULLS OF ADULT AMERICAN, SIBERIAN AND SCANDINAVIAN POLAR HARES.

Catalogue number.	Collection.	Locality.	Sex.	Total length.	Greatest breadth.	Greatest (diagonal) length of nasals.	Greatest breadth of nasals.	Width (at top) of upper incisors.	Alveolar width of upper incisors.	Alveolar length of upper molar series.	Greatest length of mandible.	Greatest breadth of mandible.	Remarks.
1,486	A. N. S.	Greenland, Robertson's Bay	♀?	100	50	41	20.5	5 6	8.5	18.8	76	48	Type of *L. grœnlandicus.*
3,173	A. N. S.	Greenland, Robertson's Bay		104?	48	42	20	5.4	8.8	19.2	75	48.5	Old adult, *L. grœnlandicus* (occipital broken).
3,297	A. N. S.	Greenland, Robertson's Bay		101	48		20	5.4	8.8	19.1			Adult *L. grœnlandicus.*
3,779	A. N. S.	Greenland, Robertson's Bay		100	48	41	21	5	8	19	75.2	50	Adult *L. grœnlandicus.*
12,456	S. I.	Baffin Land, Cumb. Sd., Niatilik		96	48	40.2	22	6.6	9	17.2	73	46	Not fully adult *L. arcticus.*
23,120	S. I.	Labrador, Ungava		96	49	42	21	5.8	8	17.8	78.5	47	Subsp. *L. a. bangsi.*
23,124	S. I.	Labrador, Ungava		98.8	52	44	22	6	8	17.8	76	46	Subsp. *L. a. bangsi.*
23,129	S. I.	Labrador, Ungava		98	51	42.5	21.5	6.2	8.2	18	74	45	Subsp. *L. a. bangsi.*
23,132	S. I.	Labrador, Ungava		95	49	40.5	21.5	5 9	8	17.4	77	45	Subsp. *L. a. bangsi.*
1,187	E A. & O. Bangs	Newfoundland, Bay St. George	♀	96.5	48 8	41	21.5	6	9	18	75.5	47	Subsp. *L. a. bangsi.*
1,189	E. A. & O. Bangs	Newfoundland, Bay St. George	♂	98	50	43.5	23	6.1	8.8	18	77.2	48	Subsp. *L. a. bangsi.*
3,754	E. A. & O. Bangs	Newfoundland, Bay St. George	♀	97 5	49	41	22	6	8 5	17.5	77.6	47	Subsp. *L. a. bangsi.*
3,752	E. A. & O. Bangs	Newfoundland, Codry.	♀	97	48	40			8.6		75	47	Type of *L. a. bangsi.*
7,203	S. I.	Northwest Ty., Fort Rae		99	51	39	19 8	6	9	19			Interior subsp. of *arcticus?*
6,122	M. C. Z.	"Yukon"		98	52		19.5	6	8.6	19			*L. tschuktschorum* (tip of occipital broken).
3,780	A. N. S.	Alaska, Choris Peninsula	♀	106?	56	43	24	7	10	20.7	83?		*L. tschuktschorum.*
15,883	S. I.	Alaska, St. Michaels		103.5	52.2	43.8	22 3	6.5	10	20.5	80 5	51	*L. tschuktschorum.*
15,884	S. I.	Alaska, St. Michaels		101	52	40.5	22	6.2	9.1	19 7	78	50	*L. tschuktschorum.*
256	Vega Exp.	Northeast Siberia	♀	109	55.5	46	25						Typical *L. tschuktschorum*, fide Nordquist.
2,69b	Vega Exp.	Northeast Siberia		109	56	43.5	23.2						Typical *L. tschuktschorum*, fide Nordquist.
7,130	S. I.	Siberia, Plover Bay		107	52.2	42	23	7	10	21	83	54	*L. tschuktschorum* (tip of occipital broken).
20,883X	S. I.	Commander Islands		98	50	42.8	25	6.6	9.2	19.6	77	50	*L. timidus?*
20,883Y	S. I.	Commander Islands		95	50	39 2	22	6.6	9 6	19 7	75	48.5	*L. timidus?*
21,985	S. I.	Kamtchatka		94	48	37	19.8	6.7	9.2	19.7	73.3	46	*L. timidus?*
411	S. I.	Sweden, Hellestad	♂	101	52	45	22.8	6.8	10	20	80	49	Typical *L. timidus.*
408	S. I.	Sweden, "near Stockholm"	♀	100	50	40	21	6.2	9	18 5	78	49	Typical *L. timidus.*
2,076	A. N. S.	Sweden		95	48.5	38	22	6.2	10	20	75	50	Typical *L. timidus.*

BODY MEASUREMENTS OF TWENTY ADULT AMERICAN, SIBERIAN AND SCANDINAVIAN POLAR HARES.

Catalogue number.	Collection.	Locality.	Sex.	Total length.	Hind foot.	Ear, from crown.	Tail vertebræ.	Remarks.
1,486	A. N. S.	Greenland, Robertson's Bay.	♀?		143	97		Type of *L. grœnlandicus* (relaxed).
1,520	A. N. S.	Greenland, Robertson's Bay.	♀		144	100		Dry.
3,779	A. N. S.	Greenland, Robertson's Bay.		520	155			Skeleton only (ligamentous).
1,047	A. N. S.	Greenland, Port Foulke.	♂		148	100		Mounted (dry).
12,456	S. I.	Baffin Land, Niantilik.				95		Head and neck (dry).
14,151	S. I.	Labrador, Solomon Is., Davis Inlet.			145	95		Dry.
14,149	S. I.	Labrador, Ft. Chimo.			140	102		Relaxed.
14,793	S. I.	Labrador, Ft. Chimo.			140	100	53	Dry.
1,187	E. A. & O. Bangs	Newfoundland, Bay Saint George.	♀	586	170	85	45	Meas. in flesh.
3,752	E. A. & O. Bangs	Newfoundland, Codry.	♀	626	160	85	63	Type of *L. a. bangsi.*
3,754	E. A. & O. Bangs	Newfoundland, Bay Saint George.	♀	603	167	85	67	Meas. in flesh.
3,756	E. A. & O. Bangs	Newfoundland, Bay Saint George.		583	159	82	65	Meas. in flesh.
3,780	A. N. S.	Alaska, Kotzebue Sound.			180	98		Relaxed.
13,886	S. I.	Alaska, St. Michaels.	♀		175	95		Dry.
13,887	S. I.	Alaska, St. Michaels.	♂		173	95		Dry.
	Vega Exp.	N. E. Siberia, near Pitlekaj.	♀	747	179	110	75	Typical *L. tschuktschorum*, fide Nordquist.
	Vega Exp.	N. E. Siberia, near Pitlekaj.	♂	720	170	100	80	Typical *L. tschuktschorum*, fide Norduquist.
408	S. I.	Sweden, near Stockholm.	♀		165	114		Relaxed.
409	S. I.	Sweden, Helsingland.	♀		165	108		Relaxed.
411	S. I.	Sweden, Hellestad.	♂		160	112		Relaxed.

EXPLANATION OF PLATES.

Plate VI.

Fig. 1. *Lepus grœnlandicus* Rhoads. Robertson's Bay, Greenland. (Topotype, No. 3,779, Acad. Nat. Sci., Phila.).

Fig. 1. *Lepus timidus* L. Near Stockholm, Sweden. (No. 408, U. S. Nat. Mus.).

Fig. 3. *Lepus tschuktschorum* (Nordq.). St. Michael's, Alaska. (No. 1,588, U. S. Nat. Mus.).

Plates VII & VIII.

Figs. 1, 2 and 3. Inferior and superior views of the same skulls figured in Plate VI, in the order there named.

Plate IX.

Figs. 1, 2 and 3. Lateral, superior and inferior views of *Lepus arcticus bangsi* Rhoads. Codry, Newfoundland. (Type, No. 3,752, ♀. Col. E. A. and O. Bangs).

Plate X.

Figs. 1 and 2. *Lepus arcticus bangsi* Rhoads. (Type). Mandible and super anterior view of rostrum.

Fig. 3. *Lepus tschuktschorum* (Nordq.). (No. 1,588, l. c.). Mandible.

Fig. 4. Upper incisor typical of *timidus* and *arcticus* types. (From a specimen of Alaskan *L. tschuktschorum*).

Fig. 5. *Lepus grœnlandicus.* (No. 3,779, l. c.). Upper incisor.

Fig. 6. *Lepus grœnlandicus.* (No. 3,779, l. c.). Mandible.

Fig. 7. *Lepus grœnlandicus.* (No. 3,779, l. c.). Super anterior view of rostrum.

Fig. 8. *Lepus timidus* L. (No. 408, l. c.). Mandible.

JULY 7.

The President, SAMUEL G. DIXON, M. D., in the Chair.

Thirteen persons present.

A paper entitled "New and little-known Mammalia from the Port Kennedy Bone Deposit," by Edward D. Cope, was presented for publication.

JULY 14.

MR. CHARLES MORRIS, in the Chair.

Fourteen persons present.

Papers under the following titles were presented for publication:—

"Insular Landshell Faunas as illustrated especially by the data obtained by Dr. G. Baur in the Galapagos Islands." By William Healey Dall.

"New Species of Fungi from various localities." By J. B. Ellis and B. M. Everhardt.

JULY 21.

MR. CHARLES MORRIS, in the chair.

Eleven persons present.

JULY 28.

The President, SAMUEL G. DIXON, M. D., in the Chair.

Fifteen persons present.

A paper entitled, "The Hemipenes of the Sauria," by Edward D. Cope, was presented for publication.

The following were ordered to be printed:—

NEW AND LITTLE KNOWN MAMMALIA FROM THE PORT KENNEDY BONE DEPOSIT.

BY E. D. COPE.

The notes contained in the following pages are based on material acquired by the Academy of Natural Sciences of Philadelphia from the locality above mentioned, and are preliminary to a complete and illustrated report which I hope to be able to publish after a full investigation of all accessible material. This paper extends and modifies the conclusions communicated to the Academy at the meeting of December 5th, 1895, where a general survey of the results was given. After a fuller study of the material presented, I have been compelled to reduce the relative number of existing species whose remains have been recovered. While the total number of species of mammalia is thirty-eight, the number of existing species is only six. They are as follows:

Erithizon dorsatum L.
Castor fiber L.
Lepus sylvaticus Bachm.
Ursus americanus L.
Felis eira Desm.
Lynx rufus Guld.

The remains of birds are not abundant, and consist chiefly of a species of turkey (*Meleagris*). Of reptiles there are a snake of the genus *Zamenis* and three species of turtles. One of the latter seems to be identical with the existing *Clemmys insculpta* Lec., while the others are apparently new. One is a large form, perhaps referable to *Clemmys*, and the other is a box tortoise.

BRUTA.

Megalonyx wheatleyi Cope.

This species was extremely abundant at the period when the fissure was open, fragments of at least sixty individuals having been obtained. The species is uniformly smaller than *M. jeffersonii*, and differs from it constantly in the form of the canine molars. Material for determination of the cranial characters has been found.

Study of the specimens shows that *M. dissimilis* Leidy was founded on inferior canine molars of *M. jeffersonii*, and that the teeth so named by me are the corresponding teeth of *M. wheatleyi*. *M. sphenodon* was founded on teeth of young individuals of *M. wheatleyi*. *M. loxodon* and *M. tortulus* are sustained as distinct.

GLIRES.

Anaptogonia hiatidens Cope. Proc. Amer. Philos. Soc., 1871, p. 91, fig. 18.

I have described from the Wheatley collection several species allied to or belonging to the voles, and in this paper I add two others. These forms are referable to those genera, which are defined as follows:

Pulp cavity and lateral grooves closed below; teeth rooted; ANAPTOGONIA Cope.

Lateral grooves and pulp cavities open below; no roots; MICROTUS Selys.

The first term in the Microtine series of genera is the genus *Anaptogonia*, where the crowns of the molars are short at maturity, and there are rather elongate roots. This is naturally the primitive genus, and it is interesting now that two fossil species referable to it have been discovered.[1]

But one species of *Anaptogonia* has been obtained from the cave formations of this country, *Anaptogonia hiatidens* Cope. It is represented by two series of the inferior molars of the right side, a first inferior molar separate, and some superior molars. The prism-formulæ of these teeth are as follows: (1) 1 six-lobed $\frac{3}{2}$ 1; (2) $\frac{2}{2}$ 1; (3) 1 $\frac{1}{1}$ 1. The first molar is larger than both of the others together. Its triangles $\frac{3}{2}$ are isolated, but anterior to these, one on each side is well defined, but the dentine is continuous with that of the anterior lobe. This lobe consists of two prominent basal loops, and two less prominent terminal rounded lobes, all unsymmetrical. There are thus six keels on each side of the crown and a rounded front border. The triangles of the M. $_2$ are acute, and the anterior of the opposite sides are not fully separated from each other, a strip of dentine connecting them. In the M. $_3$ the triangle of one side is less developed than the other, and the one extremity of the last column is smaller than the other, forming rather a curved process of a terminal triangle of the opposite side. The pulp cavity is well enclosed below, and the two roots are rather small and divergent.

[1] See Merriam, North American Fauna, No. 2, 1889, p. 28; On a new Genus and Four new Species of Arvicolinæ.

As compared with *A. rutila* of the northern parts of the earth, this species has double the linear dimensions of the teeth.

	Measurements.	*m.m.*
Diameters of M. $\frac{}{1}$	longitudinal of crown ;	6
	anteroposterior ;	4
	transverse posteriorly ;	1.6
Diameters of M. $\frac{}{2}$	longitudinal of crown ;	5
	anteroposterior ;	2
	transverse posteriorly ;	1.5
Diameters of M. $\frac{}{3}$	longitudinal of crown ;	5
	anteroposterior ;	2
	transverse posteriorly ;	1

The teeth of the second specimen are a little larger than those above measured. They are in a decayed jaw, with the incisor in place, and they agree with the types in all details, excepting only that the external column of the anterior lobe is not grooved.

The first inferior molar, which was originally described and figured, is peculiar in the failure of the anterior triangles to isolate themselves from each other. This character turns out to be inconstant, as in two other corresponding teeth the triangles are closed. The name *Anaptogonia* was applied to the species in a subgeneric sense, and although based on a worthless character, must, under the rules, be retained. It antedates the *Evotomys* of Coues, which was proposed in 1874 in the Proceedings of the Academy of Natural Sciences of Philadelphia, p. 186, for voles with rooted molars.

Anaptogonia cloacina Cope sp. nov.

Crowns prismatic, the common pulp cavity with lateral walls which close the lateral grooves, but do not close the pulp cavities ; no roots.

The dentition of this species is that which is regarded by G. S. Miller as that of the immature stage of the species which were termed by Merriam *Phenacomys.* I do not see that this dentition can be distinguished from that of *Anaptogonia.*[2]

Two individuals of this species are indicated by the specimens preserved by Mr. Mercer. These include, the first, the M. $\frac{2}{}$ and M. $\frac{3}{}$; the second, the M. $\frac{1}{}$ and M. $\frac{2}{}$. As usual in this group, the molars diminish in size posteriorly. The triangle formulæ are : M. $\frac{1}{}$, 1 $\frac{2}{2}$; M. $\frac{2}{}$, 1 $\frac{1}{2}$; M. $\frac{3}{}$, 1 $\frac{1}{2}+3$ lobes.

[2] North American Fauna, No. 12, 1896, p. 40.

In the M. $\frac{1}{\ }$ the triangles of one side are acute angled; and of the other, obtuse-angled. The posterior triangle presents an angle posteriorly as well as laterally. In the M. $\frac{2}{\ }$ the same characteristics exist, with the addition that the anterior (terminal) triangle has its acute column pinched together, but not so as to exclude the dentine. In the M. $\frac{3}{\ }$ the entering angle (groove) of one side enters the triangle of the other side opposite to it, so as to destroy its triangular character. The second triangle of the same side is also reduced by the deep inflection of the opposite groove. Opposite the apex of the second groove, a rudimental third triangle is present in the form of the section of a keel of the surface. This, I reckon as one of the three divisions of the terminal lobe. The other two are not well distinguished, one opposite to the keel just mentioned is an acute angle, and the terminal one is strongly convex. Thus on this tooth there are three keels on one side and four on the other. The anterior (terminal) column is flattened. Excepting on the M. $\frac{3}{\ }$, all the triangles are well isolated.

Measurements.		*m. m.*
Diameters M. $\frac{1}{\ }$ sp. no. 1	longitudinal;	7.5
	anteroposterior;	3.3
	transverse;	2
Diameters M. $\frac{2}{\ }$ sp. no. 2	longitudinal;	6
	anteroposterior;	2.7
	transverse;	2
Diameters M. $\frac{3}{\ }$ sp. no. 2	longitudinal;	5.5
	anteroposterior;	3
	transverse;	1.7

The walls of the common pulp cavity are broken off in most of the teeth of this species above described, but portions remain in most of them, and in the M. $\frac{3}{\ }$ they are so far perfect as to show that the pulp cavity is not closed below as in *Evotomys.*

Microtus diluvianus sp. nov.

The numerous species of the genus *Microtus* are distinguished into groups by various characters, e. g., those of the molar teeth, of the size of the ears, tail, etc. The extinct species can be most readily determined by dental characters, and as these are in all the species less matters of proportion, and more a question of the number of parts, they are to be preferred as possessing greater fixity. Thanks to the excellent work of Blasius on the Mammalia of Europe (1859), it is possible to determine the relation of the American species to the types of the divisions proposed by European authors. I am also much indebted to my friend, Mr. S. N. Rhoads for the opportunity of examining skulls of a number of rare North American species, and especially those described by himself from the Pacific coast.

The species differ as to the number of triangles in the first inferior premolar. There is, however, some lack of constancy in the relations of the anterior triangles to the treffle so that I have depended rather on the characters of the second molars in both jaws for convenience of definition of the larger groups. Thus, in the species of the *M. pinetorum* group, the last two triangles on one side fuse to a median position similar to that of the first column. In the other groups, where this tooth has two triangles on each side, the second superior molar differs in the number of its triangles. There are always two on the external side; but the posterior outer may be prolonged to the inner side, or this prolongation may be cut off into a distant triangle. These divisions include the following species:

A. Second inferior molar, triangles, $\frac{2}{2}$ 1.

1. Second superior molar, triangles, 1 $\frac{2}{2}$, *Agricola* Blasius. *M. agrestis* Europe.
2. Second sup. molar triangles, 1 $\frac{1}{1}$ 1, *Myonomes* Raf., *M. riparius*, E. N. Amer.; *M. principalis*, N. W. N. Amer.
3. Second sup. molar triangles, 1 $\frac{2}{1}$; *Microtus* Selys (=*Hemiotomys* Selys, *Paludicola* Blas., *Tetramerodon* Rhoads). *M. amphibius*; *M. nivalis*; *M. ratticeps*; *M. campestris*; *M. arvalis*; *M. subterraneus*; *M. savii*, Europe; *M. xanthognathus*; *M. townsendii*; *M. arvicoloides*, N. America; *M. speothen*; *M. sigmodus*; *M. involutus*; *M. diluvianus* Extinct, N. Amer.

AA. Second inferior molar, triangles, 1 $\frac{1}{1}$ 1.

4. Second super. molar, triangles, 1 $\frac{2}{1}$, *Pitymys* McMur. *M. pinetorum*, N. Amer.; *M. didelta*, Extinct, N. Amer.

The large size of *Microtus diluvianus* Cope distinguishes it from all the extinct and recent American members of the genus. It is only represented by the M. $\underline{1-2}$ of both sides, so that many of its characters remain to be discovered. The triangle formula of these teeth is M. $\underline{1}$ 1 $\frac{2}{2}$, M. $\underline{2}$ 1$\frac{2}{1}$. In both molars the triangles are acute and are well closed, and the posterior one presents an angle posteriorly. The lateral keels are $\frac{3}{3}$ and $\frac{3}{2}$. The valleys are wide open below.

		m. m.
Diameters M. $\frac{1}{}$	longitudinal;	9
	anteroposterior;	3.75
	transverse;	2.50
Diameters M. $\frac{2}{}$	longitudinal;	7.5
	anteroposterior;	3
	transverse;	2.2

Microtus speothen Cope. Proceeds. Amer. Philos. Soc., 1871, p. 87, fig. 13. *Arvicola (Pitymys) tetradelta*, l. c., 1871, pp. 87–8, fig. 14.

Arvicola tetradelta was founded on the M. $\frac{1}{}$ and $\frac{2}{}$ of an individual of smaller size than the types of *A. speothen*, but not otherwise different.

The species *Microtus involutus* from the Port Kennedy deposit is allied to *M. sigmodus*, while *M. didelta* is more nearly related to *M. pinetorum*.

CARNIVORA.

Ursus haplodon sp. nov. *Ursus pristinus* Leidy, Cope, Proceeds. Amer. Philos. Soc., 1871, p. 96, not *Arctodis pristinus* Leidy, Proc. Acad. Philada., 1854, 90; Holmes, Postpliocene Foss. So. Carolina, 1860, 115, pl. xxiii, figs. 3–4.

There are contained in the Academy's collection, remains of thirty-six individuals of this large bear from the Port Kennedy fissure, and parts of several others are included in the Wheatley collection. Study of this material has led me to the conclusion that *Ursus pristinus* of Leidy is a distinct though allied species. The latter was founded on a single tooth, the first inferior true molar of the left side. This tooth cannot now be found, but Leidy has given a figure which is of much excellence from an artistic point of view, and judging from other figures in the same work, is probably trustworthy, especially as it corroborates the description in every particular. I should have hesitated to distinguish the present animal, however, had it not been that the Port Kennedy material includes fourteen teeth from the same position in the jaw, three of which are in the Wheatley collection. These all agree closely and differ from Leidy's animal.

Leidy notes that in *U. pristinus* the anterior width of the tooth exceeds the posterior, and the figure confirms this statement. In *U. haplodon* the extremities of the crown are of equal width. The grinding surface of the crown is in *U. pristinus* rough with tubercles, while it is smooth in *U. haplodon*. This character might be supposed to be due to the attrition of use, but it is universal in the teeth of *U. haplodon* without regard to age. The trigon in *U. pristinus* is triangular; in *U. haplodon* it is a semicircle. The apex of the triangle is in *U. pristinus* internal, and it is split by a fissure which separates paraconid from metaconid. In *U. haplodon* the paraconid is wanting. In this respect *U. pristinus* more resembles the modern bears. I suspect that *U. pristinus* is distinct from *U. haplodon*, but of the same group; more approaching the typical Ursi. It is of smaller size, about equaling the grizzly.

Ursus haplodon belongs to the American type of the Plistocene and present ages, which is distinguished from the typical Ursi by the greater development of the sectorial part of the first inferior true molar. This is due to the more anteroposterior direction of the paraconid, the larger size of the protoconid and the smaller size of the metaconid. The tooth makes a sensible approach to that of *Hyænarctos*. To this group belong the following species, and they differ in the following ways:

I. Superior premolars crowded, overlapping. (South American.)
  Large species; *U. ornatus* Cuv., *U. bonaerensis* Gerv.
  Smaller species; *U. brasiliensis* Linn.

II. Superior premolars uninterrupted, not overlapping. (Californian.)
  Muzzle very short; *U. simus* Cope.

III. Superior premolars spaced. (E. N. America.)
  Muzzle moderate; *U. haplodon* Cope.

Where *U. pristinus* should be placed in this series can only be ascertained by future discovery. The three species first named are separated from *Ursus* under the name of *Tremarctus* (Gerv. *Arctotherium* Brav.), as the humerus exhibits an entepicondylar foramen. It is not known whether the last two species possess this character or not.

A conspicuous character is common to the living *Tremarctus ornatus* and *Ursus* (? *Tremarctus*) *haplodon*, which is not present in *Tremarctus bonaerensis* of the Pampean beds. There are two masseteric fossæ of the mandible, which are separated by a crest which extends obliquely downward and backward from below the coronoid process.

The size of the teeth of this species, as well as that of the jaws preserved, exceed the average dimensions of the grizzly bear (*Ursus horribilis*). *U. haplodon* was evidently one of the most formidable of its genus, and it probably found an abundant supply of food in the sloths of the genus *Megalonyx*, which were the most abundant of the contemporary mammalia.

Osmotherium spelaeum Cope.

This genus is characterized by inferior dentition as in *Mephitis*, but the dental formula Pm. 4, M. 2. Metaconid well developed; heel of sectorial large, cupped.

The inferior dental formula of this genus is that of the extinct form, *Potamotherium*, which intervenes between *Mephitis* and *Lutra*. The typical species of *Osmotherium*, however, resembles *Mephitis* so greatly in its inferior dentition that I suspect that the superior molar formula will be found to be Pm. 3, M. 2, as in *Mephitis*, instead of Pm. 4, M. 2, as in *Potamotherium*. The latter genus is of the Miocene age in Europe and North America, the genus *Brachypsalis* Cope from the Loup Fork formation of Nebraska being probably founded on a species of *Potamotherium*. The presence of an additional premolar is important in the Mustelidæ, but might in some case prove to be a mere individual variation, but in the present instance this is clearly not the case.

Osmotherium spelaeum Cope is represented by a left mandibular ramus which contains alveoli or roots of the C. and Pm. 4–2, with Pm. 1 and Ms. 1–2 perfectly preserved.

The ramus is robust, and its inferior border rises from below the heel of M. 1 upward and posteriorly; in *Mephitis mephitica* the ramus is less robust, and the inferior border begins to ascend below the posterior part of the M. II. The anterior border of the masseteric fossa is not sharply defined. There are three mental foramina, the first and second below Pm. 2, and the third below Pm. 1, the anterior being the largest. The molar teeth are much like those of *M. mephitica*, but are more robust. The metaconid is considerably smaller than the protoconid as in *Mephitis putorius*, and smaller than in *M. mephitica*. The borders of the heel are strongly and equally elevated, enclosing the basin completely. The Pm. I differs from that of *M. mephitica* in presenting a flat face inward and posteriorly, which is bounded externally by an angular ridge, as in *M. fossidens*. The crown of the Pm. 2 is mostly lost, but a short, flat transverse heel remains, which is similar to but smaller than that of the Pm. I. The anterior root of Pm. II is opposite the posterior root of the Pm. III; while the Pm. IV is entirely and directly in front of the anterior root of Pm. II, and exceeds it in size. The dental foramen enters at a point as far posterior to the M. II as the long diameter of the latter, about as in *M. mephitica.*

Measurements.	*m. m.*
Length of ramus from M. II inclusive,	29
Length of molar series;	25
Length of true molars;	13
Length of sectorial;	10
Width of sectorial at heel;	5.5
Length of heel of sectorial;	4.5
Length of crown of M. II;	3
Depth of ramus at Pm. IV;	9
Depth of ramus at posterior body of M. I;	9

The only question as to the validity of this form that can arise, is due to its similarity to *Mephitis fossidens.* See the description of the latter below.

Mephitis fossidens sp. nov.

Two species of the genus *Mephitis* Linn. occur in the bone deposit in considerable abundance. After a cursory examination I referred both of them to *M. mephitica,*[3] but a thorough study convinces me that this reference must be reconsidered. I give a table by which they may be distinguished from the best known recent species, *M. mephitica* and *M. putorius.* I add here that Dr. Merriam has endeavored to substantiate the reference of the latter species to a separate genus under the name of *Spilogale.*[4] He gives a list of characters which he regards as generic, but which are to me specific only, as they only consist of proportions of the skull and teeth.

I. M. $\frac{1}{}$ with para- and metaconule forming a straight longitudinal crest; no posterior ledge.

Metaconid small, low; inferior premolars 2–3 overlapping; entoconid low; *M. fossidens* Cope.

II. M. $\frac{1}{}$ with distinct V-shaped para- and metaconules separated by a fossa inwardly.

Metaconid small, low; inferior premolars 2–3 not overlapping; ramus, lower border rising posteriorly; entoconid low; *M. orthostichus* Cope.

[3] Proceeds. Acad. Nat. Sci., Phila., 1895, p. 447.

[4] North American Fauna, No. 4. 1890, p. 5.

III. M. $\frac{1}{}$ without metaconule, but with a broad posterior ledge; paraconule V-shaped.

Metaconid small; premolars not overlapping; ramus not rising posteriorly; smaller; *M. putorius* L.

Metaconid large; premolars not overlapping; ramus rising posteriorly; smaller; entoconid elevated: larger; *M. mephitica* L.

The characters above assigned to the species of *Mephitis* are established by numerous specimens. There are twenty-eight individuals represented by jaws and teeth in the Port Kennedy collection. Of them I can only determine fifteen. My own collection and that of the Academy of Natural Sciences include a number of skulls of *M. mephitica*, while the collection of Mr. S. N. Rhoads includes as many more, which he has kindly placed at my disposal. For my knowledge of the cranial dentition of *M. putorius* series I am also indebted to Mr. Rhoads, and to the monograph by Dr. Merriam above cited.

A species of this genus was found by me in a cave breccia in Wythe County, Virginia, and a left mandible ramus with complete dentition was obtained. I described it under the name *Galera perdicida*.[5] Dr. Coues has suggested that this species was founded on a specimen of *Mephitis putorius*, and on a reëxamination of the specimen I am inclined to believe that he is correct.

Mephitis fossidens[6] is represented by parts of the jaws with teeth of eight individuals. In only one of these do superior and inferior molars occur together, and this one is, therefore, regarded as the type. The species is of the same size as *M. mephitica*, and was supposed at first to be identical with that animal, until further study revealed several important differences.

The peculiarities of the dentition have been already pointed out in the synopsis of species. These are found in the relations of the paraconule and metaconule of the M. $\frac{1}{}$, in the small metaconid of the inferior sectorial, and in the overlapping of the premolars. The character of the M. $\frac{1}{}$ is seen in three specimens; of the anterior premolars in one, and of the inferior sectorial in six. The anterior portions of the mandibular rami are often injured, and the canine teeth are preserved in only two specimens, and the incisors in none.

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[5] Proceeds. Amer. Philos. Soc., 1869, p. 177, Pl. III, fig. 1.

[6] Fur Bearing Animals, 1877, p. 2).

The inferior molars resemble those of *M. mephitica* but differ in the following points: The metaconid is much smaller, resembling that of *M. putorius*. The entoconid is small and low. The Pm. 1 has a flat face, presenting backward and inward and is bounded by a ridge on the external side. This face is rounded in *M. mephitica*. The overlapping of the Pm. 2 and 3 does not occur in the latter. The inferior border of the ramus rises gently from below the posterior part of the M. $\overline{1}$. The angle is prominent and the condyle occupies a position inferior to that seen in *Mephitis mephitica* and *M. putorius*, in the two jaws in which this part is preserved. It does not rise above the level of the molars as it does in *M. mephitica*.

The M. $\underline{1}$ is the most characteristic part of the dentition. The crown is traversed by two parallel anteroposterior crests; the external consisting of the paracone and metacone, and the internal of the paraconule and metaconule. The posterior border is deeply notched between the two, and the anterior border less so. The protocone is represented by a cingulum which occupies the anterior half of the interior base of the crown, enclosing a fossa with the paraconule. Its border then rises vertically to the inner longitudinal crest which it joins about the middle. Just exterior to this crest is a small tubercle which may represent a metaconule. An external cingulum except at the base of the metacone. No anterior or posterior cingula.

In the existing species of *Mephitis* the protocone is continued into a wide ledge round the posterior side of the crown as far as the base of the metacone. The paraconule is V-shaped and does not reach the posterior part of the crown.

Measurements.	*m. m.*
Diameters of M. $\underline{1}$ { anteroposterior (greatest);	8
Diameters of M. $\underline{1}$ { transverse;	9.5
Length of inferior sectorial;	11
Depth of mandibular ramus at $\overline{\text{m. 1}}$;	6
No. 2 (with angle of mandible).	
Length of M. $\overline{1}$;	11
Length from M. $\overline{1}$ to condyle;	26
Length from M. $\overline{1}$ to angle;	23.5
Depth of ramus at M. $\overline{1}$;	7.5

No. 3 (with canine).	m. m.
Length of dental series;	31
Length of true molars and Pm. 1;	21
Length of M. $\frac{}{1}$;	11.5
Depth of ramus at M. $\frac{}{1}$;	8

This species represents a section of the genus distinct from *M. mephitica,* with which it is connected by *M. orthostichus* Cope.

Mephitis orthostichus sp. nov.

This species is represented by superior first molars of five individuals and mandibular rami of two others. Unfortunately in no case are inferior and superior dentition of the same individual preserved together. In one individual both rami are preserved.

This species is intermediate in size between *M. mephitica* and *M. putorius,* and resembles the latter species in the small metaconid. It resembles *M. mephitica* in the rising inferior outline of the mandibular ramus, and differs widely from both species in the character of the superior M. $\frac{1}{}$

The superior M. $\frac{1}{}$ instead of presenting two parallel longitudinal crests, has a slightly curved crest representing the paraconule, which reaches a trihedral cusp, the metaconule. Thus is produced an internal longitudinal crest which presents a convexity anteriorly and an angle posteriorly, and an entrant angle between the two. The protocone is a mere cingulum which rises to the apex of the metaconule, and extends no further, so that there is no posterior ledge as in the existing species. While the internal crest is quite different in its zig-zag character from that of *M. fossidens,* the species further differs from the latter in the inferior premolars which do not overlap, and in the inferior size. The posterior border of the M. $\frac{1}{}$ is not so deeply notched as in *M. fossidens.*

The inferior dentition does not differ from that of *M. mephitica* except in the small metaconid and entoconid, and the flatter posterointernal face of the Pm. 1, in which it resembles *M. fossidens.* The third premolar is in contact with the canine, and has two roots which do not overlap those of the second. The crown is longer than either and has a heel with a recurved rim. The third has the same, while the fourth is a narrow heel, with a recurved rim all around it. In no specimen is the angle of the mandible preserved.

Measurements.		m. m.
	No. 1; superior M $\frac{1}{}$	
Diameters.	anteroposterior;	8
	transverse (greatest);	8

No. 2; both mandibular rami.	m. m.
Length of premolar series;	11
Length of molar series;	13.5
Diameters M. $\overline{1}$ { anteroposterior;	10
Diameters M. $\overline{1}$ { transverse of heel.	3
Diameters M. $\overline{2}$ { anteroposterior;	3.5
Diameters M. $\overline{2}$ { transverse;	2.5
Depth of ramus at Pm. 1;	9
Depth of ramus at Pm. 2;	10
No. 3; smallest ramus.	
Length of last three molars;	17
Length of M. $\overline{1}$;	9.5
Depth of ramus at Pm. 1;	6
Depth of ramus at M. 2;	8

In two last superior molars the short angle connecting the metaconule with the paraconular crest is rudimental or wanting, so that the arrangement only differs from that of *M. fossidens* in the greater separation of the metaconule from the crest. Such teeth are nearly transitional between the two species, but they maintain the inferior size of *M. orthostichus*. The two types of molars might be regarded as representing male and female, but for the difference in the relations of the inferior premolars, as pointed out in the analytical table of species.

Pelycictis lobulatus, gen. et sp. nov.

Char. gen.—Dental formula Pm. $\overline{3}$, M. $\overline{2}$. Sectorial with basin-shaped heel, and without metaconid. Premolars without posterior lobe.

The genus *Pelycictis* is only known from the mandible. The dentition agrees in number of teeth with both *Mephitis* and *Putorius*. From the former it differs in the absence of metaconid, and from the latter in the basin-shaped heel of the sectorial molar. From *Gulo* it differs in the presence of but three premolars. But one species is known, *P. lobulatus* Cope, represented by an entire left mandibular ramus containing all the teeth excepting the third premolar and the incisors.

Char. specif.—This weasel is larger than any of the existing species of *Putorius* of North America, but equals *P. vittatus* of Brazil. In some respects the parts preserved resemble the corresponding ones of *Mephitis orthostichus*, but the differences are also conspicuous. The ramus is rather robust, and the symphysis is short. The inferior border is regularly convex, and rises to the angle, latter projects as far posteriorly as the condyle. The condyle is rather elevated, its inferior border being in the horizontal line of the apices of the cusps of the sectorial. The coronoid process preserves its anteroposterior width to near the apex, which is broadly rounded, and not contracted, as in Lutra species. There is a longitudinal keel on the inner side of the angle, distinct from the inferior margin.

The teeth form a continuous series, the anterior premolars not overlapping. The canine is rather small; the crown is somewhat compressed, and is not grooved or facetted, but is smooth. The second premolar has the heel produced backward. In the first premolar the heel is a cingulum, and is not produced. The metaconid of the sectorial is represented by a convexity of the internal edge of the protocone. Heel concave, with an elevated border on the internal edge only. This consists of a larger lobe or entoconid, and a smaller between it and the lobe representing the metaconid. Entoconid not elevated, resembling that of the extinct species of *Mephitis* already described. No cingula. The tubercular molar has a semicircular concave grinding surface, and no cingulum.

Measurements.		m. m.
Length of ramus from canine to condyle inclusive;		42
Depth of ramus at Pm. $\overline{2}$;		7
Depth of ramus at M. $\overline{2}$		8
Depth at condyle;		7.5
Depth at coronoid process;		22
Length of dental series;		25
Length of true molars;		12
Diameters of base of crown of canine;		3.5
Elevation of crown of canine;		4
Diameters of crown of sectorial	elevation;	3.5
	anteroposterior;	8.5
	width of heel.	3.5

The jaw described is about the size of that of the common skunk.

Lutra rhoadsii sp. nov.

Portions of both mandibular rami with the right superior tubercular molar represent this otter. The right ramus supports part of one of the premolars, a large part of the sectorial, and the tubercular. The left ramus supports the tubercular. In the right ramus the alveoli of the premolars and part of that of the canine are preserved. All belong to one individual, aud were found in place in the matrix.

This species differs from *Lutra canadensis* in two conspicuous points; first, the inferior border of the mandible is a nearly straight line to the angle; second, the third premolar is nearly transverse to the long axis of the jaw in position, in consequence of the much shorter mandibular symphysis.

The coronoid process is at right angles to the horizontal ramus and its anterior and posterior borders are straight and of equal inclination to the obtuse apex; the posterior border is convex in *L. canadensis.* The angle is opposite the base of the sectorial; in *L. canadensis,* it is opposite the apices of the cusps of the sectorial. The anterior border of the masseteric fossa is below the middle of the tubercular molar. The inner side of the ramus is flat and not grooved, except immediately above the angle. The mental foramina are below the middle of the first, and the anterior root of the second premolars.

Both the internal and external borders of the inferior tubercular molar are elevated, the former as a low cusp. The crown is horizontal in position and is not tipped forward as in *L. canadensis.* An external basal cingulum on both this tooth and the sectorial. In the latter the metaconid is well developed; the protoconid and paraconid are broken away. The basin of the heel has the form of of that of *L. canadensis,* and the external cutting edge is notched in front. The first premolar is longitudinal in position, but the anterior root of the second premolar is interior to the middle line. The internal root of the third premolar is near the middle of the superior face of the ramus, but the interior root is anterior to the internal border of the anterior root of the second premolar. Both are close to the canine alveolus. The crown of a premolar was displaced and adherent in the alveolus of the root of the paraconid of the sectorial. The crown probably belongs to the second premolar. It has no lobe on its posterior edge, and is expanded posteriorly at the base. The superior tubercular has lost its paracone and metacone. The interior part of the crown is a broad table with the protocone as an obtuse cusp on the interno-anterior border, with a cingulum at its base. This part of the tooth is much like that of *L. canadensis,* but is not so convex posteriorly.

Uncia mercerii Cope. Proceeds. Academy Nat. Sciences Phila., 1895, p, 448. *Crocuta inexpectata* Cope, l. c., p. 449.

Additional material of this large feline confirms its distinctness. The sectorial tooth referred to the genus *Crocuta* as above cited, with reservation that it might be found to pertain to a feline animal, must be referred here. The superior sectorial is peculiar in the small indication of protocone as in the Smilodons.

DIPLARTHRA.

Cariacus lævicornis sp. nov.

A series of superior molars of the right side lacking the last one, represents this species. There were obtained at about the same time the basal parts of the antlers of two deer of the same size, which I suspect to belong to this species. There are various bones of the skeleton of probably the same.

The true molars have internal basal columns, and the internal crescents send backward and outward processes into the lakes, as in the existing North American species of the genus. The molars are of the size of those of *C. virginianus*, but the premolars are smaller. The first and second are especially reduced in anteroposterior diameter, and while the third is larger than these, its form is different from that of the corresponding tooth in any species of this genus or of *Coassus*. The anteroposterior diameter of the crown does not exceed the transverse, and there is no ridge of the external face such as is present in all the Cervi, but only a slight convexity. This ridge is present, but indistinct in the other premolars. It is very strong on the paracone of the true molars, but weak on the metacone. The horns of all the crescents are well developed. The width of the base of the crowns of the true molars is greater anteriorly than posteriorly. There are no processes entering the lakes of the premolars such as are usual in the species of *Cariacus*.

Measurements.		m. m.
Diameters of Pm. 1	anteroposterior ;	11
	transverse ;	12
Diameters of M. 1	anteroposterior ;	15
	transverse ;	16
Diameters of M. 2	anteroposterior ;	16
	transverse ;	16.5

The fragments of horns both include the bur. This is not very prominent, and the beam is quite smooth. There are indications of tines, but they are broken off at the bases. In the shorter fragment a tine is given off on the internal side, but it is broken off near the base, and the beam beyond its base is also lost. In the second fragment the position corresponding to the internal tine is split away

Above it the beam is somewhat compressed anteroposteriorly, and sends off a smaller tine directly anteriorly. The beam in both is entirely smooth.

Measurements.

		m. m.
Diameters of beam No. 1 at base	anteroposterior;	18
	transverse;	16
Elevation to internal tine;		13.5
Anteroposterior diameter of beam No. 2 at base;		17.5
Anteroposterior diameter of beam No. 2 at superior base of anterior tine;		15.5
Transverse diameter of anterior tine;		14
Elevation of anterior tine above base;		27

The smoothness of the beam of the horns distinguishes this species from the existing species of *Cariacus* of both North and South America, and resembles the condition seen in the species of *Coassus*, where the horns are unbranched. The inferior tine originates nearer the bur than in the known species of *Cariacus*, while the anterior tine is present only in species (*C. campestris*) where the interior tine is absent. The longer beam preserved shows no tendency to an anterior curvature such as is present in most of the species of the genus.

The true molar teeth of this species are of about the same size as those of the Virginia deer.

INSULAR LANDSHELL FAUNAS, ESPECIALLY AS ILLUSTRATED BY THE DATA OBTAINED BY DR. G. BAUR IN THE GALAPAGOS ISLANDS.

BY WILLIAM HEALEY DALL.

INTRODUCTORY.

The Galapagos Islands, lying under the equator about 90° west of Greenwich, comprise two principal groups separated by nearly 1,200 fathoms of water. One of these groups, northwest of the other, contains only Culpepper (550 ft.) and Wenman (830 ft. elevation) Islands and a few insignificant rocks. Culpepper, owing to its small elevation, is nearly barren, while Wenman shows on its upper surface a thin coating of grass and other vegetation. From neither of these has any collection been made or is any land shell known.

The main group of the Galapagos rests on an elevation of the sea bottom included within the 1,000 fathom line. It may be provisionally divided into three groups, a southeastern, a central and a northeastern, in all about a dozen islands and some smaller islets and rocks.

The southeastern group comprises Charles, Chatham, Hood and Barrington Islands. Hood is destitute of water in the dry season and green only in the wet season, owing to its small elevation which does not bring it into the region of condensing clouds. Much of the surface is covered with blocks of lava. Chatham and Charles are among the most fertile islands of the group.

The central islands include the largest of the whole, Albemarle, which appears to consist of several primitive islands united by low areas of volcanic material; Narborough, which exhibited volcanic activity as lately as 1836; James; Indefatigable, and the much smaller Duncan Island, besides a number of islets.

The northeastern group comprises three comparatively small islands Abingdon, Bindloe and Tower.

The floral characteristics of the Galapagos have been mentioned by Darwin, fully discussed by Hooker and well described by Wolf, while Tanner, Baur and Agassiz have added the facts gathered by later explorations. I shall, therefore, merely briefly summarize the characteristics which these writers have noted.

The vegetation of the islands appears to be divided into three distinguishable zones. Near the sea-level the basaltic or tufaceous volcanic rocks of which the islands are exclusively composed, appear almost devoid of plants, especially in the dry season, except dry grayish-white, apparently dead brushwood which grows thickly between the blocks of ash and lava, and which on close inspection exhibits inconspicuous small leaves and flowers. The most common according to Wolf[1] and Agassiz[2] are a Verbena bush and an *Acacia*, with an occasional tree known as the Palo Santo. Near the beaches are a few species of salt loving plants, probably all identical, with forms also known from similar localities on the mainland. Cacti, *Opuntia* and *Cereus*, are found among the blocks of lava, where nothing else grows. This zone extends to a height of 800–1,000 feet, the rains in general being limited even during the rainy season (February or later, to July) to the higher levels above 500–600 feet. The change to the second zone is sometimes very abrupt, but on the leeward side of the islands the arid region extends higher than on the southern side from which the moisture-bearing winds come.

The second zone is green and wooded, the Acacia and Palo Santo increase in size, the Verbena disappears, and the region shows numerous open grassy spaces. The volcanic rocks, under the influence of moisture, have become decomposed into a soft reddish earth.

The last and highest region is bare of trees, having the aspect of an undulating plateau covered with a rather coarse grass, which extends to the highest summits of many of the islands. Here even in the dry season, there is a more or less constant deposition of moisture from the mists which sweep over the islands. However, both above and below, on several of the islands, extremely barren localities or areas occur of strangely desolate aspect; in some instances the arboreal vegetation of the second zone is supplemented at the sea-level by thickets of mangroves or other shrubby trees, so that there is, among the island floras, no absolute rule without an exception or two.

The sea currents about the islands and between them and the mainland are very complicated. In a general way it may be said that two currents converge upon the islands, one from an east-north-

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[1] Ein Besuch der Galapagos Inseln mit drei Kärtchen, 1870.

[2] General sketch of the expedition of the Albatross, Feb.–May, 1891; Bull. M. C. Zool., XXIII, No. 1, 1892.

easterly direction from the Gulf of Panama, and another from a southeasterly direction from the Peruvian coast. Both are strong currents, both have doubtless contributed their aid in populating the Galapagos, but in this the Panama current seems to have predominated, not only because it has a shorter traverse, but because around the Gulf of Panama and on the banks of the rivers falling into it, a luxuriant fauna and flora are found close to the sea, while along the Peruvian coast only in time of freshet could any large quantity of débris be expected to reach the waters of the current, owing to the aridity of the immediate shores. The two currents join forces at some distance eastward from the islands, and pour through the passages between them with considerable force. Professor Alexander Agassiz has shown how much terrigenous material the Panama current bears, and that there is no reason to doubt that trees still bearing leaves and with some of their branches above water might be carried from the Gulf and cast upon the islands, and that, at least during the rainy season and in favorable years, there would be opportunities for animals so carried, especially land shells glued by the epiphragm to the bark of branches, to gain vegetation on the shores where they could support life and propagate their kind. Though unproven, yet there can be little doubt that in this way the land mollusk fauna of the islands was introduced and preserved.[3]

The first explorer of the Galapagos Islands for land shells was Hugh Cuming, about 1830, who collected *Bulimulus nux* Brod., *B. ustulatus* Sby., and *B. unifasciatus* Sby., on Charles Island ; *B. rugiferus* Rve., *B. calvus* Sby., and *B. jacobi* Sby., on James Island; while from his collection at a later time were described *B. eschariferus* Sby., *B. rugulosus* Sby., *B. verrucosus* Pfr., *B. nucula* Pfr., and *B. galapaganus* Pfr., without definite reference to a particular island. Assuming that the last three mentioned were collected by Cuming and not obtained from later collectors, this comprises eleven species.

The next collection was made by Darwin in 1835, who obtained *Bulimulus Darwini* Pfr., *B. sculpturatus* Pfr., a *Helix* (not named or subsequently reported for over half a century but, perhaps, *Trochomorpha Bauri*) and thirteen other species not specified at the time, as well as a " *Paludina* " (probably an *Amnicola*) which has

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[3] Attention has already been called to these facts by Dr. Stearns, but in order to make the present discussion complete I have been obliged to restate them briefly here.

never been described or found since. Reeve mentions that Darwin collected *Bulimulus rugulosus* on Chatham Island, but this is the only species of Darwin's which I have been able to find in print referred to any particular island. Darwin says in his journal (Chapter XVII), "Of land shells I collected sixteen kinds (and two marked varieties) of which, with the exception of one *Helix* found at Tahiti, all are peculiar to this archipelago. A single fresh water shell (*Paludina*) is common to Tahiti and Van Diemen's Land." With the much closer drawn specific lines of the present day, it is probable that both the "*Helix*" and "*Paludina*" would be discriminated as distinct from their allies mentioned by Darwin. A part at least of Darwin's Galapagos shells went into the Cumingian collection, but I have been unable to discover any trace of the remainder, which were probably scattered.

The next recorded expedition to touch at the islands and bring back land shells, was that of Kellett and Wood in 1846. The collection was worked up by Professor Edward Forbes, who reports seven species from Chatham Island, namely, *Bulimulus nux, calvus, eschariferus, unifasciatus,* and *rugulosus* already known, and *B. chemnitzioides* and *achatellinus* Fbs., which he described as new.

Subsequently whalers and sealers frequently touched at the islands either for water or other necessaries, and a certain number of land shells reached Europe from the Galapagos Islands without positive data in regard to their origin, and have been described by various authors. Of these *Bulimulus asperatus* Albers, *B. incrassatus* Pfr., *B. nuciformis* Petit, *B. amastroides* Ancey, and several varieties of *rugulosus* and *eschariferus* may be mentioned.

In later years collections have been made by Dr. Simon Habel in 1868, who added one new species (*Bulimulus Habeli* Stearns) to the fauna of Chatham Island and collected *B. chemnitzioides* at Chatham, *B. Darwini* at Bindloe and *B. achatellinus* at Hood Island. He also collected *Auricula stagnalis* Petit, and *Pedipes angulatus* C. B. Adams at Bindloe; *Melampus trilineatus* C. B. Adams, *Tralia panamensis* C. B. Adams, at Hood; *Williamia peltoides* Dall and *Onchidella Steindachneri* Semper, all new to the fauna.

In 1872 the U. S. S. Hassler with the Agassiz party on board, spent ten days among the islands, but no list of the species collected has been published.

In 1875 Dr. Theodor Wolf, geologist of Ecuador, visited the islands and collected a few land shells subsequently described by P.

Reibisch in 1892, as will be more particularly discussed later. Dr. Wolf obtained the following species, mostly represented by a small number of individuals, and too often in an imperfect state of preservation. From Charles Island, *B. unifasciatus, nucula, asperatus, nux, nuciformis, ustulatus* and *calvus,* known forms, and *B. invalidus, venustus, cinereus* and *nudus,* described by Reibisch as new. From Chatham Island, among known species, Wolf found *B. incrassatus, rugulosus, achatellinus, chemnitzioides, Succinea Bettii,* and the following supposed to be new: *B. terebra, ventrosus* var., *acutus, curtus, lima, canaliferus, Leptinaria cymatoferus, Helicina Wolfi* and *Succinea Wolfi,* described by Reibisch. From Albemarle Island, *B. pallidus, Simrothi* and *Pupa munita,* all regarded as new by Reibisch ; Indefatigable Island supplied the new *B. Wolfi* and *Pupa clausa* Reibisch ; and Barrington Island *B. ventrosus* Reibisch. These species will submit to some additions from data furnished by letter through the politeness of Herr Reibisch, who has also sent me for examination a number of his types.

H. M. S. Peterel, Commodore Cookson, visited Charles Island in 1875, obtaining *B. nux* in numerous varieties, *B. unifasciatus, eschariferus* and the *Succinea* described by E. A. Smith as *S. Bettii* and var. *brevior,* in honor of Staff-Surgeon Bett, who collected the specimens.

In 1888, the U. S. S. Albatross, Captain Tanner, of the U. S. Fish Commission, during her voyage from Norfolk, Virginia, to San Francisco, California, spent a short time in the Galapagos group, and obtained a good many specimens of a few species of land shells, which have been discussed by Dr. Stearns in the Proceedings of the U. S. National Museum for 1892. The collection from Chatham Island comprised *Bulimulus nux, nuciformis, amastroides, chemnitzioides, Habeli,* and *Succinea Bettii ;* from Charles Island *B. nux* in numerous varieties, *rugulosus, eschariferus, Siphonaria gigas, Onchidella Steindachneri* Semper, and the new *O. Lesliei* Stearns ; Albemarle Island afforded *B. nux* and the two Onchidiums, while at Hood Island *Williamia peltoides* was obtained. The *Albatross* again visited the Galapagos under the direction of Professor Alexander Agassiz in 1891, but no land shells appear to have been collected on this occasion.

The most thorough and important exploration for land shells which has yet been made is that upon which this paper is essentially based, namely, the expedition of Dr. G. Baur in 1890, in which careful notes were made as to the occurrence of the different species, not only as to the particular island, but the altitude above the sea, the sort of vegetation, rock shelter, etc., where the species were collected. The results, tabulated by islands, of Dr. Baur's labors are as follows:

CHATHAM ISLAND.

Bulimulus nux var. *incrassatus*, 1,600 feet on leaves.
B. jacobi, typical form, 1,600 feet.
B. achatellinus, 1,600 feet, under leaves.
B. unifasciatus, 1,600 feet, under leaves.
B. Bauri, *n. s.*, 1,600 feet, under leaves.
B. curtus, 1,600 feet, under leaves.
B. nucula, 1,600 feet, under leaves.
B. chemnitzioides, 1,600 feet, under leaves.
B. eschariferus, near seashore under stones.
B. Habeli, near seashore under stones.
Conulus galapaganus, 1,600 feet, on leaves of plants.
Vitrea chathamensis, 1,600 feet, on leaves of plants.
Succinea producta, typical, 1,600 feet, on mossy rocks.
Leptinaria chathamensis, 1,600–2,000 feet, on ferns.
Helicina nesiotica, 1,600 feet, on leaves.

CHARLES ISLAND.

Bulimulus rugulosus.. *B. galapaganus*.
B. planospira. *Succinea brevior*.

SOUTH ALBEMARLE ISLAND.

Bulimulus jacobi. *Trochomorpha Bauri*.
B. Simrothi. *Succinea Bettii* and *corbis*.
Pupa Wolfii. *Leptinaria chathamensis*.

DUNCAN ISLAND.

Bulimulus olla. *B. duncanus*.

BARRINGTON ISLAND.

Bulimulus eschariferus var. *ventrosus*. *B. olla*.

JAMES ISLAND.

Bulimulus jacobi var. *cinereus*. *Succinea Bettii*, typical.

INDEFATIGABLE ISLAND.

Bulimulus olla.

The total, after suppressing a number of synonymous names, amounts to twenty-seven discriminable forms collected from seven out of the twelve principal islands by Dr. Baur.

Dr. Baur's results leave little room for doubt that a thorough exploration of all the islands, and especially of Albemarle and Narborough, would add materially to the number of determinable forms and, therefore, that the time for finally discussing or speculating upon the distribution of the species among the several islands has not arrived. Albemarle, much the largest, should when explored yield a larger harvest than the much smaller Charles or Chatham Islands, which seem to have been better explored, because they have better anchorages for a vessel. Narborough, said to be very fertile, has not been explored at all for land shells; we have nothing at all from Abingdon or Tower, and only three species from Bindloe.

Nearly all the land shells of the Galapagos are more or less arboreal and pass much, if not the whole, of the dry season attached to branches of shrubs or trees by a deposit of tough dry mucus forming a hermetic seal to the aperture, as well as a means of fixation. So tough is this material, that, when dry, the bark or the shell will break easier than the epiphragm if one tries to dislodge a specimen. The mucus is poured out in such quantity as not only to close the aperture of the shell with a brownish parchment-like membrane, but to fill the minor irregularities of the surface upon which the aperture rests and to rise around the outer margin nearly a millimeter above the edge of the shell. About a third or half a turn further inside the shell, the animal constructs a second epiphragm, behind which it rests in a torpid state until a change in the season leads to its awakening. Several specimens of *Bulimulus planospira* which had been gathered more than a year and kept in a corked vial, when they reached my hands, still contained the living animal in his self constructed refuge, and doubtless other species would have done the same if they had not been put in alcohol. Nearly all of Dr. Baur's living Bulimuli were collected during the hibernating season as indicated by the remains of bark and epiphragm still adhering to them.

Of the species not known to construct an epiphragm there are only a few identified from the islands, three small forms of *Helicidæ*, a *Leptinaria* and *Helicina*, besides the semi-amphibious salt-marsh loving *Auriculidæ*, etc. The *Helicina* has a shelly operculum with which it can hermetically seal its shell. Both it and the Helices are forms which would be apt to hide in minute crevices of bark or holes in decaying timber. The *Leptinaria* lives on ferns, and its minute size renders it possible that it might be carried on dead leaves, etc., which an exceptionally high wind blowing for eight or ten hours might carry to the islands. Such winds are not unknown, especially in the tropics, and a single hurricane blowing in the right direction might introduce a large number of seeds, insects, fern spores and minute land shells, to say nothing of larger objects.

It is obvious, therefore, that the derivation of the island flora and land shell fauna does not present us with serious difficulties. Its distinctively American type indicates the point of origin. Before discussing this branch of the subject further, it may be well to refer to the characteristics of the several islands, in order that the relations of the fauna to the fertile area may be considered.

The islands which lie most directly in the track of currents and winds are those of the southeastern group. Chatham is one of the best known and most fully explored in the whole group, and is notable for the clean cut development of the three zones and the fertility of its upper portion. On Charles there is less vegetation on the lower levels but, according to Agassiz, the beach shows many plants common to Panama and Guayaquil. Hood is so much lower than the others (640 feet) as to be chiefly in the barren zone, covered with lava blocks destitute of water in the dry season, and partially green only in the rainy season.

Of the Central group, Indefatigable is first in the track of the current, and much resembles Charles and Chatham with a vast tract of arable upland. Duncan is comparatively small with abrupt sides, and has no living water, though its upper part is somewhat verdant. The south and east parts of James Island seem partly sheltered by Charles and Indefatigable from the prevailing trade winds; at all events they are dryer and less fertile than the portion north of James Bay. Much of Albemarle Island is low and consequently barren, having a desolate burnt aspect. The highlands of the southern portion are covered with rich vegetation, and there are elevated green patches near the northern end. Although there is actually a larger area of vegetation on Albemarle than on either of the other islands, yet the fertile region is not as large in proportion to the total area as the size of the island on the chart would lead one to expect.

Narborough, from which no land shells have yet been collected, has a rich and abundant vegetation with a luxuriant growth of mangroves on the eastern shore. This island was the last to exhibit its volcanic activity, and the fauna may prove meagre, yet it can hardly be doubted that it will afford a certain number of species and possibly some novelties.

The islets of the northeastern group are small and comparatively barren. Tower and Bindloe are not high enough to profit much by the mists. Abingdon is higher, and with Bindloe shows a certain proportion of green. No land shells are known from Tower and Abingdon. From Bindloe only the following are yet reported:

Bulimulus Darwini, Auricula stagnalis, Pedipes angulatus.

From the central group come:—*Bulimulus Wolfi, B. duncanus,* B. calvus, B. jacobi, B. jacobi* var. *cinereus, B. olla, B. Tanneri, B. unifasciatus, B. Simrothi, B.* n. sp., near to *Habeli, B. rugiferus,* B. Reibischi, B. nesioticus, Trochomorpha Bauri,* Pupa clausa, Pupa Wolfii, Succinea Bettii, Succinea corbis, Leptinaria chathamensis, Leptinaria* sp. larger than *chathamensis, Helicina nesiotica.*

In all 21 forms, of which none is common to the northeastern group of islands; 14 are peculiar or not yet reported from either the northeastern or southeastern group of islands; one is of doubtful locality but provisionally placed here on account of its similarity to *B. rugiferus;* and the remaining six are common to the southeastern group. *Onchidium* is not counted.

In the southeastern group are found thirty-three forms (not counting *Onchidium*), of which the following are peculiar to, or not yet found outside of this group of islands:—*Bulimulus nux, B. achatellinus, B. rugulosus, B. nudus, B. planospira, B. ustulatus, B. eschariferus* and var. *ventrosus, B. galapaganus, B. perspectivus, B. jacobi* var. *acutus, B. nucula, B. amastroides, B. curtus, B. Bauri, B. canaliferus, B. chemnitzioides, B. Habeli, Vitrea chathamensis, Conulus galapaganus, Succinea producta, S. brevior.*

To which may be added:—*Melampus trilineatus, Tralia panamensis, Williamia peltoides, Siphonaria gigas.*

Omitting the *Auriculidæ* and *Siphonariidæ*, we have as supposed peculiar forms in each group of islands, twenty-one characteristic of the southeastern, fourteen from the central and one from the northeastern group of islands, which agrees well with the hypothesis that the species originated with forms brought by winds and currents which impinge first on the southeastern group.

On the other hand, it is certain that the southeastern islands are much better known than either of the other groups and that the area and fertility of the central group are such that there is every reason to suppose many more forms remain to be discovered there, perhaps including some of those so far known only from the southeastern islands. Prudence strongly urges that we know too little of the mollusk fauna yet to intelligently discuss its inter-island distribution.

Taking the forms enumerated in the table showing the distribution of the species and omitting the *Onchidium* and species of *Auriculidæ* and *Siphonariidæ*, all of which are denizens of the salt marshes or beaches, we have forty-six, of which fifteen are found on more than one island, five on more than two islands and three are found without material change on four islands; all of the latter are found in both the central and southeastern groups of islands. One of the species, and perhaps two, are probably common to the mainland of South America as well as the Galapagos, and all of them doubtless have been derived from the fauna of the Panamic and South American region.

The following table will show the distribution of the various species among the several islands, as far as known, their presence being indicated by an initial letter in the column devoted to the island concerned. A, stands for the Albatross expedition; B, for Dr. Baur; C, for Hugh Cuming; D, for Darwin; H, for Dr. Habel; K, for Kellett and Wood; P, for the Peterel, Captain Cookson; and W, for Wolf as reported on by Reibisch, with some additions to his printed list. The names are given in the left hand column, the columns for the islands follow in the order of their distance from the source of supply, approximately; the last column sums up the number of specimens actually examined by the writer in preparing this paper.

One or two species are noted as new, which Herr Reibisch has mentioned in his letters as now in his possession, in addition to which are several Pupas which he regards as new, but has not informed me to which islands they should be assigned.

Habits and environment.—With the exception of Dr. Baur no one seems to have noted very particularly the exact location of the species collected, either with regard to altitude or situs. A few of Wolf's species are so noted, but, as most of his specimens were dead, their value in such a discussion is impaired. Cuming noted the situs but neglected the altitude. The matter really needs the attention

TABLE OF DISTRIBUTION OF GALAPAGOS LAND SHELLS.

A, Albatross; B, Baur; C, Cuming; D, Darwin; H, Habel; K, Kellett; P, Peterel; W, Wolf; collectors or authorities.

Names of the forms.	Groups of the Islands.									Specimens seen.
	Southeastern.				Central.				N. E.	
	Chatham.	Charles.	Hood.	Bar.	Indf.	Dun.	Alb.	Jas.	Bindl.	
Bulimulus nux	K A B W	C P W A								374
Bulimulus achatellinus	K W B		H							2
*										
Bulimulus Darwini									H	—
Bulimulus Wolfi					W					1
Bulimulus duncanus						B				6
* *										
Bulimulus rugulosus	D K C	D A W B								64
Bulimulus var. nudus		W								—
Bulimulus planospira		B								71
Bulimulus ustulatus		C								14
Bulimulus calvus	K	C W A						C		2
Bulimulus nucula	B	W								6
*										
Bulimulus eschariferus	D K W A B	P								66
Bulimulus var. ventrosus				W B						4
Bulimulus var. pileatus	A									6
Bulimulus galapaganus		B								5
Bulimulus perspectivus	W									2
* * *										
Bulimulus jacobi	B W	C					B W	C		12
Bulimulus var. cinereus								W A B		4
Bulimulus var. acutus	W							C		1
Bulimulus olla				B	B	B A				16
Bulimulus Tanneri					A					4
*										
Bulimulus amastroides	A									25
Bulimulus var. curtus	W A B									34
*										
Bulimulus unifasciatus	K B	C P						C		22
*										
Bulimulus Simrothi							W B			85
* *										
Bulimulus Bauri	B									16
Bulimulus canaliferus	W									1
* * *										
Bulimulus sculpturatus							?	A		—
Bulimulus nesioticus								C		4
Bulimulus rugiferus										10
Bulimulus Reibischi					A					2
* * * *										
Bulimulus chemnitzioides	K H W A B									68
Bulimulus Habeli	H W A B									10
Bulimulus n. sp.					W			W		—
Trochomorpha? Bauri	D?						B			1
Vitrea chathamensis	B									1
Conulus galapaganus	B									3
Pupa Wolfii							W B			4
Pupa clausa					W					—
Succinea Bettii	W	P A				A	B	B		86
Succinea brevior		P B								21
Succinea producta	W B									15
Succinea corbis							B			15
Leptinaria chathamensis	W B						B			19
Leptinaria sp.							W			—
Helicina nesiotica	W B						W			55
Auricula stagnalis									H	—
Melampus trilineatus			H							—
Tralia panamensis			H							12
Pedipes angulatus									H	—
Siphonaria gigas		A								6
Williamia peltoides	H	H	H							3
Onchidium Lesliei		A					A			3
Onchidella Steindachneri		A H					A			7
Number of forms, 54.	25	17	4	2	6	3	11	9	3	1188

of a person sufficiently expert to recognize the species when collected, and to collect with judgment in all the zones. Dead specimens are so easily carried down hill by wind or temporary rills of water in the rainy season, or transported and dropped by birds in places which they did not originally inhabit, that no weight can be given to the place of their occurrence in such a discussion as this. In regard to some of the species, no information is available; some of the others have been collected in a dead condition from the dry zone below 800 feet, which are known to live in the wooded zone above, hence these may be eliminated from the local population of the dry zone. Making such eliminations, the known population of the dry, the wooded and the grassy upper plateau regions, respectively, are as follows:

DRY ZONE.

Bulimulus Wolfi.	*B. eschariferus* and var. *ventrosus.*
B. rugulosus.	*B. galapaganus.*
B. planospira.	*B. perspectivus.*
B. ustulatus.	*Pupa clausa.*
B. calvus.	*P. munita.*

WOODED ZONE.

Bulimulus nux and varieties.	*B. curtus.*	*Conulus galapaganus.*
B. achatellinus.	*B. unifasciatus.*	*Succinea Bettii.*
B. jacobi.	*B. Bauri.*	*S. brevior.*
B. acutus.	*B. canaliferus.*	*S. producta.*
B. nucula.	*B. chemnitzioides.*	*Leptinaria chathamensis.*
B. amastroides.	*B. Habeli.*	*Helicina nesiotica.*
	Vitrea chathamensis.	

GRASSY ZONE.

Bulimulus olla.	*B. Simrothi.*

It is not at all improbable that some of the species of the wooded zone extend downward into the dry or partially dry zone, and that the singular variations observed in some of the species may be due to the direct action of the differing conditions in which they, respectively, exist. Making allowance for this, the chief distinction which presents itself between the species of the dry zone and those of the wooded zone, is that the Bulimuli of the dry region show a tendency:— 1. To a pupiform shape (such as might facilitate their entry into narrow crevices beneath the lava blocks); 2. To reddish-brown coloration with rather conspicuous peripheral color bands (forming a combination not unlike the reddish streaked lavas and hence, possibly protective); and lastly 3. To a rugose, peculiar crenulation or wrinkling of the surface of those species not characteristically smooth. This last character which, for reasons which will presently be shown, is correlated with aridity or alkalinity of environment, may be regarded as having been impressed upon species which first gained a foothold in the arid region and as having persisted to some extent in their descendants when the latter succeeded in reaching the upper and more congenial zones of the islands. It is characteristically developed in the following species: *Bulimulus Darwini, nesioticus* and *Wolfi, Bulimulus sculpturatus, Bulimulus rugiferus,* partially in *Bulimulus Simrothi,* and traces of it are perceptible in some specimens of *Bulimulus Bauri.* The external appearance is such as to suggest that the shell when soft, had been pecked at with a pointed object, leaving small irregular depressions scattered more or less closely over the surface. It never appears in the nuclear whorls, rarely in the earlier ones following the nucleus, and, when a sufficient number of specimens is examined, some will be found in each species which do not exhibit it. The latter often look very unlike the commoner form of the species, and, by those unacquainted with the relation between them and unsupplied with a sufficiently large series for study, might easily be regarded as specifically distinct.

The wrinkling or indenting of the surface is distinct from the longitudinal turgid plications, or narrow warty prominences seen in *Bulimulus nux* var. *incrassatus, Bulimulus rugulosus* and *B. planospira;* nor is it the same as the granular sculpture found in the two last mentioned species, in some specimens of *Bulimulus jacobi* and in *cinereus, B. Simrothi, rugiferus,* and numerous Lower Californian and Peruvian arid region species, such as *B. proteus* and *B. montezuma.* This sculpture is more ancient in the history of the group, its elements may often be detected on the nuclear whorls and their subsequent development on later turns is often correlated with the presence of epidermal cirrhi or hairs, sometimes numerous enough to form veritable fringes. Something of this is visible in a perfectly preserved young *B. Simrothi;* in the full grown shell the delicate hairs have fallen or been lost through abrasion. Nevertheless, the extra development of this and the above mentioned plicate sculpture are generally associated in arid regions with the dryness, and in moist regions with the presence of some alkaline salt, which accentuates the action of those factors in the organism which are concerned in the formation of the minor irregularities of the shell surface. The manner in which this is brought about is one of the prettiest illustrations of the direct action of the environment which I know, and seems to be sufficiently established by both geological and physiological evidence.

In the arid region of the far west, especially in the desiccated lake basins of Utah, Nevada and California, it has long been observed by the writer, Dr. R. E. C. Stearns and others, that in the successive beds of fresh water marl, which the now dried up lakes deposited in Pliocene and Pleistocene times, the shells indicate a progressive change in surface characters as the alkalinity of the water increased, until at last the amount of alkali became so great that the mollusks were exterminated or found a precarious refuge in the fresh water streams which fell into the basins in question. The shells, without regard to genus or systematic relations, showed a unanimous tendency to become ridged, plicated or rugose; the regularity of the gastropod coil was interfered with, abnormalities became more common, and, toward the last, almost general. Projecting sculpture, spiral threading, carinæ, riblets, etc., were exaggerated; size generally diminished, the height of the spire relatively to the diameter became less, and general degeneration curiously combined with extreme accentuation and irregularity of surface characters. Something of the same sort is visible at the present time in the shells of fresh water gastropods in the irrigating ditches of farms in the alkaline arid region; those shells, in the ditches where the water has leached out alkaline matter from the soil, showing evidences of change in the same direction in surface sculpture, as I have personally observed in the Honey Lake Valley, Nevada.

In Whitfield's observations on the degeneration of *Limnæa megasoma*—kept for many generations in an aquarium where the water lost by evaporation was constantly replenished, the old residual supply not being emptied, so that a concentration of the salts contained in the much greater bulk of the original water took place in the aquarium—somewhat analogous but less marked changes are recorded.

The dynamical origin of these changes may be explained by considering the origin of the surface characters of the shell. The deposition of the shell substance and epidermis takes place from the surface and the edge of the mantle. The process is not absolutely continuous, but is carried on at more or less frequent intervals when the animal is in a state of rest. At times when deposition is going on, the margin of the mantle is in a more extended state than usual, reaching to a point where the extremely thin and delicate membrane is in contact with the extremest margin of the already formed shell. The glandular epithelium of the edge of the mantle secretes less lime than that of the surface behind it, and is chiefly responsible for the periostracum of the shell, while the rest of the mantle has the task of secreting the more limy matter which makes up the bulk of the calcified shell. As the margin expands or contracts over the still viscous secretion, the ornamentation of the mantle edge, cilia, papillæ, fringes, etc., everything which by its form or bulk varies the flatness of the filmy membrane itself, mechanically influences the form of the surface over which it passes, as the teeth of a rake leave shallow furrows over the gravel of a garden walk. Essentially in this way are the spiral striæ, the revolving threads and similar ornamentation developed on the surface of a fresh water gastropod. The transverse sculpture, usually known as incremental lines, arises from the periodicity of secretion, while ribbing or spinose ornamentation originates in a periodic turgidity of the mantle (how induced normally is not known) which rhythmically affects that organ, and by its tidal rise and subsidence causes the shell secreted during such epochs to be more inflated or capacious than at the corresponding intervals. These features and modes of growth can be observed in an aquarium with the more common fresh water gastropods.

It is a matter of common observation that alkaline salts, dust and dryness are very inimical to land and fresh water mollusks. Salts of chlorine and lime or soda will destroy slugs or snails subjected to their influence; the creature exudes a copious protective mucus up to a point when exhaustion results and death soon follows. The tissues under the action of such agents contract violently, shrivel, and finally die. Against hot pure dry air and dust the slug protects himself by burrowing and secreting a protective coccoon of limy mucus, which dries to a leathery substance preventing further evaporation. The shell-bearing snail retreats into its house and closes the door with a succession of almost air-tight epiphragms of which the outer one, is often applied to a stone, a bit of bark, or the surface of a tree or shrub, either on the branches or leaves. The comatose condition which follows is only broken up by the presence of moisture in the air, which the prisoner perceives and takes advantage of to return to active life. The state of torpor may occasionally last for years, but is general among land shells during the dry season in the tropics and during the winter of the colder zones. Most of the collections made at the Galapagos seem to have been made in the dry season. This was the case with Darwin's work and all the *Bulimuli* collected in a living state by Dr. Baur retain the whole or portions of the epiphragm, showing that they were in retirement when taken from the trees. If the creature, by an early diminution of humidity, is forced into its state of hibernation before its normal period of growth is absolutely completed, it frequently happens that the portion of the shell about the aperture is irregular and bears indications of having been secreted under abnormal conditions. The incremental rugæ in the vicinity of the margin will be exaggerated or crowded, the color of this part of the shell absent or different from the rest, the pillar irregularly tuberculose or keeled at the base; abnormal thickenings or tubercles may appear on the outer lip or on the parietal portion of the aperture, and the margin of the lip will take on an irregular form, presumably to adapt itself to the irregularities of the surface to which the creature is about to attach itself for hibernation. Reeve's figure of *Bulimulus Darwini* shows a state of affairs such as I have described, so does the form figured under the name of *B. Simrothi* by Reibisch, and similar indications are afforded by specimens of *B. nux*, *B. rugulosus*, *B. tortuganus* and *B. Bauri*. An understanding of these facts is necessary in order to avoid the use of these temporary and individual dynamic mutations as specific characters, an error several authors have not succeeded in escaping.

To return to the modification of the surface of the shell by local conditions, the facts above cited enable us to understand how under normally favorable conditions the organism deposits the mucus matter, which, by a process analogous to the crystallization of salts in a colloid medium, hardens into the shell substance, which then forms a compound of crystallized lime (aragonite) and conchioline (not chitine as stated by Osborn[4] and others).

Now if we assume the attenuated film of secretive tissue constituted by the margin of the mantle expanded, in order to divest itself

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[4] Studies from the Biol. Laboratory, Johns Hopkins University, II, p. 431, 1883.

by the usual process, of the products of secretion, to be suddenly brought in contact with alkaline salts either as dust or in solution in the moisture about the animal, the result will be a sudden contraction of the portion of the mantle affected, consequently the mucus deposit either will not be laid down evenly on the margin of the shell or its deposition may be for the moment retarded. In either case an irregularity will result. The mantle, turgescent with secretion, cannot indefinitely retain the secreted fluids, and, after a time, even if the alkaline irritant is still active, the mucus must be exuded. But if this is done by a film of tissue, more or less irregularly contracted, the deposition will be correspondingly irregular in its location. As the epidermis is first laid down, and the more calcareous matter subsequently upon its elastic surface, it follows that an irregular surface of the epidermis will be reinforced by shelly matter and, as it were, petrified in its irregularity, which will be exhibited permanently in the external surface of the shell. If a minute process of the mantle edge would normally produce a spiral thread on the surface of the shell, and its regular deposition is interrupted by the alkalinity of dust, air or moisture about it, the tissue will be obliged to contract after a short period of expansion, and the spiral thread will consequently appear broken up into a series of granules. The more violent the induced contraction the greater will be the amount of undeposited mucus contained in the respective glandular cells, and which must be got rid of at the next period of expansion, and, consequently, the coarser will be the granules formed by its exudation at the next opportunity. The coil of the shell is determined partly by that portion already existing, against which the new deposit must be laid down, and partly by the form and mass of the body of the animal within the shell. The direction of the coil is a resultant of the reactions between these two factors, guided to a limited extent by gravity which pulls the shell, pendant from the extruded animal to one side or the other, while the animal is active. Yet as the deposition of shelly matter takes place chiefly, if not entirely, when the animal is contracted and at rest, mostly within the shell, it cannot be expected that the action of gravity should have much influence on the form of the shell. But, if the growth of the soft parts be accelerated so that they increase in length of coil disproportionately to the growth of the shell, the direction of the coil is correspondingly less dependent on the form of the existing whorls and more dependent on the posture assumed by the extruded soft parts, so that if the suggested growth be sudden, as if forming a climax during which maturity is rapidly assumed (a state of things readily induced by changes in the reproductive organs and the ripening of their contents), a sudden change in the direction and form of the whorl may be induced dynamically. This is what I believe takes place in such forms as *Holospira, Cylindrella* and various *Cyclostomatidæ.* If we picture the animal on a twig, holding on by the foot and partially retracted, the spire heavy with contained ova and the animal at rest, pending secretion of shell matter, it is easy to imagine the manner in which the mature aperture may be built up on the margin of a perpendicularly pendant immature shell, without following the cycloidal curve of the earlier whorls.

The influence of a very dry warm atmosphere on the expanded mantle will be analogous to that of alkaline matter, but likely to act with less irregularity. A particle of alkaline dust might affect a small part of the margin of the mantle and not the rest, while the air might be expected to act on the whole expanded margin. It is probable even then, however, that some portions of the edge might dry quicker than others and more or less irregularity would almost certainly result. Of course, if the margin of the mantle were to become actually desiccated, secretion would cease and could not go on again until the dry tissue had been cast off and replaced. But it is probable that the tissue is too sensitive for such an event to occur under ordinary conditions. It would probably operate so that when the animal felt the mantle becoming uncomfortably dry, it would simply retract, and temporarily cease secretion as in the presence of alkali. But enough has been said to indicate the mode by which drought and alkaline matter may act upon the growing mollusk and directly modify its secretions, and, by consequence, its hard parts. That this action takes place substantially as suggested I have little doubt, and that its results may be differentiated from those of normal growth in continuously favorable conditions, I think will be shown to be probable.

Let us consider the features presented by *Bulimulus Simrothi* and see how far they exemplify the processes above described. The deposition of ova may take place with the opening of the wet season. No data are available, but none of the specimens collected in the hibernating state by Dr. Baur, and of which the soft parts were examined, contained any developed ova. It would be in accordance with what we know of species in other regions if the ova were rapidly developed and deposited in the early part of the wet season. The nuclear portion of the shell presents the features so characteristic of many continental *Bulimuli* in that the first whorl is angulated above and the vertex is consequently concave or even funicular. The surface of the nucleus is evenly, closely, transversely ribbed, with fine spiral striæ perceptible between the ribs upon magnification. The sculpture of the nuclear whorl merges gradually into that of the succeeding whorls, the ribbing becoming finer until it is lost in the incremental sculpture. The spiral striæ become stronger and practically cover the whole shell. Four delicate, fine spiral threads are evenly spaced on the whorls between the periphery and the suture, somewhat broken by the rather regularly spaced incremental elevated lines. Where the two intersect, the epidermis is raised in microscopic cilia only visible in finely preserved young specimens. In this condition there are four or five whorls besides the nucleus. They are of a reddish-brown with a pale olive-greenish narrow peripheral band. Up to this point, unless it be that the shell is slightly narrower, the species is indistinguishable from *B. unifasciatus.* About this time, earlier in some later in others, the peculiar indented irregularities of the surface begin to appear; at first exaggerated slightly irregular incremental lines, then irregular broken surface markings recalling rusted metal which has been cleaned but preserves the maculæ of oxidation. Finally the aperture shows a slightly reflected lip, a pillar thickened, keeled at the base, tubercular with a single tubercle set anywhere along its length; the outer lip with one or two adjacent tubercles, the umbilicus from large and ample to very contracted, almost closed.

The peripheral band persists in some cases; the warty prominences are whiter than the shell normally would be, having a bleached aspect. I should read the developmental history of this species generally as follows: The species sprang from a form not unlike *B. Xantusii* of Lower California, the superficially more similar Peruvian *B. rhodacme* and *pruinosus* having a different nucleus. The ova hatching in the height of the rainy season grew normally, and, if the rainy season had been long enough, would have developed into shells with the color and sculpture of *B. unifasciatus* and the form of a small slender *B. jacobi.* Some of the specimens almost attain this ideal. Toward the end of the season either occasional hot spells or the influence of salts leached out of the decomposed lava soil by the rains began to effect the growing shells, some more and some less, and continued to do so until they completed their shells, or were forced, immature, to go into hibernation. Completing their shells under pressure and affected by the environment the thickening of the aperture was more or less irregularly deposited, and the excess of shell matter appears in the form of tubercles or lumps of callus disposed about the aperture. As might be expected, so far as we know the situs of the various species, these peculiar deformations occur chiefly among the species of the dry zone below or the grassy zone above, the conditions of the intermediate wooded zone are probably more uniform, or, perhaps, species living on the ground or on low herbage are more likely to be affected by alkaline efflorescences than those which live at a greater height on trees and shrubs.

If these views are correct, we should expect to find analogous effects produced on similar mollusks in similar situations throughout the world. They should be produced without reference to the line of descent of the species, that is, species of the European *Buliminus* or the African *Achatina* should in analogous situations exhibit practically the same sort of deformation as has just been described in species of *Bulimulus* isolated on the Galapagos. Is this the case? Analogous situations are not very numerous. Wanted, an island habitat with volcanic rocks, a climate combining periodical dryness with occasional wet mists and a regular rainy season. In the Hawaiian Islands we have something of the sort, but, owing to their larger size, there is a much more continuous flow of water in streams, the climate is not so hot and the parallel is far from exact. The island of Fernando de Noronha has been said to have a remarkable resemblance to the Galapagos, and so did St. Helena before it was deforested. A glance at the fauna will be of interest.

The island of Fernando de Noronha like the Galapagos is volcanic, with a soil formed by decomposition of the basalt, and is well supplied with vegetation and water. Smith says of the mollusk fauna[5] "Of the land shells two are well known West Indian species, one has been recorded from Brazil, Peru and the island of Opara, and the remaining four, up to the present, appear to be peculiar to the island. One of these, however, *Bulimus Ramagei* suggests a faunistic similarity to Brazil, as the section of *Bulimus* to which it belongs (*Tomigerus*) with one exception occurs only in that country."

The species are as follows according to Smith :

1. *Helix* (*Polygyratia*) *quinquelirata* Smith.

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[5] Journ. Linn. Soc. Zool., Vol. XX, p. 484, 1890.

2. *B.* (*Tomigerus?*) *Ramagei* Smith.
3. *B.* (*Bulimulus*) *Ridleyi* Smith.
4. *Pupa solitaria* Smith.
5. *Stenogyra* (*Opeas*) *octonoides* C. B. Ads.
6. *S.* (*Opeas*) *subula* Pfr.
7. *S.* (*Opeas*) *Beckiana* Pfr. var.

This fauna is of South American type. While there are some Australasian forms which recall *Polygyratia* in their shell characters, their anatomy is still unknown. The nearest relatives of this species appear to be the continental *H. pollodonta* Orbigny, and such forms as *H. endodonta* of Ecuador. It is curious that the Helices of oceanic islands so frequently belong to groups which have the throat of the shell armed with spiral lamellæ, and the fact will be considered later in connection with the St. Helena fauna. None has yet been described from the Galapagos, yet one cannot help wondering if the *Helix* not specifically named, found by Darwin, and supposed by Cuming and himself to be identical with a Tahitian species, might not have been of this type. It is obvious that the Noronha fauna is too small to admit of basing much upon its characters, but small as it is, they are quite suggestive. The second species is referred with some doubt to *Tomigerus* by Smith. It seems to the writer that the doubt is well founded, and that the curious species in question is hardly more different from *B. Ridleyi* than *B. Darwini* is from *B. jacobi* or *Simrothi.*

Bulimulus Ridleyi is fuscous with a pale peripheral line. The incremental lines are cut by slender spiral striæ and the shell is umbili cated. The aperture recalls that of *B. Simrothi* and in some respects that of the fossil *Bulimuli* of the Oligocene silex beds of Tampa, Florida. It is found on trees and under stones rather widely distributed on the island. According to Smith "It resembles somewhat in form certain species of *Partula;* it faintly recalls, chiefly on account of color, *Bulimulus jacobi* from the Galapagos Islands." It will be observed that all the forms with which it is compared are of insular habitat, Florida in Oligocene times having been an island, while in the Oligocene beds of the continent, of the same horizon as the silex beds, no *Bulimuli* have been found.

Pupa solitaria Smith, is so similar to the variable *P. Wolfii* Miller of Guayaquil (*P. munita* and *P. clausa* Reibisch of the Galapagos) that, bearing in mind the wide dispersion of these minute species, I strongly suspect a sufficient number of specimens would demonstrate their identity. The species of *Stenogyra* are obviously West Indian or continental and call for no special remark.

The land shells of St. Helena have been described by Smith (P. Z. S., 1892, pp. 258–270), from collections by Captain W. H. Turton R. E. The National Museum is indebted to Captain Turton for a nearly complete series of his St. Helena shells, including one or two species accidentally introduced since the settlement of the island. These have proved of great value for comparison, as the best figures fail to give the peculiarities of surface texture with which, in this discussion, we are largely concerned. Omitting synonyms, mere varieties and recently introduced species, the land shell fauna of St. Helena comprises four species of helicoid shells without lamellæ, which have been referred to *Patula* but which may prove to be edentulous species of *Endodonta*, ten[6] species of *Endodonta* (section *Helenoconcha* Pilsbry) with more or less complicated oral lamellæ; *Achatina* (*Pachyotus*) *auris-vulpina* Dillw., and two or three related species; *Achatina* (*Cleostyla*) *exulata* and *subtruncata; Bulimulus* (*Pachnodus*) *helena* and two related species; a *Tomigerus*-like shell, *Pupa* (*Campolæmus*) *perexilis* (Smith) Pilsbry, and two minute species of *Pupa;* and, lastly, three species of *Succinea,* in all twenty-nine species. Of these, by the gradual desiccation of the island, twenty-two are become extinct.

The native forms found living comprise two species of *Endodonta, Pachyotus melanoides* and *P. Turtoni*, and three species of *Succinea.* The mollusk fauna as a whole, is Oceanic, and shows no strong affinity with either America or West Africa, especially the former. The manner in which these mollusks reached the island is a mystery, the more so as it is said that the flora and insect fauna also show no special relationship with those of South America. Nevertheless, the contours of the sea bottom as well as certain features of the fauna indicate a previous more intimate relation between South America and Africa than has recently existed, and, whatever this bond may have been, it is not improbable that St. Helena participated in it. Any ordinary means of transport would seem to be insufficient to account for the presence of *Pachyotus,* of which even the eggs are six millimeters long. We are not obliged for present purposes to concern ourselves with this problem of origin. The in-

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[6] *H. Alexandri* Forbes and *polyodon* Sby., are both represented in Captain Turton's series and are distinct species; a single specimen of a species apparently undescribed also occurred among those sent to the National Museum.

timate structure of these animal as related to the conditions in which they live is the object of consideration.

The Helices are of less importance in this discussion because we do not know what species may be found to inhabit the Galapagos on thorough search. But we may, in passing, note that the species have certain characteristics which are almost exclusively found in members of insular faunas, of which the most remarkable are the parallel spiral lamellæ running inward from the aperture. They are obviously protective and their presence would suggest a peculiar enemy, entering the aperture to devour the inhabitant of the shell, as prevalent in island faunas.

If we examine Pfeiffer's list of species belonging to the section of *Patula* called *Endodonta*, to which these Helices were referred by him, we shall find that of those with basal lamellæ all are insular species, the largest body of land to which any species is referred being Tasmania. Of the eighteen forms with parietal lamellæ all are insular on tropical islands from New Caledonia to Hawaii. Of those with both parietal and basal lamellæ, omitting those described from St. Helena, the entire thirty-three species are insular and from mountainous tropical islands, most of which are known to be volcanic.

Of the other land shells the singular *Pupa* or *Tomigerus perexilis* appears to be a local development, but there are two ordinary Pupas one of which is very similar in its general features and type of lamellation to the Noronha and Galapagos species, a likeness already noted by Smith. The Succineas again, over and above the general similarity of the species everywhere, exhibit certain peculiarities which appear to be associated with an insular habitat. The *Succinea brevior* of the Galapagos can hardly be discriminated from *S. helenæ* from St. Helena. *S. Bettii* is parallel with *S. picta*, and *S. Wolfi* with *Bensoniana*. In endeavoring to find, in our large collection of domestic and foreign Succineas, some species with sculptured surface to compare with *S. corbis*, the only forms of the kind which the National Museum afforded were insular, from Samoa, Martinique, St. Helena, etc. Doubtless the peculiar vermicular or dichotomous impressed lines which these species show are due to causes similar to those already described which modify the surface sculpture in *Bulimulus*. Not all them show it, but those which do show it are, so far as I have yet observed, either insular or subjected to locally arid conditions. Those species in which this sort of sculpture has become habitual are all insular and tropical.

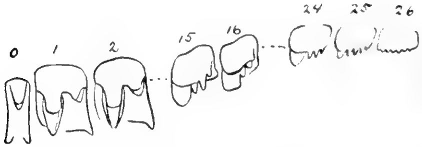
There remain only the Bulimoid forms; these being mostly fossil have received little attention in the usual works of reference. The well known *Bulimus auris-vulpina* of Dillwyn (sp.) was erected into a genus by Beck as early as 1837 under the name of *Pachyotus.*[7] With it Beck associated a number of species of the type of *Bulimus bilabiatus* and *melanostomus*, which arrangement was followed by Pfeiffer and most subsequent writers. There are distinct points of resemblance, but these are probably dynamic rather than ontogenetic. To the writer the relations of *Pachyotus* are directly with a certain number of its associates of St. Helena.

The Bulimiform Helicacea of St. Helena may be divided into two groups[8]:—one (Achatinoid) typified by the *Pachyotus auris-vulpina* and characterized by a closed or nearly closed umbilicus and a cork screw twisted axis, the other (Bulimuloid) by a straight axis and more or less open umbilicus. The last group comprises *Bulimulus Blofieldi* and *Seleanus* of Forbes and *B. helena* Quoy and Gaimard. The *Pachyotus* group[9] comprises all the other species of the island.

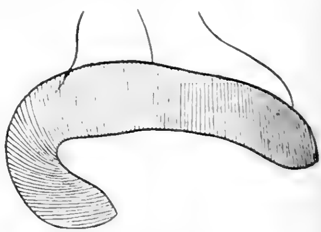
[7] The type was selected from among Beck's species by Gray in 1847. In 1848 Fischer de Waldheim named it *Chilonopsis.*

[8] According to Mr. H. A. Pilsbry, whose opinion on the subject is entitled to the greatest weight, the two principal groups are probably referable to the *Achatinidæ* (*Pachyotus* and *Cleostyla*) and the *Bulimulidæ* (*Pachnodus*). The former would be nearest to *Perideris*, and the latter to *Pachnodus* as typified by *P. velutinus*. As the so-called *Tomigerus* of St. Helena is probably a modified *Pupa* (*Campolæmus* Pilsbry) analogous to *Boysidia* and *Hypselostoma*, it would seem that the affinities of the St. Helena fauna are West African, Oriental or Oceanic, rather than South American, in spite of the presence in South America of the Achatinoid "*B.*" *coronatus* and "*B.*" *Hanleyi* Pfr.

[9] The teeth of the radula of *P. melanioides* are in nearly straight transverse rows, and the rhachidian teeth are narrow, with a single small cusp, as in typical *Achatinidæ*. The laterals are bicuspid. On the marginal teeth the outer cusp splits, forming two or three denticles on the inner, four or more on the uter teeth. The formula is 14.12.1.12.14. The arcuate jaw (distorted in my preparation) is very closely and finely striated, as in *Limicolaria*.



Teeth of *Pachyotus melanioides.*



Jaw of *P. melanioides.*

The main character of the dentition different from other genera of *Achatinidæ* is the multiple splitting of the outer cusp on the marginals, as in *Cionella*, *Pupidæ*, *Vallonia*, etc.—H. A. P.

Those who are not accustomed to recognize the flexibility of organisms nor to discriminate ancestral from dynamic characters will, perhaps, be astonished at any arrangement which includes in one group species apparently so dissimilar as *auris-vulpina* and *melanioides,* but I think a little unprejudiced study of the specimens, in connection with *B. subplicatus,* will convince any one of the likelihood of their genetic relationship.

To treat the simplest and smallest group first, we may take the *B. helena* and its allies. This species was placed in the section *Næsiotus* by Pfeiffer in 1856 (Mal. Blatt., II, p. 161); and it is quite similar in several respects to some of the Galapagos species, but is probably derived from another shoot of the genus *Bulimulus.* The nucleus in this species, in *B. Blofieldi* and *Seleanus,* is swollen and almost smooth. It has no axial dimple and the surface seems not to have had any coarse sculpture. The species show the microscopic irregularity of the incremental lines, the undue thickening of the shell and the broken lines of spirally disposed granulations which indicate the influence of an arid or alkaline habitat. Full grown specimens generally show the irregularities of the aperture characteristic of individuals which have been forced into long continued hibernation before the mantle had discharged all its surplus calcareous salts, or had, by reason of long continued aridity, to caulk the vicinity of the aperture with shelly matter in order not to be absolutely desiccated by evaporation. These characters are precisely those we find imposed upon the Galapagos, Lower California and other arid region species.

The Achatinoid group though possessing many dynamic characters in common is probably derived from two sources. *B. exulatus* Benson and *B. subtruncatus* Smith have an imperforated twisted axis, a plump small nucleus followed by a few small and then several rapidly enlarging whorls, a flaring aperture angulated below and with a keel or angle on the edge of the pillar. They show less than any of the others the effects of aridity and have rather thin shells. They originally had translucent or brownish shells with a pale tracery of opaque white or yellowish. The aperture is regular and there is but little callous deposit. For this section the name *Cleostyla* may be used. Its resemblance to *Pseudachatina* seems to be slight and superficial.

The second group, *Pachyotus* of Beck, with *C. auris-vulpina* as type, comprises also *B. melanioides, B. subplicatus* and probably *B.*

Turtoni, though the latter is less certain and may possibly belong to a third section. The typical *Pachyotus* has a dimpled nucleus, though it is not keeled like that of *Næsiotus* and the Lower Californian and Peruvian *Bulimuli*. In its sculpture the transverse predominates over the spiral. The surface of the shell is everywhere transversely wrinkled and toward the suture is more or less gathered into short rounded plaits, stronger in the younger whorls. The colors are dark, more or less translucent tesselated with paler opaque markings or streaks. The axis is minutely tubular and twisted, especially as the last whorl is being finished off, where at maturity a plait is more or less distinctly developed.

The aperture has a simple, somewhat expanded, more or less thickened edge, which, in old specimens which have hibernated, may show heavy deposits of callus, which is always angulated or obscurely channelled at the base of the pillar. Specimens which have survived hibernation have the usual irregularities about the margin. A careful inspection reveals no reasons for supposing that *P. auris-vulpina* might not have been the descendent of a form like *P. melanioides*. I have seen no completely adult specimens of the latter or of *B. Turtoni*, but see no reason to suppose that the lip would not, under suitable conditions, be thickened in them as it is in *P. subplicatus*. Perhaps at present *P. melanioides* inhabits a region where it does not now suffer from aridity, which would account for the difference in the deposit about the mouth. It is well known that great fluctuations have taken place in the rainfall on the island due to variations in the woods and forests, their destruction and partial restoration. However this may be, the living species of the group have but little callous deposit about the mouth ; *P. subplicatus* which evidently from the freshness of its colors, cannot have been long extinct, has a greater amount, and *P. auris-vulpina* in addition to the marginal thickening shows a parietal tubercle of callus often of large size, and the irregularities of form, size, and margin of the aperture are such as to indicate clearly degeneration leading to extinction by increasing aridity of its habitat.

Curiously enough, according to Mr. Smith, only one *Helix*, an introduction from other regions, has been found in Ascension Island ; the other known terrestrial mollusk is *Limax ascensionis* Quoy, which may well be an introduction also. The explanation of this difference between St. Helena and Ascension lies in the greater aridity of the latter. Though thorough search might reveal some extinct species, it is highly probable that this island was never wooded and has always been much dryer than St. Helena.

It would carry us too far afield to undertake a discussion of the characteristics of the terrestrial mollusk fauna of those Pacific islands which by their elevated and volcanic character and geographic situation might be comparable with those we have already reviewed. A comparison of other highland subtropical faunas where the situation is complicated by seasonal or general aridity, will throw much light on the principles involved. I have elsewhere examined the Lower Californian *Bulimuli* (Proc. U. S. Nat. Mus., 1893) a group which, like that of the highlands of Peru and Chili, offers an excellent field for study. But the absence of detailed knowledge of the situs affected by the several species is a great drawback to safe generalization. A species which spends its existence burrowing in the succulent fronds of cactuses can hardly be said to be subject to arid conditions, even if the cactus stands in a desert, and similar doubts and difficulties are encountered at every turn, when one would investigate a general question of this kind. On isolated islands like the Galapagos and St. Helena, the conditions are comparatively simple, but on the continents it is different, and there the complexity of conditions is too great to allow us with safety to take much for granted.

Fischer has pointed out that existing faunas are most nearly related to the antecedent tertiary faunas of the same region (Man. Conch., p. 118), the writer has shown that this is true for the American and Antillean regions, and others have recognized the same truth in other parts of the world. In pursuance of the same idea, the writer believes that, in the majority of cases, a circumscribed local fauna of land shells will be found in the main to be most nearly related to geographically adjacent groups from which it has probably been derived; that the conditions of the environment are capable of inducing directly and without the aid of natural or any other kind of selection, certain changes in the form and surface characters which, on the present basis of classification, are generally taken as of systematic value; that these characteristics may be so loosely worn as to disappear in the individual or in the whole group if the pressure of the environment inducing them be altered or removed; that in time, and especially if the characters be of useful nature, they may become fixed by hereditary, transmission or natural selection, or both combined; that similar factors in the environment if not too intimately complicated with others, will produce in organisms of the same general nature similar results wherever situated; and, lastly, that the resulting features strikingly similar though they may be, are, conversely, no evidence of ontogenetic relationship. In any census undertaken with a view to determining systematic relationship, such characters must be eliminated in order to avoid an erroneous conclusion.

It is only by close and minute study of the details of the situs of species and of their minor, though by no means unimportant, characters of form and surface, that we shall be able to recognize those features which may be classed as dynamic as opposed to those which even if dynamic also in their ultimate origin, have become genetically constant. The noxious and stupefying multiplication of specific names, which has been characteristic of a certain school of workers during the last twenty years, could never have gained scientific recognition had there been any general appreciation of the extent to which dynamic modifications affect all organisms. It is much easier to describe and name a character than it is to search out its reason for existence. It is even easier, with proper apparatus, to count the cells in an organism of moderate size than it is to recognize and discriminate the influence of the environment upon the organic total of those cells. By inspecting the fragments of a building one may learn something of construction, but it is only by contemplating it as a whole that the higher elements of architecture can be recognized.

Recognizing the imperfection and inadequacy of our knowledge, even of the limited groups discussed in this paper, the writer thinks that some glimmerings of light may be had on the subject of dynamic characters from the accompanying study of insular land shells.

The following summary will express, tentatively, such of the conclusions as appear justified from the study of the specimens:

A. Given a region of volcanic origin and mountainous character, with local or seasonal aridity, more or less arboreal vegetation as well as herbage and a tropical or nearly tropical climate, moderate isolation and safety to propagate and increase.

B. Into this region let land shells of the principal continental types be introduced, and allowed the necessary time to become dispersed over the region, multiply abundantly and respond to the environment.

C. What results in the shape of dynamic modifications may be anticipated?

Answer.—The first result of room to spread, safety and plenty of food, would be to release the species from the shackles of the environment from which they had been transplanted and to promote general variability.

(Ex. Wonderful variability of insular shell faunas, such as those of Madeira, Galapagos and St. Helena Islands).

Secondly, the particular features likely to indicate local dynamic influence under the assumed conditions would be:

On the surface: wrinkling, corrugation or shagreening.

(Ex. The great majority of land shells in such situations, as the *Helicidæ* in Madeira, the *Bulimuli* in the Galapagos, *Succinea* in many islands, etc.).

At the suture: plaiting or wrinkling more or less rhythmical.

(Ex. *B. achatellinus* Forbes and *B. nux* Brod. of the Galapagos; many *Achatinella;* all the *Pachyotis,* etc.).

At the vertex: loose coiling or dimpling of the nuclear coil.

(Ex. *Bulimuli* of Lower California, Galapagos, Peru, St. Helena, etc.).

Of the axis: Exhibition of a tendency to irregularity, cork screw twisting, or outward (internal to the tube of the axis, but external to the tube of the shell) grooving in shells of elongated form, resulting in a tendency to form an angle or keel at the anterior edge of the pillar within the aperture and an obscure channel at its extremity.

(Ex. All the *Pachyotis,* many of the *Næsioti, Cleostyla, Pleuropyrgus, Achatinella,* etc.).

Of the aperture: Thickening of the margin in connection with hibernation, the formation of ill defined tubercles on the lips or paries, irregularity of the margin with respect to the plane of increment, and a tendency to contraction at the full grown aperture during or after hibernation.

(Ex. *Pachyotus,* many *Næsioti,* some *Bulimuli* of Lower California, etc.).

Of these characters some are more likely than others to be selected as beneficial to the species, and these relate chiefly to general form and coloration. In the matter of form the particular situs of the species has a preponderating influence, small and slender shells being easier to manage in the narrow fissures under stones frequented by many species; short and stout forms apparently succeeding better among dead leaves and the short herbage in stony places, while more elongated medium-sized forms are more in vogue among those which live on trees and high shrubs. It may also be the case that when hibernating, affixed to a branch or leaf stalk, a form simulating a bud or spine would to a certain extent be protected from thrushes and other mollusk-eating birds.

In the matter of color, selection undoubtedly has much influence. Subtranslucent browns and pinkish flesh-color harmonize with dead leaves, and the opaque tracery of yellowish streaks so common on the ground loving species obviously adds to the difficulty of recognizing the snail in such localities. Among the lava rocks sienna browns flecked with white are common and unquestionably protective. On trees everywhere the tendency is to spiral stripes of color, the surface is frequently more polished, the color brighter, with a tendency to the development of green among the colors, which is, so far as I know, never found in species living on the ground. In *Achatinella* these tendencies may be studied with advantage, and they can be recognized in the *Næsioti* and other *Bulimuli* almost everywhere. They are recognizable also among the Helices. In insular faunas the Helices which seem to persist most effectively are small with many whorls, a wrinkled surface, yellowish or olive coloration often with reddish radiating flecks when fresh, or wholly reddish-brown. Many of them have a protective armature of lamellæ obstructing the aperture, perhaps against the hard round-bodied millipedes, like *Julis*, which eat snails and are not uncommon in insular faunas.

In an insular or isolated fauna, under the conditions we have assumed, we should expect to find under the bulimoid forms (even in a limited number of species derived from a still more restricted number of ancestral types) a globose, a medium and a very attenuated type. This is well-illustrated in almost all the faunas, as in the Hawaiian Islands (*Achatinellidæ*), Bulimuli of Lower California, Galapagos Islands and St. Helena. Leaving out the more normal or medium type, a few examples may be mentioned:

Locality.	Globose.	Very slender.
Hawaii,	*A. kauiensis*, etc.	*A. subula, plicata*, etc.
Galapagos,	*B. Darwinii, nux*,	*B. Habeli, chemnitzoides.*
St. Helena,	*B. auris-vulpina*,	*B. melanioides.*
Lower Cala.	*B. sufflatus, pilula*,	*B. artemesia.*

There is no reason why such exceptional forms should maintain themselves, unless there is a niche in the environment which they are especially qualified to fill.

The small *Zonitidæ*, commonly known as *Hyalinia*, *Conulus*, etc., are especially fitted by their size and lightness to be transported by winds, adhering to dead leaves or other light objects. They are also well-adapted to maintain themselves under adverse circumstances, excepting against extreme aridity. Consequently it is not surprising that they, and the small *Pupidæ* of which the same is true, should be found as members of nearly all insular faunas where many other common types are wanting.

Other small, thin and light shells like *Leptinaria*, *Balea*, *Subulina*, etc., are so easily transported that their presence in insular faunas excites no surprise, though the mystery as to how *any* of these shells reached their present habitat remains as provoking as ever. The distribution of land shells is full of such mysteries, toward the solution of which so little has been done. Thus, the *Helix* (*Tachea*) *subglobosa* of Binney is apparently not distinguishable from the pale unicolorate variety of the *H. hortensis* of Europe and has been confidently asserted to have been introduced by commerce. It is the only representative of its particular group in America, and is known only from the extreme northeastern border of the United States from Massachusetts to Cape Breton Island, living everywhere close to the sea or even on small islands off the coast. The suspicion that this species is an importation is very natural, but nevertheless it is found in the clays of the Champlain epoch of the coast of Maine and in prehistoric shell-heaps of the same region, so that, if it was imported, Leif Ericsen had a predecessor in the glacial epoch. The banded forms of *hortensis*, since imported, do well and multiply varieties without difficulty and in profusion. How did it happen, then, that the importer of the *subglobosa* brought only one of the rarer varieties and planted it along a thousand miles of coast? And why should it appear living chiefly on rocky islets, never occupied or tilled by man? The answer to such questions involves matters of the greatest interest and importance in the history of the distribution of life on the globe. Applied to the Galapagos Islands, it is evident that occupation, especially by sheep, will render it impossible forever to get any complete data. May it not be hoped, therefore, that some one will undertake to make a thorough and complete survey of the malacology of these islands before it is too late. The study of the development of specific forms can never be made complete in the Hawaiian Islands, because the sheep and goat have preceded the investigator. There is still a chance to study the problem in the Galapagos Islands, and it should not be lost.

SUMMARY OF THE LAND SHELL FAUNA OF THE GALAPAGOS ISLANDS.

Genus BULIMULUS Leach.

Section NAESIOTUS Albers.

Næsiotus Albers, Heliceen, p. 162, 1850. Type *B. nux*.
Rhaphiellus Pfr., Versuch einer Anordnung der Heliceen nach natürlichen Gruppen. Malak. Blätter, II, p. 160, 1855. Type *B. achatinellinus*, Martens in Albers, Ed. ii, p. 238, 1860 (Sect. *Bulimini*).
Omphalostyla H. & A. Adams, Gen. Rec. Moll., ii, p. 161, 1855; not of Schleuter, Syst. Verz., p. 7, 1838.
Nesiotes Martens, in Albers, ed. ii, pp. 220–21, 1860.
Nesiotus Clessin, in Pfeiffer, Nom. Hel. Viv., p. 254, 1881.
Ataxus sp. Clessin, *op. cit.*, p. 253.
Pelecostoma Reibisch (*exparte*) in Isis, Abh. 3, p. 13, 1892.

The nomenclature of this section has had serious vicissitudes, as indicated by the above synonymy.

The group was named *Næsiotus* by Albers who gave no derivation for it, though the sound of the word naturally inclined the hearer to suppose that it was suggested by νησιώτης, islanders, and on this assumption von Martens proceeded to modify the spelling to *Nesiotes*, which would be a proper latinization of that Greek word. There is no rule of nomenclature which authorizes any one to supply a gratuitous derivation for a word published without any; still less because the original does not agree with the later assumption is any one authorized to modify or destroy a name properly proposed in other respects. Consequently von Marten's substitute cannot be accepted.[10]

In describing his *Bulimus achatellinus*, Forbes says that it "is unlike any known *Bulimus*, and its characters distinctly indicate affinity with the *Achatinellinæ*." Elsewhere he speaks of it "distantly," indicating "affinity with the fauna of the Sandwich Islands." This was not an unnatural conclusion when drawn from a few specimens, but, as is elsewhere shown in this paper, rests upon purely superficial characters. Actually the species is American in its relations, and is very closely related to some varieties of *B. nux*, from which protean species it may even be an offshoot. Conse-

[10] This seems to be a suitable occasion to protest against the unauthorized meddling with generic names which has lately been fashionable among writers from whom more sensible things would have been expected.

quently the sectional name proposed for it must fall into the synonymy of that given earlier to *B. nux* and its allies. It is probably due to the great rarity of this species that its situation in accepted systems has not been challenged before this; certainly if it had been as common as *B. nux*, the facts could hardly have escaped attention so long. I have not found anywhere any reasons stated for putting the species into *Buliminus* rather than *Bulimulus* where it really belongs.

The name *Omphalostyla* was applied by Schlüter to *Bulimi* with the pillar vertically twisted, and his sole example was the African shell, since better known under the name *Achatina ustulata* (Lam.) Menke. It was probably to some accidental confusion of the species with the *Bulimus ustulatus* Sby. of the Galapagos, that is due the application by the brothers Adams of Schlüter's name to the *Næsioti*.

The type of the section *Pelecostoma* Reibisch, is a *Næsiotus* which shows a ridge at the base of the pillar which gives a peculiar channelled aspect to the adjacent part of the aperture. This feature will be found more or less distinctly present in some specimens of almost any Galapagos species of which a large number is examined, showing that it is dynamic or individual, and not of systematic value. The second species of this "section" is *Leptinaria chathamensis*, a species belonging to a totally distinct group. The name *Pelecostoma*, therefore, may be safely laid away on the synonymic shelf.

The question remains as to whether the section *Næsiotus* has any just claims to be separated from *Thaumastus, Scutalus* and other nominal sections of *Bulimulus* into which so many diverse forms have been gathered. The diagnostic characters given by von Martens in his second edition of Albers are certainly not distinctive or even characteristic of the whole group, or even of several separate species of the same group. The shells are by no means always "aperte perforata," even in the same species; the columella is as often "plicata" as "recta," and the peristome, while generally "simplex," and sometimes "acutum," is not seldom denticulate or tuberculous and more or less distinctly reflected. The anatomical details, as elsewhere shown, offer no characters by which the species may be differentiated from many of the *Bulimuli* of the mainland. The utmost that can be said, therefore, is that *Næsiotus* is a convenient term for the geographical group inhabiting the Galapagos Islands, and, as such, we may retain it, without giving way to the delusion that it stands for anything more important.

In the recent revision[11] by Prof. H. A. Pilsbry of the genus *Bulimulus* Leach, the subgenus *Bulimulus* s. s. is defined as having the apex irregularly wrinkled or with the wrinkles broken into granules or dislocated, while the subgenus *Orthotomium* has regular vertical riblets. *Nœsiotus* is referred to the former. The South American *Bostryx* has the apex smooth and slightly swollen, not funiculate.

An examination of the entire series of *Nœsiotus* in the National Museum shows that the apex is nearer to that of *Orthotomium* than to that of *Bulimulus* s. s. It is characterized invariably by vertical riblets sometimes strong and with subequal furrowed interspaces; sometimes distant with wider, flat interspaces, and sometimes extremely delicate and fine ; but, except when worn, always unbroken and regular and with extremely fine spiral striæ visible in a good light, between the riblets. The apex always has a dimple or funicle over the axis, but the upper margin of this is rounded, never keeled as in some species of *Orthotomium.* This is an important point, as it indicates the origin of the *Nœsioti* from the more northern stock, or from the same source as the more northern stock.

It often happens, especially among those species which have the riblets low and fine, that they are broken by wear on the periphery of the nepionic whorls, thus suggesting the *Bulimulus* type ; or even that they may be entirely removed, while the polished surface shows no traces of erosion. But in young, fresh specimens, they may always be found unbroken and regular, except in the case of rare abnormal individuals. Of the latter, I have come across only one or two in all my series of several hundreds of specimens.

Bulimulus (Naesiotus) achatellinus Forbes. Plate XVII, figure 13.

Bulimulus achatellinus Fbs., P. Z. S., 1850, p. 56, pl. IX, figs. 5 a–b.
Bulimulus achatinellinus Pfr., Mon. Hel. viv., III, p. 429, 1853; Küster, in Chemn. Conch. Cab. ed. ii, *Bulimus*, No. 112, pl. 31, figs. 19–20. Pfr. Mon., IV, p. 492, 1859.
Bulimus (*Rhaphiellus*) *achatinellinus* Pfr., Vers. in Malak. Blätt., II, p. 160, 1855.
Bulimulus (*Omphalostyla*) *achatinellus* H. & A. Ads., Gen. Rec. Moll., II, p. 161, 1855; Wimmer, Sitz. Akad. Wiss. Wien., lxxx, p. 43, 1879.
Buliminus (*Rhaphiellus*) *achatinellinus* Martens, in Albers, Heliceen, ed. ii, p. 238, 1860. Reibisch, Isis, 1892, p. 15, t. ii, fig. 8.
Bulimina (*Rhaphiellus*) *achatinellina* Pfr., Nom. Hel viv., p. 300, 1881.
Bulimulus (*Rhaphiellus*) *achatinellinus* Stearns, Proc. U. S. Nat. Mus., XVI, p. 428, 1893.

Habitat. Upper levels of Chatham Island on trees and bushes, Kellett, Wolf and Baur; Hood Island, Habel, fide Wimmer.

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[11] Nautilus, IX, No. 10, p. 114, 1896.

Three specimens examined, of which one, collected by Dr. Baur, contained the soft parts. Owing to the fact that the specimen had been partially dried up, it was impossible to examine the genitalia.

The jaw was like the jaw of *B. nux*, with about 18 irregular flat plate-like ribs, whose blunt ends denticulate the margin, especially the cutting edge. The outer margin of these plates is a little raised and thickened, the color is pale amber, darker where thickest. The radula was rather broad, the single teeth did not differ in outline from those of *B. nux* more than those of one specimen of *nux* differs from those of another. The number of laterals is 14, of marginals 23, the formula $\frac{\frac{1}{3}}{23+14\cdot14+23}$

It will be observed from these facts that nothing in the dentition of *B. achatellinus* justifies the presumption that it deserves a section to itself. In Dr. Baur's specimen, the nucleus is delicately transversely ribbed, the vertex almost umbilicate, the earlier whorls nearly white and opaque, pinched up into irregular little tubercles at the suture; the later whorls have revolving dark brown color bands, separated by whitish interspaces covered with a yellowish epidermis. The base is mostly pale, with a dark band around the umbilicus. The outer lip is sharp-edged, and the umbilicus small. The pillar is short and straight.

A specimen sent by Cuming to Dr. Lea is not so large, and is darker colored, the ground color being an olivaceous brown with a narrow chestnut band at the periphery; the base pale and the umbilicus entirely closed. The nodulous band in front of the suture is present and of a whitish color.

The name applied by Forbes was *achatellinus*, which, by several authors, on the assumption that it was intended as a diminutive of *Achatinella*, has been emended to *achatinellinus*, a most awkward and clumsy word. But it is just as likely that he intended the word as a diminutive of the same root as *Achatina;* and, at any rate, no one has the right to make changes on an unsupported assumption, for which reason the original form is retained here.

Bulimulus (Næsiotus) nux Broderip. Plate XVI, figure 6; Plate XVII, figure 10.

Bulinus nux Brod., P. Z. S., 1832, p. 125, (Charles Id.); Sby., Conch. Ill., p. 6, figs. 37, 37*, 1833.

Bulimus nux Desh. in Lam. An. s. Vert., ed. ii, vol. viii, p. 276, 1838; Pfr., Mon. Hel. Viv., II, p. 183, 1848; Reeve, Conch. Icon., pl. xxiii, fig. 150 (not typical); Smith, P. Z. S., 1877, p. 72.

Buliminus nux Beck, Ind. Moll., p. 70, 1838.

Bulimus (*Næsiotus*) *nux* Albers, Heliceen, p. 162, (Type of section).

Bulimulus (*Omphalostyla*) *nux* H. & A. Adams, Gen. Rec. Moll., II, p. 161, 1855.

Bulimulus (*Nesiotes*) *nux* Martens, in Albers ed. II, p. 220, 1860.

Bulimulus (*Næsiotus*) *nux* Pfr., Nom. Hel. viv., p. 254, 1881.

Bulimus nuciformis Petit, Journal de Conchyl., IV, p. 365, pl. xi, fig. 7, 1853; Pfr , Mon. Hel. Viv., IV, p. 410, 1859.

Bulimus (*Næsiotus*) *nuciformis* Pfr., Mal. Blatt., ii. Vers., p. 161, 1854.

Bulimulus (*Nesiotes*) *nuciformis* Martens in Albers, ed. ii, p. 220, 1860.

Bulimulus (*Næsiotus*) *nuciformis* Pfr., Nom. Hel. Viv., p. 254, 1881.

Bulimus incrassatus Pfr., P. Z. S., 1852, p. 157; Küster in Chemn. Conch. Cab., ed. ii; *Bulimus*, No. 88, pl. 30, figs. 13, 14; Pfr., Mon. Hel. Viv., III, p. 415, 1853.

Bulimulus (*Omphalostyla*) *incrassatus* H. & A. Ads., Gen. Rec. Moll. II, p. 161, 1855.

Bulimulus unifasciatus Reibisch (non Sby.) Isis, 1892, p. 20, pl. i, fig. 1, *not* p. 3.

Bulimulus (*Næsiotus*) *nux* Reibisch, Isis, 1892, p. 3.

Bulimulus (*Næsiotus*) *incrassatus* Reibisch, Isis, 1892, p. 4, t. i. fig. 4a; var. *sulcatus* Reib., Ibid, p. 4, t. i, figs. 4b c; var. *nuciformis* Reib., Ibid., p. 4, t. i, fig. 4d.

Bulimulus (*Næsiotus*) *nux* Stearns, Proc. U. S. Nat. Mus., xvi, pp. 376–381, 425, 426, 1893.

Variety **verrucosus** Pfeiffer.

Bulimus verrucosus Pfr., P. Z. S., 1885, p. 116, (Gal. Is.); Mon. Hel. viv., IV, p. 475, 1859.

Bulimus (*Næsiotus*) *verrucosus* Pfr., Mal. Blätt. ii, Vers., p. 161, 1854.

Bulimulus (*Næsiotus*) *verrucosus* Pfr., Nom. Hel. viv., p. 254, 1881; Reibisch, Isis, 1892, p. 3.

Bulimulus asperatus Reibisch (non Pfr.), Isis, 1892, pl. 1. fig. 3, (syn. excl.).

Variety **asperatus** Albers.

Bulimus asperatus Albers, Malak. Blätt., IV, p. 98, 1857; Pfr., Mon. Hel. viv., IV, p. 475, 1859; VI, p. 121; Novit. Conch., IV, p. 145, pl. 133, figs. 8, 9.

Bulimulus (*Nesiotes*) *asperatus* Martens in Albers Heliceen, ed. ii, p. 220, 1860.

Bulimulus (*Næsiotus*) *asperatus* Pfr., Nom. Hel. viv., p. 254, 1881; not of Reibisch, Isis, 1892, pl. 1, fig. 3, = *verrucosus* var.

Bulimulus invalidus Reibisch, Isis, 1892, p. 5, t. i, fig. 6.

Habitat. Original typical *nux* of Broderip on bushes, Charles Island, in the upper wooded region; mut. *nuciformis*, Chatham Island, U. S. Fish Commission; mut. *incrassatus*, on the under side of leaves hibernating, 1,600 feet above the sea, on the S.-W. end of Chatham Island, Baur; mut. figured by Reeve in Conch. Icon., abundant on Charles Island, U. S. Fish Commission; variety *verrucosus*, Chatham Island; var. *asperatus*, Charles Island, abundant, Wolf and U. S. Fish Commission. The reference to Albemarle Island for this species in Stearns' list appears to be due to some accidental misplacement of labels, as no specimens from that locality are in the collection or among the duplicates. Number of specimens examined, three hundred and seventy-four.

The synonymy exhibits, almost as clearly as the specimens, the great variability of this species. The facts also seem to indicate quite positively that a great proportion of this variability in this instance is due quite as much to an intrinsic tendency to vary in the matter of color and form as to any direct influence of the environment promoting by special circumstances any special variation. At least, while it is not questionable that some of the variations might easily be made permanent by natural selection, it is probable, as yet, that matters have not reached that stage, since the evidence of collectors seems to establish the fact that the different variations of color and form are found indiscriminately in the same region and under the same conditions. Further and more precise observation is needed to establish this beyond controversy, but at present there seems no escape from this conclusion.

An examination of several specimens by Mr. Binney afforded the following anatomical data: "Genitalia with a short, stout, linguiform, bluntly pointed ovary; testicle of numerous bunches of long blunt cæca; epididymis long, convoluted along nearly its whole length; oviduct long; genital bladder small, oval, on a long stout duct; penis sac long, narrow, subcylindrical, white, with a silken lustre, receiving the retractor muscle at its upper third, the vas deferens at its apex."

Jaw low, wide, ends rather blunt, but little arcuate, anterior surface with about 20 broad, flat, crowded ribs, squarely denticulating both margins. It is thin, membranaceous, light horn-colored, of equal height throughout, with the outer edges of the ribs reinforced.

Radula long and narrow, formula $\frac{\frac{1}{3}}{31.9+9.31}$; rhachidian with a long central and two shorter lateral cusps, the whole narrower than the base; true laterals bicuspid, the outer cusps shorter, 9 in number on each side; marginals low, wide, with one long wide bifid inner cutting point and one outer short bifid cutting point, the latter in the extreme marginals becoming irregularly serrate. In the figure (plate XVI, fig. 6) of the genitalia, the proximal orifices are separated, an accident of dissection, the two canals actually open into a single atrium.

Bulimulus (Næsiotus) rugulosus Sowerby. Plate XVII, figure 1.

Bulinus rugulosus Sby., Conch. Ill. Part 142, fig. 87 (a, b), 1839.
Bulimus rugulosus Pfr., Mon. Hel. Viv., II, p. 113, 1848.
Bulimus eschariferus Reeve, Conch. Icon., pl. xx, fig. 121, (text, figure excluded), 1848, not of Sowerby.
Bulimulus (*Omphalostyla*) *rugulosus* H. & A. Adams, Gen. Rec. Moll., II, p. 161, 1855.

Bulimulus (*Næsiotus*) *rugulosus* Pfr., Nom. Hel. viv., p. 254, 1881; Ancey, Bull. Soc. Mal. France, IV, p. 294, 1887, (Chatham Island); Stearns, Proc. U. S. Nat. Mus., xvi, pp. 381, 426, 1893.

B. rugulosus var. *infuscata* Ancey, op. cit., p. 294, 1887,

? *Bulimulus* (*Næsiotus*) *nudus* Reibisch, Isis, 1892, p. 9, t. i, fig. 15.

Not *B. rugulosus* Reibisch, Isis, 1892, p. 7, t. i, figs. 11 a–b, = *B. perspectivus* Pfr.

Under stones near the shore, Blackbeach Road, Charles Island, Dr. Baur; Charles Island, Darwin and Wolf; Chatham Island, Darwin, Kellett and Cuming.

Jaw thin, membranaceous, light horn-colored, low, wide, arcuate, of equal height throughout, ending bluntly; anterior surface with about 20 broad, flat ribs, their outer edges reinforced, the margins of the jaw squarely denticulated by the projecting ends of the ribs.

Some varieties of *B. nux* approach this species quite closely, especially that to which Reibisch gave the name of *invalidus*.

Bulimulus (Næsiotus) planospira Ancey, Plate XVI, figure 3.

Bulimus eschariferus Reeve, Conch Icon., pl. xx, fig. 121 (bad, text excl.), 1848.

Bulimulus rugulosus var. *planospira* Ancey, Bull. Soc. Mal. de France, IV, p. 294, 1887.

Bulimulus rugulosus Reeve (Smith, in litt.) *ex parte*.

Northeast end of Charles Island, at about 200 feet, Dr. Baur.

This is one of the most elegant species of the group. It is very closely related to *B. rugulosus* from which it may be discriminated by its larger size and greater number of whorls, and by the deeper suture and more lax manner in which the last whorl is coiled. In *B. planospira* the spiral sculpture is usually more elevated and conspicuous. It has been found only on a limited portion of Charles Island, while *rugulosus* is common on both Charles and Chatham. As this form has not been figured I include a figure of it.

Bulimulus (Næsiotus) ustulatus Sowerby.

Bulinus ustulatus Sby., P. Z. S., 1833, p. 72, (Charles Island); Conch. Ill., p. 6, fig. 42, 1833.

Bulimus ustulatus Desh. in Lam. An. s. Vert., ed. II, vol. viii, p. 279, 1838; Pfr., Mon. Hel. Viv., II, p. 217, 1848; Küster, in Chemn. Conch. Cab., ed. II, *Bulimus*, t. 62, figs. 16–18; Reeve, Conch. Icon., pl. xxi, fig. 130, 1848.

Buliminus ustulatus Beck, Ind. Moll., p. 70, 1838.

Bulimulus (*Omphalostyla*) *ustulatus* H. & A. Ad., Gen. Rec. Moll., II, p. 161, 1855.

Bulimus (*Næsiotus*) *ustulatus* Albers, Heliceen, p. 162, 1850.

Bulimulus (*Nesiotes*) *ustulatus* Martens in Albers, ed. ii, p. 221, 1860.

Bulimulus (*Næsiotus*) *ustulatus* Pfr., Nom. Hel. Viv., p. 254, 1881; Stearns, Proc. U. S. Nat. Mus., xvi, p. 427, 1893.

Bulimulus (*Næsiotus*) *venustus* Reibisch, Isis, 1892, p. 5, t. i, fig. 7; not *B. ustulatus* Reibisch, Isis, 1892, p. 4, t. i, fig. 5, = *nux* var.

Charles Island, Cuming.

This species is notable for the yellowness of its paler parts and the bright sienna brown of its darker portions. It is closely related to *B. calvus* Sby., which is a smaller and more streaky shell. The form figured by Reeve and Reibisch under this name is larger than the true *ustulatus*, and is considered by Dr. Stearns to be a banded variety of *B. nux*.

Bulimulus (Næsiotus) calvus Sowerby.

Bulinus calvus Sby., P. Z. S., 1833, p. 72 (James Island); Conch. Ill., p. 6, fig. 41, 1833.

Bulimus calvus Desh. in Lam. An. s. Vert., ed. ii, vol. viii, p. 179, 1838; Pfr., Mon. Hel. Viv., II, p. 225, 1848; Kuster, in Chemn. Conch. Cab., ed. ii, *Bulimus*, t. 62, figs. 37, 38.

Buliminus calvus Beck, Ind. Moll., p. 70, 1838.

Bulimulus (*Omphalostyla*) *clavus* H. & A. Ad., Gen. Rec. Moll. II, p. 161, 1855.

Bulimus calvus Reeve, Conch. Icon., pl. xx, fig. 126, 1848.

Bulimulus (*Nesiotes*) *calvus* Martens in Albers, ed. ii, p. 221, 1860.

Bulimulus (*Næsiotus*) *calvus* Pfr., Nom. Hel. Viv., p. 254, 1881; Reibisch, Isis, 1892, p. 6, t. i, fig. 8; Stearns, Proc. U. S. Nat. Mus., xvi, p. 427, 1893, *ex parte*.

James Island, Cuming; Charles Island, U. S. Fish Commission, Cuming and Wolf; Chatham Island, Kellett.

Specimens sent under this name by Cuming and Reibisch agree well with those collected by the U. S. Fish Commission. It is closely related to *B. ustulatus* and is rather nearly approached by certain dwarfish, unusually smooth specimens of *B. rugulosus*. *B. nucula* Pfr. is also closely allied.

Bulimulus (Næsiotus) nucula Pfeiffer.

Bulimus nucula Pfr., P. Z. S., 1852, p. 60 (Gal. Is.); Mon. Hel. Viv., III, p. 415, 1853; IV, p. 475, 1859.

Bulimus (*Næsiotus*) *nucula* Pfr., Mal. Blatt. II. Vers., p. 161, 1854.

Bulimulus (*Omphalostyla*) *nucula* H. & A. Ads., Gen. Rec. Moll., II, p. 161, 1855.

Bulimulus (*Nesiotes*) *nucula* Martens, in Albers Heliceen, ed. ii, p. 221, 1860.

Bulimulus (*Næsiotus*) *nucula* Pfr., Nom. Hel. Viv., p. 254, 1881; Reibisch, Isis, 1892, p. 3, t. i, fig. 2.

Bulimulus (*Næsiotus*) *nux* var. Stearns, Proc. U. S Nat. Mus., xvi, pp. 380, 426, 1893.

Charles Island, Wolf, fide Reibisch; Chatham Island near the S.-W. end, at a height of 1,600 feet, Baur.

A specimen submitted to Mr. Edgar A. Smith of the British Museum, was said to be somewhat darker colored and more coarsely striated than the type of *nucula* in that collection. These are, however, trivial differences under the circumstances. It agrees closely with a specimen sent by Reibisch under the name of *nucula*. It is a smoother, smaller and more compact shell than *rugulosus*, and shows a somewhat attenuated and dark colored apex, resembling that of *galapaganus* Pfr. It is, perhaps, most closely related to *B. ustulatus* or *B. calvus* Sby., and a sufficient series might very likely connect them. No living specimens of this species were collected, though there are some fresh shells.

Bulimulus (Næsiotus) eschariferus Sowerby.

Bulinus eschariferus Sby., Conch. Ill., figs. 85 (a, b), 1833.
Bulimus eschariferus Pfr., Symb., II, p. 45; Mon. Hel. Viv., II, p. 115, 1848; Smith, P. Z. S., 1877, p. 72.
Bulimulus (*Næsiotus*) *eschariferus* Pfr., Nom. Hel. Viv., p. 254, 1881; Reibisch, Isis, 1892, p. 2.
Bulimus rugulosus Reeve (not Sby.), Conch. Icon., pl. xx, fig. 123, 1848 (citation, diagnosis and figure refer to *eschariferus*).
Bulimulus (*Omphalostyla*) *eschariferus* H. & A. Ad., Gen. Rec. Moll. II, p. 161, 1855.
Bulimulus eschariferus Ancey, Bull. Soc. Mal. France, IV, p. 295, 1887.
B. eschariferus var. *bizonalis* Ancey, op. cit., p. 295, 1887.
B. eschariferus var. *subconoidalis* Ancey, op. cit., p. 295, 1887.
Bulimulus (*Næsiotus*) *eschariferus* Stearns, Proc. U. S. Nat. Mus., xvi, pp. 381, 426, 1893.

Chatham Island, Darwin, Kellett, U. S. Fish Commission and Dr. Baur, under stones near the shore at Wreck Bay and elsewhere; Charles Island, H. M. S. Peterel.

Though this species, as usually received, is apparently smooth and polished, it has minute more or less granular spirals, which it is probable in the young state bear hairs. Among the living specimens obtained at Chatham Island by the U. S. Fish Commission were some rather smaller than the average and covered with a dense brown epidermis, which bears numerous spiral lines more or less minutely granulose, a small hair or process of the epidermis projecting from each granule, giving the shell a pilose appearance. These specimens measure about 12 mm. in length and 5 mm. in diameter, the color of the shell is browner than in the type, and, when denuded of the periostracum, the shell is seen to be marked by numerous fine sharp, almost microscopic spirals. It may, perhaps, form a variety *pileatus*, of the typical *eschariferus*.

Bulimulus (Næsiotus) eschariferus var. **ventrosus** Reibisch. Plate XVII, figure 3.

Bulimulus (*Næsiotus*) *ventrosus* Reibisch, Isis, 1892, p. 7, t. i, fig. 12 a–b.

Barrington Island, common; Wolf, fide Reibisch, also Dr. G. Baur, who found it under stones near the shore.

A specimen of this form was sent to Mr. Smith at the British Museum, and by him compared with the type of *B. eschariferus* with which he identified it. In color, form and range of variation the Barrington Island shells agree perfectly with those from Chatham and Charles Island (*eschariferus*), but the latter are always a little more slender if the specimens I have seen can be taken as a criterion. Twenty-four of them averaged 16 mm. long by 5 mm. in diameter above the aperture, while the diameter of the most slender of forty-two Barrington Island specimens was 6 mm. The latter have the spire less attenuated and slightly more compact. On the whole, it is doubtful if this form can rank higher than as a local race of *eschariferus*.

Jaws light horn-colored, low, wide, thin, slightly arcuate, of equal height throughout, with blunt ends; anterior surface with about 16 irregularly wide flat ribs, their outer edges reinforced, their ends bluntly denticulating the upper and lower edges of the jaw.

Radula long and narrow; formula $\dfrac{\frac{1}{3}}{\frac{13+9}{\times \;\; 2} \cdot \frac{9+13}{2 \;\; \times}}$; rhachidian tooth tricuspid, the lateral cusps shorter; lateral teeth bicuspid; marginals with one longer inner bifid cutting point and the outer short, wide cusp broken up into three or four denticles.

Bulimulus (Næsiotus) galapaganus Pfeiffer.

Bulimulus galapaganus Pfr., P. Z. S., 1854, p. 58. Mon. Hel. viv. IV, p. 503, 1859.
Bulimulus (*Næsiotus*) *galapaganus* Pfr., Mal. Blatt. II, Vers., p. 160, 1854.
Bulimulus (*Nesiotes*) *galapaganus* Martens, in Albers Heliceen, ed. ii, p. 221, 1860.
Bulimulus (*Næsiotus*) *galapaganus* Pfr., Nom. Hel. viv., p. 1881; Reibisch, Isis, 1892, p. 8; Stearns, Proc. U. S. Nat. Mus., XVI, p. 427, 1893.

Charles Island, at about 200 ft. elevation, near the northeast end of the island, Dr. Baur.

This is very closely related to *B. ustulatus* Sby., is slightly longer and more pupiform, and wants the bright yellowish bands. The whorls are more rounded in *B. galapaganus* than in *B. perspectivus*, and the latter is darker and more uniformly colored.

Bulimulus (Næsiotus) perspectivus Pfeiffer.

Bulimus perspectivus Pfr., P. Z. S., 1846, p. 33; Mon. Hel. viv., ii, p. 97, 1848; Reeve, Conch. Icon., *Bulimus*, pl. 63, fig. 435.
Bulimulus (*Ataxus*) *perspectivus* Pfr., Clessin, Nomencl. Hel. viv., p. 253, 1881.
Bulimulus (*Næsiotus*) *rugulosus* Reibisch, Isis., 1892, p. 7, t. i, figs. 11 a–b.

Chatham Island, Galapagos, 300–600 ft., Wolf, fide Reibisch, on rocks and under stones.

This species is in the British Museum, and appears in the literature, without a known habitat, but Herr Reibisch has courteously forwarded two specimens for inspection, with the information that they are from Chatham Island, Wolf, collector.

The species resembles *B. eschariferus* in form, but it is of a deep, reddish, instead of an olivaceous brown, and is more rudely striated. One specimen shows traces of a narrow, pale band on the last whorl, the other does not. The lip is dark colored. One of the specimens has the base of the pillar very prominent, almost channelled, the other is quite normal. The shell is midway between the typical *eschariferus* and the var. *ventrosus* in size. The first reference of it to *B. rugulosus* by Herr Reibisch was undoubtedly an error, which that gentleman detected upon examining the specimens in the British Museum.

Bulimulus (Næsiotus) jacobi Sowerby.

Bulimus jacobi Sby., P. Z. S., 1833, p. 74 (James Id.) Conch. Ill., p. 7, figs. 45, 45 (2 vars.) 1833.

Bulimus jacobi Desh. in Lam. An. S. Vert., ed. ii, vol. viii, p. 281, 1838; Pfr., Mon. Hel. viv., II, p. 98, 1848 (not of Reeve, Conch. Icon., pl. XXI, fig. 135, 1848 = *B. olla*).

Buliminus jacobi Beck, Ind. Moll., p. 70, 1838.

Bulimulus (*Omphalostyla*) *jacobi* H. & A. Ads., Gen. Rec. Moll., ii. p. 161, 1855.

Bulimus (*Næsiotus*) *jacobi* Albers, Helic., p. 162, 1850; Pfr., Vers., p. 160.

Bulimulus (*Nesiotes*) *jacobi* Martens, in Albers, ed. ii, p. 221, 1860.

Bulimulus (*Næsiotus*) *jacobi* Pfr., Nom. Hel. viv., p. 254, 1881. Reibisch. Isis, 1892, p. 6. Not *B. jacobi* Stearns, Proc. U. S. Nat. Mus., XVI, p. 381, 1893.

Bulimulus (*Næsiotus*) *pallidus* Reibisch. Isis, 1892, p. 6, t. i, fig. 9.

Bulimulus (*Næsiotus*) *acutus* Reib., op. cit., p. 8, t. i, fig. 13, 1892.

James Island, Cuming; Charles Island, Cuming; typical, in U. S. Nat. Mus., from original specimens received by Dr. Lea; 1,600 ft. near Wreck Bay, Chatham Island, on the under side of leaves of plants (var. *pallidus*), and on East Albemarle Island, Dr. Baur; Albemarle Island, 200–800 ft. on bushes and stones, Wolf, fide Reibisch (var. *pallidus*); Chatham Island, 900–2,000 ft., in damp places and on the trunks of trees (var. *acutus*) Wolf.

The variety *pallidus* differs from the typical form in being slightly smaller and more slender without the wrinkles, and it is probable that a large series would show no dividing line between the variety and the type.

The variety *acutus* differs from *pallidus* in the almost entire absence of the spiral granulated sculpture, leaving much of the surface polished and smooth, except for incremental lines. Reibisch's figure shows one whorl more in the same length than the specimen he was kind enough to send me for examination, but slight differences of this kind are common among these very variable forms. It also comes very close to some varieties of *B. nucula* and *B. amastroides*, the latter being slightly smaller and more spindle-shaped.

The typical *B. jacobi*, sent by Cuming to Dr. Lea in 1838, is a small, stout shell, with rather inflated whorls, covered with fine granulations, minute, obliquely transverse broken wrinkles, and fine granular spirals, hardly visible without magnification. The shell is pale reddish-brown, sometimes with a narrow, pale peripheral band. The pillar and body are without fold or tubercular callus. Those collected by Dr. Baur on Charles Island are the smallest I have seen which can be positively referred to this species. The larger, smooth form figured by Reeve under this name is distinct, and will be found referred to under the name of *B. olla*.

Bulimulus (Næsiotus) jacobi var. **cinereus** Reibisch. Plate XVI, fig. 14.

Bulimulus (*Næsiotus*) *cinereus* Reibisch, Isis, 1892, p. 7, t. i, fig. 10.
Bulimulus jacobi var. *vermiculatus* Dall, Nautilus, VII, p. 53, Sept., 1893.

James Island at James Bay, Dr. Baur and Wolf. No living specimens of this species appear to have been collected.

This variety is hardly separable from the smaller *B. jacobi*, though the dead and the fresh shells appear quite dissimilar. It is somewhat smaller than the smallest undoubted *jacobi*, and the granular sculpture is more dense and uniform. I have not seen any specimens with a spire as long and pointed as in Reibisch's figure. A specimen sent by him agrees in every way with those collected by Dr. Baur.

Bulimulus (Næsiotus) olla Dall. Plate XVI, fig. 2.

Bulimus jacobi Reeve, Conch. Icon. *Bulimus*, pl. XXI, fig. 135, 1848.
Bulimulus olla Dall, Nautilus, VII, p. 53, September, 1893.

James Island, Cuming, Lea Collection; Duncan Island, all dead, but fresh, Dr. Baur; Barrington Island, dead, Dr. Baur; Conway Bay, Indefatigable Island, Dr. Baur.

This shell is closely related to *B. jacobi*, and was figured by Reeve under that name. *B. olla* is larger, and wants the granulations of *B. jacobi*, its surface is nearly smooth and almost polished, marked with faint incremental lines, has seven whorls (against six in the other species) and a very bulbous pillar. The present species inhabits the grassy upper zone, while *B. jacobi* is found in the wooded area.

Bulimulus (Næsiotus) Tanneri Dall. Plate XVI, fig. 5.

Bulimulus (*Næsiotus*) *Fanneri* Dall, Nautilus, VIII, p. 127, March, 1895 (err. typ. pro *Tanneri*, corrected in the index, p. iii, April, 1895).

Shell short, stout, pointed, with two nepionic and four subsequent whorls; nucleus rather coarsely transversely ribbed, the interspaces somewhat wider; the subsequent whorls marked by incremental lines and obsolete traces of fine, partly granulose, inconstant spiral threads, only perceptible under a lens; color pinkish or brownish-white with no traces of a peripheral paler band; whorls somewhat inflated, suture conspicuous, umbilicus large and deeply pervious; aperture large with a widely expanded lip, the outer lip much bent over at the body, closely approaching the pillar and united to it by a distinct callus; length 11; max. diameter 7·0 mm.

Indefatigable Island, U. S. Fish Commission.

This is about the size of *B. cinereus* Reib., but is more conical, inflated and stouter, with a very differently shaped aperture, the lip being more expanded and reflected than in any other species yet described from these islands. It is named in honor of Capt. Z. L. Tanner, U. S. N., commanding the U. S. S. Albatross during the Galapagos explorations. None of the specimens were living.

Bulimulus (Næsiotus) duncanus Dall. Plate XVI, fig. 7.

Bulimulus (*Næsiotus*) *duncanus* Dall, Nautilus, VII, p. 52, September, 1893.

The shell is short, stout, inflated, thin, with two nepionic and four-and-a-half subsequent whorls. The apex is rather pointed, the axial dimple small, the whorls rapidly enlarging, with the suture behind the last whorl deeper than the rest and more oblique to the axis; the aperture is relatively small and rather oblique, the lip simple, sharp, not reflected, connected across the body with a thin callus, a single tubercle on the body, well within the aperture, and about equidistant from either lip; umbilicus perforate, narrow; height of the shell 18, of the last whorl 12·5; diameter of shell 11 mm.

Dead specimens only were found on Duncan Island, by Dr. Baur.

The sculpture comprises only incremental lines and faint wrinkles in harmony with them, especially just in front of the suture and near the end of the last whorl. When perfectly fresh, there were probably microscopic granules spirally arranged and sparsely distributed, but these are now represented only by minute spots of erosion. Except the largest specimens of *B. nux*, these shells are the largest *Bulimuli* described from the islands. They are, however, thinner than any specimens of *B. nux,* in this respect resembling *B. unifasciatus* Sby.

Bulimulus (Næsiotus) Darwini Pfeiffer.

Bulimus Darwini Pfr., P. Z. S., 1846, p. 29 (Gal. Ids). Mon. Hel., viv. ii, p. 199, 1848; Reeve, Conch. Icon., pl. XXI, fig. 136 (Gal. Ids.), 1848.
Bulimulus (*Omphalostyla*) *Darwini* H. & A. Ad., Gen. Rec. Moll., II, p. 161, 1855; Wimmer, Sitzb. Akad. Wiss. Wien, lxxx, p. 44, 1879.
Bulimulus (*Nesiotes*) *Darwini* Martens, in Albers, Heliceen, ed. ii, p. 220, 1860.
Bulimulus (*Næsiotus*) *Darwini* Pfr., Mon. Hel. viv. p. 254, 1881; Reibisch, Isis, 1892, p. 10; Stearns, Proc. U. S. Nat. Mus., XVI, p. 427, 1893.
Bulimus manini "Pfr." Carpenter, Rep. Brit. Assoc., 1856, p. 359; Stearns, Proc. U. S. Nat. Mus., XVI, pp. 405, 427, 1893 (Err. typ.).

Bindloe Island, Habel, fide Wimmer.

The type specimen of this species has disappeared from the Cumingian Collection, and I have been unable to obtain a specimen for examination. The only reference to the particular island upon which it lives is derived from Habel.

Bulimulus (Næsiotus) Wolfi Reibisch.

Bulimulus (*Næsiotus*) *Wolfi* Reibisch, Isis, 1892, p. 10, t. ii, figs. 1 a–b; Stearns, *op. cit.*, pp. 414, 427, 1893.

Indefatigable Island, Wolf, fide Reibisch.

A specimen of this species kindly forwarded for examination by Herr Reibisch is clearly distinct from anything I have seen. It resembles *B. Simrothi* Reib., but is more robust, the surface of the upper whorls smoother and more regular in sculpture, the pillar-tooth is more prominent and stronger, the parietal tooth, apparently normal, is not found in any *Simrothi* I have seen, the umbilicus is larger than in the latter species. It resembles Reeve's figure of *B. Darwini* somewhat, but the latter is 17 mm. long, while *B. Wolfi* only reaches a length of 13·5 mm.

Bulimulus (Næsiotus) unifasciatus Sowerby. Plate XVII, figs. 6, 11.

Bulimus unifasciatus Sby., P. Z. S., 1833, p. 37 (Charles Id.). Conch. Ill., fig. 55, 1833.
Bulimus unifasciatus Desh. in Lam. An. s. Vert., Ed. ii, vol. viii, p. 277, 1838. Reeve, Conch. Icon., XXIII, fig. 149 (bad) 1848. Pfr., Mon. Hel. viv. II, p. 195, 1848. Smith, P. Z. S., 1877, p. 72.
Bulimulus unifasciatus Beck, Index, p. 67, 1838.
Bulimulus (*Omphalostyla*) *unifasciatus* H. & A. Ads., Gen. Rec. Moll., II, p. 161, 1855.
Bulimulus (*Nesiotes*) *unifasciatus* Martens, in Albers, ed. ii, p. 220, 1860.
Bulimulus (*Næsiotus*) *unifasciatus* Pfr. Nom. Hel. viv., p. 254, 1881; Stearns, Proc. U. S. Nat. Mus., XVI, p. 427, 1893.
Bulimulus unifasciatus Reibisch, Isis, 1892. p. 3, syn.; but not p. 20, pl. i, fig. 1 (= *nux* var.).

James Island, under lava, Cuming in Lea Collection; Chatham Island, near the southwest end, at a height of about 1,600 feet, Dr. Baur; Chatham Island, Kellett; Charles Island, Cuming and H. M. S. Peterel.

Jaw thin, horn colored, arcuate, of equal height throughout, with blunt ends; anterior surface with about 14 broad, crowded, flattish ribs, reinforced along their outer edges; the ends of the ribs broad, squarely denticulating the upper and lower margin of the jaw.

Radula long, thin, narrow; formula $\frac{1}{8+12 \cdot 12+8}$; rhachidian tooth stout, tricuspid, with very short lateral cusps; perfect laterals, about twelve in number, bicuspid, with very short outer cusps; marginals low, wide, with a long bifid inner cusp outside of which the cutting edge is broken up into four or five denticles of nearly equal length.

In its thin and ample shell, uniform reddish-brown color, and narrow, well-defined peripheral pale band, this form resembles the species of the mainland more than any other Galapagos species. The transverse riblets on the nepionic shell are very fine and almost always decorticated; the granular spirals are almost microscopic, and when fresh and perfect, bear small projections of the periostracum.

Bulimulus (Næsiotus) Simrothi Reibisch. Plate XVI, figs. 11, 12, 13; Plate XVII, fig. 2.

Bulimulus (*Næsiotus*) *Simrothi* Reibisch, Isis, 1892, p. 11, t. 2, fig. 2; Stearns, Proc. U. S. Nat. Mus., XVI, pp. 414, 428, 1893.
Bulimulus (*Næsiotus*) *tortuganus* Dall, Nautilus, VII, p. 54, 1893.

La Tortuga, grassy zone, South Albemarle, Baur; 1,000–2,000 feet, in the moist region, Albemarle Island, Wolf.

Herr Reibisch has kindly furnished a photograph of one of his types of *B. Simrothi* with which I have compared my specimens of *tortuganus*. Wolf's shell in the photograph appears smoother, without the deeply indented markings, and exhibits color streaks in harmony with the lines of growth which none of the specimens of *tortuganus* do. Nevertheless, the two forms should probably be united, especially as Reibisch's description agrees better than the photograph as respects surface and color. As the specimens collected by Wolf were more or less immature, the original diagnosis needs some additional data.

Jaw light horn colored, thin, membranaceous, arcuate, of equal height throughout and with the ends blunt; anterior surface with about 17 rather narrow, flat crowded ribs, with thickened outer edges, the upper and lower margins of the jaw bluntly denticulated by the squarish ends of the ribs. Radula of the same type as in the species previously mentioned.

I have figured several specimens to show the variations of form and sculpture. When mature the shell always has a pretty solidly thickened peristome. The young are more translucent and show projecting points of epidermis along the minute granular spiral lines, as in *B. unifasciatus*, and like that species show a distinct peripheral paler band.

Bulimulus (Næsiotus) Bauri Dall. Plate XV, fig. 12; Plate XVII, figs. 7, 15.

Bulimulus (*Næsiotus*) *Bauri* Dall, Nautilus, VII, p. 54, September, 1893.

Hibernating on the under side of leaves of plants at the southwest end of Chatham Island, 1,600 feet above the sea, Dr. Baur.

Jaw thin, light horn colored, arcuate, of equal height throughout, with blunt ends; anterior surface with about 12 broad, flat, crowded ribs, their outer edges reinforced and their ends bluntly denticulating the upper and lower edges of the jaw.

Radula long and narrow; formula about $\frac{1}{15+9\cdot9+15}$; rachidian tooth and nine perfect laterals, differing little from those of the other species already described; marginals with the inner cusp broad and bifid or at the extreme margin trifid, the outer cusp broken up more or less irregularly into several denticles or groups of denticles.

Genitalia essentially as in *B. nux*.

This is a very distinct little species, with a pale yellow-brown body whorl darkening toward the tip of the spire, with conspicuous, lighter transverse wrinkles on the upper whorls, and fine ribbing on the nepionic shell which is of a livid purple, almost black. In specimens which have survived hibernation, the aperture is usually produced, contracted, and conspicuously thickened. Many specimens have a narrow, pale line in front of the suture. There is no spiral sculpture.

Bulimulus (Næsiotus) amastroides Ancey. Plate XV, fig. 16.

Bulimulus (*Nesiotus*) *amastroides* Ancey, Bull. Soc. Mal. de France, IV, p. 293, 1887.
Bulimulus jacobi Stearns, Proc. U. S. Nat. Mus., XVI, pp. 381, 426, 1893, not of Sby.
Bulimulus calvus var.? Stearns, *op. cit.*, p. 427.

Chatham Island, U. S. Fish Commission.

This is the smooth form of which the plicate aspect is *B. curtus* of Reibisch and *Anceyi* of Dall. Jaw membranaceous, horn colored, low, wide, thin, of equal height throughout, ends terminating bluntly; anterior surface with about 22 broad, crowded ribs, their outer edges thickened, their ends bluntly denticulating the upper and lower margins of the jaw.

The shell has an olivaceous tint which distinguishes it at once from the mostly reddish or yellowish-brown species of which the fauna contains so many.

Bulimulus (Næsiotus) curtus Reibisch. Plate XV, fig. 13; Plate XVII; fig. 8.

Bulimulus (*Næsiotus*) *curtus* Reibisch, Isis, 1892, p. 9, t. i, fig. 14.
Bulimulus (*Næsiotus*) *amastroides* Ancey, var. *Anceyi* Dall, Nautilus, VII, p. 53, September, 1893.

Chatham Island, near Wreck Bay, at a height of 1,600 feet, Baur; usually on the under surface of the leaves of plants. Also reported from Chatham by Wolf (Reibisch) in grassy places and on the trunks of trees, at from 900 to 2,000 feet, and by the U. S. Fish Commission.

This is very closely related to *B. amastroides* Ancey, of which it is probably an offshoot. It has, in general, a more plicate surface, ruder aspect, smaller mouth, and more angular periphery. Specimens submitted by Herr Reibisch as representing his *curtus* agree exactly with the types of my variety *Anceyi*.

Jaw as in typical *amastroides*. Radula long and narrow; formula $\frac{1}{11+9 \cdot 9+11}$; rhachidian tooth tricuspid; laterals tricuspid; both with the lateral cusps quite short; marginals subquadrate, low, wide, with a longer bifid inner cusp and an outer, shorter cutting edge with three or four denticles upon it.

Genitalia essentially as in *B. nux*.

Bulimulus (Næsiotus) canaliferus Reibisch. Plate XV, fig. 14.

Bulimulus (*Pelecostoma*) *canaliferus* Reibisch, Isis, 1892, p. 13, t. ii, fig. 6; Stearns, Proc. U. S. Nat. Mus., XVI, pp. 415, 428, 1893.

Chatham Island, in moss and on ferns, 900–2,000 feet, Wolf, fide Reibisch.

This is a peculiar shell, characterized by its many-whorled spire, short aperture, and a large umbilicus with its walls deeply excavated, so that the groove shows as a prominent ridge on the pillar within the aperture. In the specimen sent by Herr Reibisch the edge of the aperture is hardly thickened and not at all reflected, there is a thin callus deposit over the body, but no trace of a parietal tooth. The species, with a totally different surface, has somewhat the form of *B. rugiferus*, but with a less slender and shorter spire. Reibisch's figure gives the impression of a more slender shell than the specimen I have examined.

Bulimulus (Næsiotus) sculpturatus Pfeiffer.

Bulimus sculpturatus Pfr., P. Z. S., 1846, p. 29 (Gal. Is.). Mon. Hel. viv., II, p. 183, 1848; IV, p. 476, 1859.
Bulimus (*Næsiotus*) *sculpturatus* Pfr., Mal. Blatt. ii. Vers., p. 161, 1854.
Bulimus sculpturatus Reeve, Conch. Icon., pl. XX, fig. 125, 1848.
Bulimulus (*Omphalostyla*) *sculpturatus* H. & A. Ads., Gen. Rec. Moll., ii, p. 161, 1855.
Bulimulus (*Nesiotes*) *sculpturatus* Martens, in Albers, Heliceen, Ed. ii, p. 220, 1860.
Bulimulus (*Næsiotus*) *sculpturatus* Pfr., Nom. Hel. viv., p. 254, 1881; Reibisch, Isis, p. 10, 1892; Stearns, Proc. U. S. Nat. Mus., xvi, p. 427, 1893.

The particular island to which this species, collected by Darwin, belongs, is not known. I have not been able to obtain a specimen for examination. Reeve's figure recalls a specimen of *B. Simrothi* in which the lip has not yet been developed fully, but if his measurement is correct, the shell should be a little larger as well as more slender than in *B. Simrothi*.

Bulimulus (Næsiotus) rugiferus Sowerby.

Bulimus rugiferus Sby., P. Z. S., 1833, p. 36 (James Id.), Conch. Ill., fig. 40, 1833.
Cochlicellus rugifer Beck, Index, p. 63. No. 11, 1838.
Bulimus rugiferus Desh. in Lam. An. s. Vert., Ed. ii, vol. viii, p. 276. 1838. Pfr. Mon. Hel. viv., II, p. 115, 1848. Reeve, Conch. Icon., XX, fig. 118, 1848.
Bulimulus (*Omphalostyla*) *rugiferus* H. & A. Ad., Gen. Rec. Moll., II, p. 161, 1855.
Bulimulus (*Nesiotes*) *rugiferus* Martens, in Albers, ed. ii, p. 220, 1860.
Bulimulus (*Næsiotus*) *rugiferus* Pfr., Nom. Hel. viv., p. 254, 1881. Reibisch, Isis, 1892, p. 9. Stearns, Proc. U. S. Nat. Mus., XVI, p. 427, 1893.

James Island, Cuming.

This species is related to *B. nesioticus* and *B. Reibischi* from both of which it is distinguished by details of form. I have seen a number of specimens, but all were from the original series in the Cumingian Collection.

Bulimulus (Næsiotus) nesioticus Dall n. s. Plate XVI, fig. 1.

Shell small, thin, pale brown, with two nepionic and five subsequent whorls; spire slender, suture distinct, umbilicus small or obsolete, apex rather blunt with an axial dimple, nepionic whorls transversely ribbed with fine, even regular riblets with about equal interspaces; the next whorl is sculptured with fine spirals, close set, under which are fine transverse wrinkles; the subsequent whorls show a more or less variable transverse ribbing, in which the ribs have a tendency to break up and vary in direction ; these are crossed by fine, often granulose spirals, which are swollen where they cross the riblets; aperture small, throat yellowish, the pillar white, widely reflected without any terminal plait or callus, outer lip thickened, somewhat expanded, continuous with the pillar and a slight callus on the body. Length 12, breadth 5 mm.

James Island, U. S. Fish Commission.

This interesting species was obtained on James Island in small numbers, one specimen fresh but none living, the one figured has rather sparser ribbing than the best preserved specimen. Most of them are bleached white. The shell appears to be intermediate in character and size between *B. sculpturatus* as figured, and *B. rugiferus* Sby. It was at first referred to the latter species, but further study showed *B. nesioticus* to have two whorls less in the same length and to be a perceptibly stouter shell.

Bulimulus (Næsiotus) Reibischi Dall. Plate XVI, fig. 4.

Bulimulus (*Næsiotus*) *Reibischi* Dall, Nautilus, viii, p. 126, March, 1895.

Shell elevated, slender, with nine whorls of a pale ferruginous color and rather solid consistency; sculpture like that of *B. nesioticus* but rather more closely ribbed; the suture distinct, somewhat appressed, whorls little inflated but not flattened; umbilicus a mere chink; aperture oval, higher than wide, rounded in front, the pillar simple, the margins thickened but not reflected; length 11.0, diameter 2.5 mm.

Indefatigable Island, two specimens, U. S. Fish Commission.

This shell, though shorter, is intermediate between such forms as *B. chemnitzioides* and the more normal *Næsioti*. It is named in honor of Herr Paul Reibisch, of Dresden, who recently worked up the land shells collected by Wolf in these islands, in a paper to which I have made frequent reference.

Bulimulus new species. Plate XV, fig. 15.

Shell of about nine whorls, small, slender, with flattish sides, almost cylindrical, transversely finely wrinkled, suture distinct; aperture small, the outer lip sharp, the pillar lip short, broadly reflected, without plait or projecting callus; length 11.5, breadth 2.5 mm.

One specimen found on James and two on Indefatigable Island, Reibisch *in litt.*

The above description and figure are taken from a photograph kindly submitted to me by Herr Reibisch. I refrain from naming the species as the last mentioned gentleman had over two years ago announced his intention of describing it, but has so far, I believe, published nothing referring to it. As a distinct form from any previously reported from these islands, I have thought best to briefly indicate it.

Bulimulus (Næsiotus) chemnitzioides Forbes. Plate XVII, fig. 4.

Bulimus chemnitzioides Fbs., P. Z. S., 1850, p. 55, pl. ix, fig. 6; Pfr., Mon. Hel. Viv., III, p. 303, 1853; Küster in Chemn. Conch. Cab., ed. ii, *Bulimus* No. 113, pl. 31, figs. 21–23.

Bulimus (*Næsiotus*) *chemnitzioides* Pfr., Vers. Malak. Blatt., p. 160, 1855.

Bulimulus (*Omphalostyla*) *chemnitzioides* H. & A. Ads., Gen. Rec. Moll., ii, p. 161, 1855.

Bulimulus (*Pleuropyrgus*) *chemnitzioides* Martens in Albers Heliceen, ed. ii, p. 221, 1860; Pfr., Nom. Hel. Viv., p. 254, 1881; Reibisch, Isis, 1892, p. 12, t. ii, fig. 4; Stearns, Proc. U. S. Nat. Mus., XVI, p. 381, 1893.

Bulimulus (*Pleuropyrgus*) *lima* Reibisch, Isis, 1892, p. 13, t. ii, fig. 5.

On Chatham Island, at 300–600 feet elevation, with *B. perspectivus* Pfr., on rocks and under stones, Wolf; on the leaves of plants at 1,600 feet elevation, near the southwest end of Chatham Island, Dr. Baur; also Kellett, Habel and the U. S. Fish Commission.

The younger specimens named *lima* by Reibisch though apparently differing somewhat in form, appear to grade directly into the others. This species sometimes shows a small but distinct parietal tooth or callosity, but this is quite exceptional.

Jaw almost membranous, thin, light horn-colored, slightly arcuate, of almost equal height throughout, low, wide, with blunt ends and margins bluntly denticulated by the broad ends of the ribs; anterior surface with about 20 broad, flat ribs, reinforced at their outer edges and separated by very narrow interstices.

Radula long and narrow, formula about $\frac{1}{22+8\cdot 8+22}$; rhachidian tooth tricuspid as in the other species; perfect laterals about eight on each side, bicuspid; marginals low, wide, with one inner long bicuspid cutting point and a shorter wide outer cutting edge broken up into three or more denticles.

The specimens examined anatomically were so much shrunken by the alcohol and had genitalia so little developed that they could not be satisfactorily dissected. This species is connected so closely by such forms as *B. Reibischi* and *B. rugiferus* with the typical *Næsioti* that it is obvious that they should be referred to the same section of the genus. The nepionic whorls are usually decorticated and smooth, but when perfect, show the usual transverse ribbing.

Bulimulus (Næsiotus) Habeli Stearns.

Bulimulus (*Pleuropyrgus*) *Habeli* (Stearns MS.) Dall, Nautilus, Jan., 1892, p. 99; Stearns, Nautilus, Dec., 1892, p. 86; Stearns, Proc. U. S. Nat. Mus., xvi, pp. 382, 428, 1893.

Bulimulus (*Pleuropyrgus*) *terebra* Reibisch, Isis, (Oct.) 1892, p. 14, t. ii, fig. 3.

Chatham Island, Habel, U. S. Fish Commission Steamer Albatross and Dr. G. Baur, under stones near the shore, at the southwest end of the island (typical form); Chatham Island, under stones and on mossy rocks in the moist region, 900–2,000 feet above the sea, Wolf fide Reibisch (*B. terebra*).

The specimen of *B. terebra* submitted by Herr Reibisch is slightly larger, more dull colored and has a more evident umbilicus than the typical specimens of *Habeli* which were obtained in a more unfavorable station, but the differences do not appear to be sufficient to be worthy of a specific name, at least judging from the material I have been able to study. No specimens of *B. Habeli* containing the soft parts have been received by me. The nepionic whorls are usually decorticated and smooth, but when perfect show extremely fine transverse ribbing. In the single specimen I have seen of the variety *terebra* Reibisch the nepionic ribbing is coarser and more evident.

Pupa (Leucocheila ?) Wolfii Miller. Plate XVII, fig. 14.

Pupa (*Leucochila*) *Wolfii* Miller, Reibisch, Isis, 1892, pt. 3, p. 15, t. ii, fig. 11.

Pupa (*Leucochila*) *munita* Reibisch, Isis, 1892, pt. 3, p. 15, t. ii, fig 9.

? *Pupa Eyriesii* Drouet, Essai Moll. Terr. Guyane Française, p. 71, pl. ii, fig. 16–17, 1859.

Guayaquil, Ecuador, Wolf, fide Reibisch, op. cit.; Albemarle Island, on bushes near the shore, Wolf; on bones of dead tortoises, Albemarle Island, Baur; on the trunks of trees, Ilet-la-Mer, French Guiana, Drouet.

Several specimens of a minute *Pupa* were obtained by Dr. Baur adhering to dry bones picked up on Albemarle Island. According to their age these show the following denticles in the aperture: 1. On the body is a deeply grooved prominent tooth which in some specimens is so far bifid as to appear like two slender teeth close to each other, this is present on all the specimens; 2. On the pillar, well up near the body a small but very distinct horizontal lamella, present in all specimens, but less developed in the younger ones; 3. Well within the lip is a series of small short denticles side by side, longer in the direction of the whorls; the first almost vertically below the parietal denticle is small, the next to the right, close to it, is higher, slightly bifid at the tip when most completely developed and longer in an antero-posterior direction than either of the others; the third is small like the first, and the fourth and last (in any of the specimens seen) is still smaller and appears only after the others are well developed. The figure of *P. Wolfii* given by Reibisch shows the parietal, columellar and three basal denticles; in the figure of *P. munita* the fourth basal and another denticle in the angle between the body and the pillar have appeared. Drouet's figure of *P. Eyriesii* has the parietal tooth represented as double, while the columellar tooth is present only two of the basal denticles appear. All these figures are poor and the resemblance between them, allowing for bad drawing, are so close and the differences between the actual specimens I have studied are so great, that I am strongly inclined to believe they will all prove to be the stages of one and the same species. Even Reibisch's *P. clausa* which is somewhat smaller than those above referred to, shows differences of denticulation from *P. Wolfii* not greater than are observable in the different ages of some North American species.

Pupa (Leucocheila ?) clausa Reibisch.

Pupa (*Leucochila*) *clausa* Reibisch, Isis, 1892, pt. 3, p. 15, pl. II, fig. 10.

On bushes near the sea, Indefatigable Island, Wolf.

This form differs from the most fully developed *P. Wolfii* in having one more denticle on the pillar near its base, in having the other teeth more strongly developed, and in being slightly smaller. According to Reibisch it has $4\frac{2}{3}$ whorls, while *P. Wolfii-munita* has from 5 to $5\frac{1}{2}$ turns. It is so difficult to fix on a common point in settling where the first apical whorl ends, that I do not put much confidence in differences of less than a full turn. It can only be decided by study of a large number of specimens whether this species is distinct from the *P. Wolfii* or not, and at present the material is not accessible.

Herr Reibisch wrote in February, 1894, that he had three or four well differentiated species of *Pupa* from different islands, but, so far, I have not noticed any publication of them, and have not been able for eighteen months to obtain any information as to the whereabouts of Herr Reibisch himself.

? Trochomorpha Bauri Dall. Plate XV, figs. 8, 9.

Zonites (*Hyalinia*) *Bauri* Dall, Nautilus, V, p. 98, Jan., 1892.

South Albemarle Island, on weathered bones of tortoises, Dr. Baur.

The single specimen of this interesting form is not quite adult, and the slight angulation at the periphery may be lost in the fully mature shell. The fine spiral striation which characterizes the species recalls that of several Polynesian species. The close resemblance to *T. calculosa* Gould, of Tahiti, leads to the query as to whether the unnamed "*Helix*" collected by Darwin, and said to be identical with a Tahitian species not named, may not have been this species. It can only provisionally be referred to the group *Trochomorpha*, as the animal is unknown.

Conulus galapaganus Dall. Plate XV, fig. 11.

Conulus galapaganus Dall, Nautilus, VII, p. 55, Sept., 1893.

Under leaves at 1,600 feet elevation, southwest end of Chatham Island, Dr. Baur.

This species is close to *C. fulvus* but has five whorls to four in a specimen of *fulvus* of the same diameter. It has a very well marked suture and the whorls between the sutures are more convex than in *fulvus*. The height is greater in *C. galapaganus* in proportion to the number of whorls. It seems to differ from *C. fulvus* and related forms by its smaller size, very brilliant surface, inflated whorls and number of turns. It has no spiral striation like that of *T. Bauri*, and, in short, seems like an elevated, dwarfed inflated *C. fulvus*.

Vitrea chathamensis Dall. Plate XV, figs. 3, 10.

Hyalinia chathamensis Dall, Nautilus, VII, p. 54, 1893.

On dead leaves at an elevation of 1,600 feet, southwest end of Chatham Island, Dr. Baur.

This is a small, thin, straw colored shell, much like *V. arborea* Say, depressed, with four rounded whorls, a distinct suture, the polished surface sculptured with numerous slightly flexuous radial indented lines; the umbilicus is deep, exhibiting all the volutions, but rather narrow. The aperture is like that of *H. arborea*.

Succinea Bettii Smith. Plate XV, fig. 6.

Succinea Bettii Smith, P. Z. S., 1877, p. 72, t. xi, fig. 8.
Succinea Wolfi Reibisch, Isis, 1892, pt. 3, p. 16, t. 2, fig. 12 a-b.

Charles Island, H. M. S. Peterel, U. S. Fish Commission; James Island at James Bay, Dr. G. Baur; Chatham Island, 900–2,000 feet in the moist region, among moss and stones and on herbage, Wolf; South Albemarle Island? on dry bones of turtles, young specimens only, Dr. Baur.

This species very closely resembles the British *S. putris*, the specimen figured by Jeffreys in his British Conchology might almost be interchanged with a specimen from James Island as regards its general form. The Galapagos shell, however, has a less even surface, being somewhat irregularly wrinkled with a dull unpolished aspect.

Succinea brevior Smith. Plate XV, fig. 4; Plate XVI, fig. 8; Plate XVII, fig. 9.

Succinea Bettii var. *brevior* Smith, P. Z. S., 1877, p. 77.
Succinea brevior Dall, Nautilus, VII, p. 56, Sept., 1893.

Found near Black Beach, Charles Island, at about 1,000 feet elevation on the stems of shrubbery; the stems were of a grayish-brown color, covered with small lichens, Dr. Baur.

Jaw arched, high, thick, horn-colored, the ends acuminate and recurved; anterior surface without ribs, cutting edge with a median projection; upper interior margin with a quadrate insertion plate as usual in the genus.

Radula long and narrow, formula $\frac{1}{24+6\cdot6+24}$; rhachidian tooth tricuspid; on each side six bicuspid laterals, each with the usual thinning on the lower edge of the base of attachment; marginals low and wide, the inner cusp larger and longer, bifid, the outer cusp with several denticles; the extreme laterals lose the distinction between the cusps and show a somewhat irregularly serrate cutting edge.

This species closely resembles a small specimen of *S. obliqua* Say, its color is less ruddy and paler than in *S. producta*, but the apex is even more vividly rosy; the axis is pervious in the last whorl, but not as in *S. Bettii* clear to the summit of the shell. It is readily distinguished from either of the other Galapagos species by its short rather blunt spire.

Succinea producta Reibisch. Plate XV, fig. 7; Plate XVI, fig. 10; Plate XVII, fig. 5.

Succinea (*Tapada*) *Wolfi* var. *producta* Reibisch, Isis, 1892, pt. 3, p. 16, t. ii, fig. 12 c.

Chatham Island, 900–2,000 feet elevation, in moist places among moss and stones, Wolf; southwest end of Chatham Island, on damp lava rocks of a blackish color often covered with very small lichens, Dr. Baur.

Jaw light born-color, strong, thick, high, strongly arched with the ends rapidly shortened to a point, the interior upper margin with the usual quadrate insertion plate; anterior surface without ribs, the cutting edge with a short, wide, mesial projection.

Radula long and narrow, formula about $\frac{1}{26+14\cdot14+26}$; rhachidian tooth tricuspid; 14 perfect laterals with two rather widely separated cusps, the outer shorter; the lower edge of the base of attachment thinned out as usual in the genus; marginals low, wide, bicuspid, the cusps subdivided into minor denticles giving a serrate look to the outer marginals.

This species is of a reddish-yellow color, with the apex of a pronounced rosy tint, the surface somewhat rough as in *S. Bettii*, from which it differs by its more produced spire and the manner in which the outer lip is bent over so as to reach the body whorl vertically instead of obliquely. Only young, and very few even of the young, are quite as slender as the one figured by Reibisch. The outer lip in fully adult specimens is more expanded than in *S. Bettii*, both have a gyrate and pervious axis, but the *S. Bettii* has it more open than the other species.

Succinea corbis Dall. Plate XV, fig. 5.

Succinea corbis Dall, Nautilus, VII, p. 55, Sept., 1893.

South Albemarle Island, on dry bones of turtles, Dr. Baur.

Shell small, of two and a half whorls, to which a black mould adheres with tenacity. The first whorl and a half are salmon-pink in the adult, but in the young of that size are pale amber colored. The shell resembles *S. producta* in form, but is smaller and has a more contracted aperture, it is instantly recognized when examined with a good lens, by its surface, which is minutely shagreened all over with an excessively fine network of closely reticulated incised lines. Alt. of shell 7, max. diam. 4·5, extreme length of aperture 4 mm.

The remarkable sculpture is not visible to the naked eye except as a sort of hoary bloom on the surface; under a compound microscope it looks like closely woven basket work. I have examined a great many Succineas without finding any other species possessing this character, but, from the description, *S. solidula* Pfr. from Christmas Island, in the Indian Ocean, must have somewhat such a surface. Mr. Edgar A. Smith (P. Z. S., 1887, p. 518) states that *S. solidula* has "the texture of very fine linen, or minute criss-cross lines," which fairly well describes the surface of *S. corbis*. *S. solidula* exhibits the further peculiarity of having a slight but evident internal thickening of the peristome, but as the specimens of *S. corbis* are all evidently immature or not fully grown, they would show nothing of such a character even if the fully adult possesses it. A close examination of the black earthy substance with which the shells are nearly covered, leads to the suspicion that it is composed of the execreta of the animal itself, as it is laid on in little sausage-like or subcylindrical masses and attached by a dry substance, recalling the silvery streaks left by crawling slugs.

Leptinaria chathamensis Dall. Plate XVI, fig. 9; Plate XVII, fig. 16.

Leptinaria chathamensis Dall, Nautilus, V, p. 98, 1892; Stearns, Proc. U. S. Nat. Mus., xvi, pp. 418, 428, 1893.
Bulimulus (*Pelecostoma*) *cymatoferus* Reibisch, Isis, 1892, pt. 3, p. 14, t. ii, fig. 7.

Chatham Island, on ferns 1,600–2,000 feet above the sea, Dr. Baur; also on dry bones of tortoises, South Albemarle Island, Baur.

Shell small, horn-colored, with a blunt apex and six rounded whorls; suture very distinct, surface polished, delicately marked with lines of growth; base rounded, relatively rather widely umbilicated; aperture with the margin hardly thickened, rounded in front and at the suture; pillar broad, thin; body with a single elevated, thin, sharp lamina, extending spirally inward from a point a little behind the peristome and nearly equidistant from the inner and outer lips; alt. of shell 3.0, max. diam. 1.6 mm.

Analogous forms are found in the mountains of the Panamic region and on several of the Pacific Islands. As all the American species are believed to belong to *Leptinaria*, as distinguished from *Tornatellina*, I have no hesitation in referring this species to the American type. The radula of this form is extremely minute and difficult to find when boiled out in liquor potassæ. I sacrificed several specimens without success, and the tooth figured is from a sketch by Mr. Binney. His slide has deteriorated so much in keeping that I have been unable to find the radula upon it after long scrutiny.

Helicina (Idesa) nesiotica Dall. Plate XV, figs. 1, 2; Plate XVII, fig. 12.

Helicina (*Idesa*) *nesiotica* Dall, Nautilus, v, p. 97, Jan., 1892; Stearns, Proc. U. S. Nat. Mus., xvi, p. 418, 1893.
Helicina Wolfi Reibisch, Isis, 1892, pt. 3, p. 17, t. ii, fig. 13; Stearns, Proc. U. S. Nat. Mus., xvi, p. 416, 1893.

On the leaves of plants 1,600 feet in elevation, near the S.-W. end of Chatham Island, Dr. Baur; Albemarle Island, Reibisch *in litt.*

Shell small, depressed, with rounded periphery, base moderately convex, and peristome not thickened nor reflected; epidermis of a bright reddish chestnut, polished, but with obvious regular incremental lines; base with a thin white callus merging into the lower lip without notch or angle; spire depresssd, suture very distinct, not channelled; operculum smooth, whitish, angulated only at the upper extreme; alt. of shell 2.3, max. diam. 3.3 mm.

This was the first species of the family to be reported from the Galapagos. The type is not known from the west slope of the Andes, though it would be rash to infer that it may not yet be found there; it is present in the Panamic province. Though first obtained from Chatham Island Herr Reibisch writes that he has now received examples from the Albemarle Island.

An examination of the radula shows points of interest. The rhachidian tooth has a distinct cusp which is wanting in the Helicinas heretofore figured; there are one major and three minor laterals. The inner pair are channelled on the back and have a simple outwardly directed cusp; the next is smaller, with the cusp pointing inward. The major lateral appears very differently according to the position in which it is viewed. In the normal position the cusp is large, short with about seven subequal denticles, the base is plain and without accessory projections; the uncini are numerous, close-set, simple and very small. Formula $\frac{1}{\times\frac{1}{7}\,3\cdot3\,\frac{1}{7}\times}$.

Auricula stagnalis Orbigny.

Auricula stagnalis Orbigny, Mag. de Zoöl., 1835, p. 23, No. 3.
Auricula granulina Anton, Verz., p. 48, 1839.
Auricula papillifera Küster, Auric., p. 25, t. 3, figs. 9, 10, 1844.
Ellobium granulinum H. & A. Adams, P. Z. S., 1854, p. 7.
Ellobium stagnale H. & A. Adams, Gen. Rec. Moll., ii., p. 238; Wimmer, Sitzb. k. Akad. Wiss., Wien, Bd. lxxx, p. 44, No. 87, 1879.

Panama and Guayaquil, Orbigny and Adams; Tumaco Island, Cuming; Bindloe Island, Habel fide Wimmer.

Melampus trilineatus C. B. Adams.

Auricula trilineata Adams, Pan. Shells, Ann. Lyc. Nat. Hist., N. Y., V, pp. 436, 543, 1852.
Melampus trilineatus Pfeiffer, Mon. Auric., p. 44, 1856; Wimmer, Sitzb. k. Akad. Wiss., Wien, lxxx, p. 44, 1879.

Panama, Adams; Hood Island, Habel, fide Wimmer.

Tralia panamensis C. B. Adams.

Auricula panamensis Adams, Pan. Shells, Ann. Lyc. Nat. Hist., N. Y., V, pp. 433, 542, 1852.
Tralia panamensis H. & A. Adams, P. Z. S., 1854, p. 10; Wimmer, *op. cit.*, p. 45, 1879.

Hood and Charles Islands, Habel, fide Wimmer; Panama and Taboga, C. B. Adams; Cocos Island, U. S. Fish Commission.

Genus PEDIPES (Adanson) Scopoli.

Pedipes (Adanson) Scopoli, Intr. Hist. Nat., p. 392, 1777.

Pedipes angulatus C. B. Adams.

Pedipes angulata C. B. Adams, Pan. Shells, Ann. Lyc. Nat. Hist., N. Y., V, pp. 431, 542, 1852.
Pedipes angulatus Pfeiffer, Novit. Conch., I, p. 24, t. 6, figs. 26–28, 1854; Wimmer, *op. cit.*, p. 45, 1879.

Panama, Adams; Bindloe Island, Galapagos, Habel, fide Wimmer.

Genus SIPHONARIA Sowerby.[12]

Siphonaria gigas Sowerby.

Siphonaria gigas Sowerby, Tank. Cat., p. vi, No. 808, 1825; Reeve, Conch. Icon., *Siphonaria*, pl. 1, fig. 3.
Siphonaria characteristica Reeve, *op. cit.*, pl. 2, figs. 8 a–b.

Charles Island, U. S. Fish Commission; Peru, Cocos Island, Panama and north to the Gulf of California.

Genus WILLIAMIA Monterosato.

Ancylus sp. (*Gussoni*) Costa, Cat., p. 20, 1829; Scacchi, Cat., p. 18, 1836.
Patella sp. Phil., Enum. Moll. Sicil., I, p. 255, 1836; II, p. 84, 1844.
Nacella sp. Cpr., Ann. Mag. Nat. Hist., 1864, I, p. 474, No. 15; Cooper, Geogr. Cat. Moll., Cala., p. 23, 1867.
Siphonaria (*Liriola*) sp. Dall, Am. Journ. Conch., VI, p. 37, 1870.
Pilidium subg. *Allerya* Mörch, Journ. de Conchyl., Vol. XXV, p. 210, 1877. Not *Allerya* Bourguignat, Atti Accad. Sci. Let. ed. Arti. di Palermo, VI, pp. 1–7, 1876.
Scutulum Monterosato, Ann. Mus. Civ., Genova, IX, p. 427, 1877.
Not *Scutulum* Tournouër, Bull. Soc. Geol. de France, 1869 (*Echinidæ*).
Liriola sp. Dall, Journ. de Conchyl., XXVI, p. 68, 1878.
Anisomyon ? Dall, Journ. de Conchyl., XXVII, p. 287, 1879; (? Meek. Am. Journ. Sci. & Arts, 2, XXIX, p. 33, pl. 1, 1860).
Gadinia sp. Jeffreys, Ann. Mag. Nat. Hist., 1870, p. 11.
Williamia Monterosato, Nom. Conch. Medit., p. 150, 1884.
Umbrella sp. Cossmann, Cat. Coq. Fos. env. Paris, IV, p. 326, 1891.
Parascutum Cossmann, Cat. Coq. Fos. env. Paris, V, p. 78, 1892.

Type *W. Gussoni* (Costa) of the Mediterranean and Azores; other species are the *W. Krebsii* Mörch, West Indies, *W. vernalis* Dall, Monterey, Cala., *W. peltoides* Cpr., of the Gulf of California and south to the Galapagos.

The synonymy of this interesting little genus of *Siphonariidæ* had become so complicated that it seemed best to take this opportunity of clearing it up. The wide distribution of the species is partly due to their habit of perching on floating sea-weeds.

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[12] *Siphonaria scutellum* Deshayes, was referred to the Galapagos Islands by Carpenter, owing to a confusion between its true locality, Chatham Island, New Zealand, with the Galapagos Chatham Island. This species according to Deshayes is identical with *S. obliquata* Sby. described sixteen years earlier in the Tankerville Catalogue.

Williamia peltoides Carpenter.

Nacella peltoides Carpenter, Ann. Mag. Nat. Hist., 1864, i, p. 474, No. 15; Suppl. Rep. Brit. Assoc., 1863, pp. 418, 545.

Nacella subspiralis Carpenter, Proc. Cal. Acad. Sci., iii, p. 213, 1866; Suppl. Rep. Brit. Assoc., 1863, pp. 612, 640.

Siphonaria (*Liriola*) *peltoides* Dall, Am. Journ. Conch., vi, p. 37, 1870; Journ. de Conchyl., xxvi, p. 68, Jan., 1878.

Anisomyon peltoides Dall, Journ. de Conchyl., xxvii, p. 288, Oct., 1879.

Nacella subspiralis Wimmer, Sitzb. k. Akad. Wiss., Wien, lxxx, p. 41, 1879.

Siphonaria (*Williamia*) *peltoides* Stearns, Proc. U. S. Nat. Mus., xvi, p. 384, 1893.

Chatham, Charles and Hood Islands, dead on the beach, Dr. Habel; northward to Panama, Mazatlan, Cape St. Lucas, San Diego and the Santa Barbara Islands, California. The variety *vernalis* Dall, which will require to be specifically separated from *peltoides*, extends from the Santa Barbara Islands northward to Monterey, Purissima, Lobitas and Crescent City, California. It is much larger than either of the others.

The *Nacella subspiralis* and *peltoides* of Carpenter are undoubtedly conspecific with the Galapagos shell, which from its perching habit on fronds of *Laminaria* may be widely distributed by ocean currents. The well known *Ancylus Gussoni* of Costa belonging to the South European fauna is congeneric, and from the shells alone it is doubtful if the species could be separated. The *W. Krebsii* of Mörch is extremely similar, and it is possible that all three should be specifically united, but until the anatomy has been compared it is probably best to keep them distinct. I figured the dentition and jaw of *W. vernalis* and *W. Gussoni* in the *Journal de Conchyliologie* in 1878 and 1879, showing specific differences between them, but the West Indian and West American tropical forms have not yet been examined.

M. Cossmann has described a species, *W. Raincourti*, from the Eocene of Chaumont, Paris Basin, which differs from the recent species in being radially striate; this seems to partially bridge the gap between the latter and the upper Cretaceous *Anisomyon*.

Onchidium Lesliei Stearns.

Onchidium Lesliei Stearns, Nautilus, VI, p. 87, Dec., 1892; Proc. U. S. Nat. Mus., XVI, No. 942, p. 383, pl. 51, figs. 2, 3, 1893.

Living between tide marks on Charles and Albemarle Islands, U. S. Fish Commission.

Dr. Stearns' description is as follows:

"Form rounded ovate, nearly as broad as long. Dorsum coriaceous, nearly black, shiny, closely irregularly reticulated with finely incised lineation, and otherwise characterized by somewhat distant, flatly rounded papillæ. Under side dingy, yellowish white; margin of mantle wide, nearly smooth; edge of same simple. Anal opening posterior near edge of mantle and somewhat produced. Respiratory orifice smaller, in median line with and in front of anus; sexual orifice anterior, on the right side under the edge of the large oral hood or collar; labial palpi thin, largely expanded. Dimensions: Length 37.5; breadth 31.5 millimeters. These proportions vary slightly in different individuals."

Onchidella Steindachneri Semper.

Onchidella Steindachneri Semper, Arch. Phil. Bd. III, Heft. VI, p. 295, 1883; Stearns, Proc. U. S. Nat. Mus., XVI, p. 384, pl. 51, figs. 4, 5, 1893.

Charles Island, Habel; Charles and Albemarle Islands, between tide-marks, U. S. Fish Commission.

Dr. Stearns' remarks are as follows:

"A well marked species; edge of mantle prettily fringed on the under side with rather regularly placed trifoliate processes; dorsum entirely covered with closely set, rounded, granular papillæ, which also cover the surface of the wide mantle margin beneath, up to the edge of the creeping disk. Color dark grayish or smoky black above; dingy whitish on the under side. Anal orifice posterior, central just behind the end of the creeping disk? Respiratory orifice on the right side near the vent; sexual orifice anterior near the tentacle or oral appendage, under the edge on the right side. Length about 20, breadth about 17 millimeters. These proportions vary somewhat in different specimens. Some allowance must be made for the contraction caused by the alcohol in both the above and *O. Lesliei.*

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Sowerby, George Brettingham. Conchological Illustrations, Bulinus, parts 31, 34, 35 and 142, 1833–41. London, G. B. Sowerby, 1841, 8°.

This work was issued in parts and when completed the letter press, or portions of it, was reprinted and the whole issued as a volume dated 1841. The parts in the copies which I have seen do not have any dates, but Pfeiffer cites the list of *Bulinus* as 1833 (Mon. Hel. Viv., i, p. xxxii, 1848). It is probable that part 142, containing *B. rugulosus* was issued in 1839, but the plates containing the other Galapagos species may be as early as 1833.

Sowerby, George Brettingham. Descriptions of new species of shells collected by Hugh Cuming. Proc. Zool. Society of London, 1833, part i, pp. 72–74.

This article contains descriptions of several species of *Bulimulus* afterward figured in the Conchological Illustrations.

BRODERIP, WILLIAM JOHN. Description of new species of shells collected by Hugh Cuming. Proc. Zool. Society of London, 1832, p. 125.

Though this is the first reference to Cuming's Galapagos land shells, only one species, *B. nux*, is described from Charles Island.

PFEIFFER, DR. LUDWIG. Description of thirty new species of Helicea belonging to the collection of H. Cuming, Esq. Proc. Zool. Society of London, 1846, pp. 28–29.

This article describes two new species of *Bulimulus* collected by Charles Darwin at the Galapagos Islands.

DARWIN, CHARLES. Journal of Researches into the Natural History and Geology of the countries visited during the voyage of H. M. S. Beagle round the world, under the command of Captain Fitz Roy, R. N. New York, D. Appleton & Co., 1882, 8°. X, 519 pp. from the second English edition of 1860. See Chapter xvii, pp. 372–401, and especially the notes on mollusca, pp. 390–91.

This celebrated work first appeared in parts 1844–45, and was published by Murray. The "Zoology of the Beagle" edited by Darwin, contains no reference to the mollusca collected.

FORBES, PROF. EDWARD. On the species of mollusca collected during the surveying voyages of the Herald and Pandora by Captain Kellett, R. N. C. B., and Lieutenant Wood, R. N. Proc. Zool. Society of London, 1850, pp. 53–56.

In this article the *Bulimulus chemnitzioides* and *achatellinus* Forbes, upon which two subgenera have subsequently been founded, are described and other species collected at the Galapagos Islands are enumerated with comments. All are said to have been collected on Chatham Island.

ALBERS, JOHANN CHRISTIAN. Die Heliceen, nach natürlicher Verwandtschaft systematisch geordnet. Berlin, Enslin, 1850, 8°, 262 pp.

In this volume, pp. 162–3, the Galapagos Bulimuli are grouped together under the name of *Næsiotus.* In the second, posthumous edition, (Leipzig, Englemann, 1860) issued under the supervision and revision of von Martens, *Nesiotes* is substituted for the earlier name, and two of the species set off into new sections; for *chemnitzioides* the name *Pleuropyrgus* is proposed, and Forbes' *achatellinus* is removed to *Buliminus* (where it does not belong) and made the type of the subgenus *Rhaphiellus,* following Pfeiffer (Vers. einer Anordnung der Heliceen, Malak. Blätt, ii, pp. 112–160, 1856).

REEVE, LOVELL. Conchologia Iconica, v, Mon. Bulimus, 1848–50. London, Reeve, Benham & Reeve, 1850, 4to.

Most of the species described at that time from the Galapagos are more or less accurately figured in this work.

CARPENTER, DR. PHILIP PEARSALL. Report on the present state of our knowledge with regard to the mollusca of the west coast of North America. Report of the British Association for the Advancement of Science for 1856. London, Taylor & Francis, 1857, 8°.

The mollusks of the Galapagos Islands are discussed and enumerated pp. 358–62. These include twenty species of Pulmonates.

Smith, Edgar A. Account of the Zoological Collection made during the visit of H. M. S. Peterel to the Galapagos Islands. Mollusca. Proc. Zool. Soc. London, 1877, pp. 72–3.

Three of the already known species are enumerated, and *Succinea Bettii* Smith with its variety *brevior* are described as new.

Ancey, C. F. Nouvelles contributions malacologiques, vi; Etudes sur la faune malacologique des îles Galapagos. Bull. Soc. Malac. de France, iv, pp. 293–299, July, 1887.

A new species and several new varieties are described and the fauna briefly discussed.

Wimmer, August. Zur Conchylien-Fauna der Galapagos Inseln. Sitzber. der k. Akad. der Wissenschaften, Wien Bd. lxxx, pp. 1–50, Dec., 1879.

This paper, based chiefly on the shells collected by Dr. Habel, refers to two species of *Bulimulus* and four *Auriculidæ*, the latter all new to the fauna.

Dall, William Healey. On some types new to the fauna of the Galapagos Islands. Nautilus, Jan., 1892, Vol. v, pp. 97–99.

In this short article the presence of *Pupa* is announced, and *Helicina* (*Idesa*) *nesiotica*, *Leptinaria chathamensis*, *Zonites* (*Hyalinia*) *Bauri* and *Bulimulus* (*Pleuropyrgus*) *Habeli* (Stearns, MS.) are described from collections made by Drs. Habel and Baur.

Reibisch, Paul. Die conchyliologische Fauna der Galapagos Inseln. Abh. Ges. Isis in Dresden, iii, pp. 1–20, taf. i–ii, October, 1892.

This paper discusses the land shells of the group and is chiefly based upon the collections of Dr. Wolf, Government geologist of Ecuador, though referring to collections made by others. A large number of forms supposed to be new are described and figured.

Stearns, Dr. R. E. C. Scientific results of explorations by the U. S. Fish Commission Steamer Albatross, No. xxv. Report on the mollusk fauna of the Galapagos Islands with descriptions of new species. Proceedings of the U. S. Nat. Mus., xv, No. 942, pp. 353–450, pl. 50–52, August, 1893.

This important paper discusses the mollusk fauna of the islands at large, both land and marine forms, especially those of shallow water and the shores. The deeper dredgings from the last expedition are not included and will be worked up later. References to previous lists of the fauna are very full and the discussion of the land shells includes some suggestions of serious importance.

Dall, William Healey. Preliminary notice of new species of land shells from the Galapagos Islands collected by Dr. G. Baur. Nautilus, September, 1893, Vol. vii, pp. 52–56.

In this article *Bulimulus* (*Næsiotus*) *duncanus*, *B. amastroides* Ancey var. *Anceyi*, *B. jacobi* var. *vermiculatus*, *B. olla*, *B. tortuganus*, *B. Bauri*, *Hyalinia chathamensis*, *Conulus galapaganus* and *Succinea corbis* are described as new, and the relationship of the *Næsioti* to the North American Bulimuli of the type of *serperastrus* is pointed out.

DALL, WILLIAM HEALEY. New species of land shells from the Galapagos Islands. Nautilus, March, 1895, Vol. viii, pp. 126–7.

Bulimulus (*Næsiotus*) *Reibischi* and *B. Tanneri* are described as new.

EXPLANATION OF PLATES.

NOTE.—Since the figures are of different degress of magnification, the length of each shell in millimeters follows the reference to each figure.

PLATE XV.

Fig. 1. *Helicina* (*Idesa*) *nesiotica* Dall, base, lat. 3.7 mm.; p. 451.
Fig. 2. *Helicina* (*Idesa*) *nesiotica* Dall, profile; p. 451.
Fig. 3. *Vitrea chathamensis* Dall, base, lat. 3 mm.; p. 448.
Fig. 4. *Succinea brevior* Smith, alt. 12 mm.; p. 449.
Fig. 5. *Succinea corbis* Dall, alt. 7.0 mm.; p. 450.
Fig. 6. *Succinea Bettii* Smith, alt. 12 mm.; p. 448.
Fig. 7. *Succinea producta* Reibisch, alt. 11.5 mm.; p. 449.
Fig. 8. *Trochomorpha? Bauri* Dall, alt. 1.5 mm.; p. 447.
Fig. 9. *Trochomorpha? Bauri* Dall, base, lat. 2.2 mm.; p. 447.
Fig. 10. *Vitrea chathamensis* Dall, lat. 3 mm.; p. 448.
Fig. 11. *Conulus galapaganus* Dall, lat. 2.5 mm.; p. 448.
Fig. 12. *Bulimulus Bauri* Dall, alt. 10 mm.; p. 441.
Fig. 13. *Bulimulus curtus* Reibisch, alt. 9.6 mm.; p. 442.
Fig. 14. *Bulimulus canaliferus* Reibisch, alt. 9.5 mm.; p. 442.
Fig. 15. *Bulimulus* sp. n., alt. 11.5 mm., from photograph; p. 444.
Fig. 16. *Bulimulus amastroides* Ancey, alt. 10 mm.; p. 441.

PLATE XVI.

Fig. 1. *Bulimulus nesioticus* Dall, alt. 12 mm.; p. 443.
Fig. 2. *Bulimulus olla* Dall, alt. 15 mm.; p. 437.
Fig. 3. *Bulimulus planospira* Ancey, alt. 19.25 mm.; p. 432.
Fig. 4. *Bulimulus Reibischi* Dall, alt. 10.5 mm.; p. 444.
Fig. 5. *Bulimulus Tanneri* Dall, alt. 11 mm.; p. 438.
Fig. 6. Genitalia of *Bulimulus nux* var. *incrassatus* Pfr. considerbly magnified; the male and female orifices (IX, X) open into a single vestibulum and are separated here by an accident of dissection; I, albumen gland; II, hermaphoditic duct; III, ovotestis; IV, oviduct or uterus; V, prostate; VI, retractor penis; VII, penis sac; VIII,

vas deferens; IX, male; and X, female orifice, accidentally parted; XI, duct of spermatheca; XII, spermatheca. From a drawing by W. G. Binney, Esq., p. 429.

Fig. 7. *Bulimulus duncanus* Dall, alt. 17.5 mm.; p. 438.

Fig. 8. *Succinea brevior* Smith, camera lucida outline of jaw, considerably magnified; p. 449.

Fig. 9. *Leptinaria chathamensis* Dall, alt. 3.5 mm.; p. 451.

Fig. 10. *Succinea producta* Reibisch, outline of jaw, magnified, from camera lucida sketch; p. 449.

Fig. 11, 12, 13. *Bulimulus Simrothi* Reibisch (*tortuganus* Dall) showing variation in individuals and character of surface; alts. respectively 12.25, 11.0 and 10.75 mm.; p. 440.

Fig. 14. *Bulimulus cinereus* Reibisch, alt. 8.5 mm.; p. 437.

Plate XVII.

Figures all drawn from camera lucida sketches.

Fig. 1. Jaw of *Bulimulus rugulosus* Sby., much magnified; p. 431.

Fig. 2. Jaw of *Bulimulus Simrothi* Dall; p. 440.

Fig. 3. Teeth of *Bulimulus ventrosus* Reibisch, central and inner lateral, 3a two extreme outer laterals or marginals; p. 434.

Fig. 4. Rhachidian and innermost lateral teeth of *Bulimulus chemnitzioides* Forbes; 4a, three of the outermost laterals; p. 445.

Fig. 5. Rhachidian, inner lateral and 5a, two outer lateral teeth of *Succinea producta* Reibisch; p. 449.

Fig. 6. Rhachidian and adjacent laterals and 6a, one of the outermost laterals of *Bulimulus unifasciatus* Sby.; p. 439.

Fig. 7. Rhachidian tooth and adjacent laterals and 7a, two outer laterals of *Bulimulus Bauri* Dall; p. 441.

Fig. 8. Rhachidian tooth, adjacent laterals and 8a, two outer laterals of *Bulimulus curtus* Reibisch; p. 442.

Fig. 9. Rhachidian tooth, adjacent lateral and 9a, two more marginal laterals of *Succinea brevior* Smith; p. 449.

Fig. 10. Rhachidian and two adjacent lateral teeth and 10a, an outer lateral and marginal tooth of *Bulimulus nux* var. *incrassatus* Pfr.; p. 429.

Fig. 11. Jaw of *Bulimulus unifasciatus* Sby.; p. 439.

Fig. 12. Rhachidian tooth, laterals of one side and part of the uncini of *Helicina nesiotica* Dall; p. 451.

Fig. 13. Jaw of *Bulimulus achatellinus* Forbes; p. 428.

Fig. 14. *Pupa Wolfii* Miller (*Bauri* Dall, MS.) alt. 2.5 mm.; p. 446.

Fig. 15. Jaw of *Bulimulus Bauri* Dall; p. 441.

Fig. 16. Single tooth of *Leptinaria chathamensis* Dall, from a sketch by W. G. Binney, much magnified; p. 451.

AUGUST 4.

The President, SAMUEL G. DIXON, M. D., in the Chair.

Twelve persons present.

A paper entitled "New and Interesting Eocene Mollusca of the Gulf States," by Gilbert D. Harris, was presented for publication.

AUGUST 11.

MR. BENJAMIN SMITH LYMAN, in the Chair.

Seven persons present.

AUGUST 18.

MR. BENJAMIN SMITH LYMAN, in the Chair.

Seven persons present.

AUGUST 25.

The President, SAMUEL G. DIXON, M. D., in the Chair.

Thirteen persons present.

Mr. Thomas Chalkley Palmer was elected a member.

The following was ordered to be printed:—

ON THE HEMIPENES OF THE SAURIA.

BY E. D. COPE.

In the course of preparation of a work on the scaled reptiles of North America for the Smithsonian Institution, it has become necessary to examine some neglected parts of the anatomy. This I have recently done for the hemipenes of the Ophidia, with results of considerable importance to the systematic indications.[1] In the present paper I give the results of a similar investigation into the corresponding part of the anatomy of the lizards. Very little attention has been given to the subject hitherto, and our knowledge up to 1856[2] is thus summarized by Stannius: "A duplication or bifurcation of each organ is present in *Lacerta* and in *Platydactylus guttatus*. The copulatory organs of the Chamaeleonidæ are distinguished by their shortness. In various Varanidae which have been investigated the internal cavity (external when protruded) has transverse concentric folds. A fissure interrupts these folds so that they are not complete annuli. The extremity is acuminate and expands at the base, forming a kind of glans."

In 1870[3] J. E. Gray describes and figures this organ of *Varanus heraldicus*, giving the best illustration that I know of. Besides these references I know of nothing later.

As was to have been anticipated, I have found these organs to correspond with the rest of the structure, and to furnish invaluable aids to the determination of affinities among the Sauria. Reference to them cannot be omitted henceforth in cases where the other characters render the question of affinity uncertain.

In the Sauria the male intromittent organ or hemipenis, presents much variety of structure, showing some parallels to the corresponding part in the snakes. It is, however, rarely spinous, as is so generally the case in the Ophidia, the only spinous forms being, so far as I have examined, the American Diploglossinæ and genera allied to *Cophias*. The higher Sauria have the apical parts modified as

[1] Transactions of the American Philosophical Society, 1895, p. 187.

[2] Zootomie der Amphibien, p. 266.

[3] Annals Magaz. Nat. History, 1870, VII, p. 283.

in the Ophidia, by the presence of calyculi. Such are characteristic of the Rhiptoglossa and Pachyglossa. The Nyctisaura possess the same feature. The Diploglossa, Helodermatoidea and Thecaglossa have the organ flounced, the flounces often pocketed or repand on the margin. In the Leptoglossa we have laminae only; in the Tiidæ mostly transverse, and in the Scincidae mostly longitudinal. In various genera terminal papillæ are present. The organ may be simple or bifurcate or merely bilobate. I have not met with the case so common in Ophidia, where the sulcus spermaticus is bifurcate and the organ undivided.

The structures of the hemipenis have a constant systematic value. As in the Ophidia, the value differs with the character, but it varies from generic to superfamily in rank.

In the Chamaeleonidæ the greater part of the surface of the hemipenis is coarsely calyculate, generally in a transvere direction. There are remarkable papillæ at the apex, which differ in the different forms. In *C. pardalis* there is a kind of membranous apron proximad of the papillæ which presents an apex proximad opposite to the sulcus spermaticus. In *C. vulgaris* and *C. gracilis* the papillæ are erect, laminiform and transverse and serrate on the edges. The principal pair have a few papillæ in front of and behind them, and in *C. gracilis* there is, behind these, on each side, an oval body which is composed of three serrate laminæ packed obliquely together. In *C. gracilis* the proximal laminæ are low and have a margin of acute tubercles, and each serves as a collar to a much larger papilla. The latter is largely free and tongue-shaped, with the apex proximad, and its flat external surface is covered with three or four rows of conic papillæ.

I have had the opportunity of examining the hemipenis of a relatively small number of species of the Agamidae; the surface is generally calyculate. I have not found terminal papillæ in the genera *Uromastix, Agama, Liolepis, Physignathus* or *Calotes.* The general construction is, that opposite the sulcus spermaticus is a strong longitudinal welt. Near the apex this welt becomes adherent to the side on which the sulcus runs, dividing the organ into two apical portions. The sulcus bifurcates and passes along the base of this partition. In *Liolepis* there are two welts enclosing a smooth space between them. In *Calotes cristatellus* there is a lesser welt on each side of the principal one. In all the genera the basal part is smooth, and it is sometimes thrown into longitudinal folds.

I have examined the hemipenis in thirty species of the Iguanidæ of the following genera: *Anolis, Xiphocercus, Polychrus, Basiliscus, Ctenosaura, Cyclura, Iguana, Corythophanes, Sauromalus, Crotaphytus, Dipsosaurus, Sceloporus, Callisaurus, Holbrookia, Enyalioides, Doryphorus, Microlophus, Uraniscodon* and *Phrynosoma.* These differ in the bifurcation of the organ, varying from undivided (*Cyclura, Iguana*) to deeply bifurcate (*Anolis, Doryphorus, Microlophus, Uraniscodon*). Other differences are seen in the number of welts and their surface structure, and the distribution and size of the calyces. Thus the calyces extend to the base in *Anolis,* but are confined to the apex in *Crotophytus.* They exist in series only in *Cyclura, Iguana, Ctenosaura, Corythophanes* and *Sauromalus.* They cover most of the organ in *Sceloporus* and *Phrynosoma.* The systematic arrangement of the genera in accordance with the characters is as follows:

I. Calyces always present.

A. Three welts, one opposite the sulcus spermaticus and one parallel on each side of it transversely laminate: CTENOSAURA, CYCLURA, IGUANA, CORYTHOPHANES, SAUROMALUS, CROTAPHYTUS.

B. Three welts; one opposite sulcus, the others on each side of sulcus converging to median welt, and enclosing spaces with it; surfaces calyculate.

ꭓ Median welt confluent proximad: DIPSOSAURUS, LIOCEPHALUS, PHRYNOSOMA.

ꭓ ꭓ Median welt projecting free proximad: CALLISAURUS, HOLBROOKIA.

C. No median welt; lateral welt from sulcus: SCELOPORUS.

D. A median, no lateral welts; calyculate.

ꭓ Not bifurcate; welt wide: ENYALIOIDES (calyces coarse).

ꭓ ꭓ Bifurcate; welt long and narrow: ANOLIS (calyces minute).

E. No welts.

ꭓ Deeply bifurcate; calyces confined to branches: MICROLOPHUS, URANISCODON, DORYPHORUS.

ꭓ ꭓ Shortly bifurcate; calyces extending proximad of branches: BASILISCUS.

II. No calyces or welts.

ꭓ Bifurcate; surface coarsely wrinkled: POLYCHRUS.

In the genera *Ctenosaura, Cyclura, Iguana, Sauromalus* and *Enyalioides* (*laticeps*) the organ is entire; in the others it is bilobate or bifurcate.

Of the Nyctisaura I have examined the hemipenis in the genera *Thecadactylus, Platydactylus, Phyllodactylus* and *Gymnodactylus*. In these this organ is short and wide, appropriately to the fragility of the tail. It is also more or less deeply divided into two branches. The entire surface is calyculate, generally minutely so. In *Thecadactylus* each fork has three strong welts. In *Platydactylus* there is a welt opposite the sulcus which is very large in *P. aegyptiacus*, and divides, sending a half into each branch. In *Gymnodactylus pulchellus* the welts are not so heavy, below the bifurcation is a welt which encloses a circular area which is incomplete proximad. In *Eublepharis* the hemipenis is closely similar to that of the Gecconidæ. It is short and deeply bifurcate; it has a single prominent welt. The surface of this is smooth, but the remainder of the surface is calyculate.

Of the Zonuridæ I have only seen the hemipenis of *Z. cordylus*. It is short and swollen, so that the spiral structure is accentuated; there is a rigid welt opposite the sulcus, which leaves a triangular space at one side proximad, which is finely calyculate. On the opposite side of the welt distad, is a wide space with radiating laminæ from a smooth center. The presence of calyculi noted is exceptional in the *Diplogossa*, and indicates approximation to the *Pachyglossa* as far as it goes.

In the Anguidæ the hemipenis presents well marked characters, which distinguish the genera and perhaps the subfamilies. In *Celestus* the extremity carries an osseous spicule of relatively large size. Distad of the flounces are more (*C. stenurus*) or less (*C. badius*) numerous longitudinal series of recurved osseous spines which are longer near the sulcus spermaticus. In *C. stenurus* the flounces are apiculate at regular intervals; organ undivided. In the Gerrhonotinæ the flounces are cupped and continue to the apex without spines; in *Barissia* and *Gerrhonotus* the organ is bifurcate, in *Elgaria* simple. In *Anguis* a welt on each side of the sulcus has tubercular cross-ridges, and the remainder of the surface is marked with oblique folds with tubercular margins forming a chevron which is directed distad. In *Pseudopus apus* the organ is not symmetrical. Opposite the sulcus is a low, broad, smooth welt, and on each side the sulcus is margined by a thin welt or lip. This is coarsely plicate transversely, the plicae extending to the welt. On the other side, the transverse plicae terminate at a band of fine longitudinal folds. In *Ophisaurus* the organ is undivided, and there is a welt with one edge and the proximal end free. It is covered with robust papillæ.

In Xantusiidae the hemipenis is bifurcate and is shortened as in many Gecconidae, appropriately to the fragile tail. There is a welt on each side of the sulcus spermaticus which follows a short spiral direction. Opposite to the sulcus are two short, thick welts, which have the direction of parts of consecutive threads of a screw. All of the welts are deeply cross-folded.

In the Tiidæ two types may be observed of the structure of the hemipenis, but I have not had access to sufficient material to enable me to refer all the genera to the one or the other. In the typical members, as in the genera *Dracaena, Tupinambis, Amiva* and *Cnemidophorus*, the pattern consists of numerous delicate, imbricate, transverse laminæ which are closely applied to each other. Opposite the sulcus all the genera display a welt, which has free borders. These are entire in *Dracaena* and pectinate in *Amiva* and *Cnemidophorus;* between these and the borders of the sulcus is a rounded welt on each side. The laminæ are sublongitudinal, diverging proximad from the sulcus; on the first welt they turn sharply distad; between this and the welt they make a second chevron distad, turning proximad. Proximad of the median welt these laminæ meet, forming a curve or chevron turned proximad. In *Cnemidophorus* there is one less chevron. In this genus and *Amiva* there is a strong, fleshy papilla at the apex of each tract between the welt and sulcus.

A modification is seen in *Centropyx* (*pelviceps*). Here there is a narrow welt opposite the sulcus; on each side of the sulcus a prominent welt diverges from it proximad and approaches the proximal end of the median welt, so as to enclose a space with it. It is transversely plicate and the enclosed space on each side the median welt has the delicate transverse lamination characteristic of the Tiidæ. What is entirely peculiar is the presence at the apex of each of the laminate spaces of a large patch of acute flexible papillæ.

The plan is the same in *Anadia bogotensis*, but the details are different. The organ is bifurcate. A strong welt opposite the sulcus is divided into fine longitudinal folds, which are crimped transversely. The space between this and the sulcus is marked with folds which diverge distad from the welt and become longitudinal, and are transversely crimped. In the longitudinal direction of the plicæ this genus differs from the Tiidæ, and it is likely that *Ecpleopus* and other allied genera are similar.

In a third type represented by *Heteroclonium bicolor*,[4] a welt bounds the sulcus on each side. The space between these is marked by a few feeble cross folds, and the borders support a single series of closely placed recurved spines. Genera allied to *Cophias* are likely to present this structure.

Of the Lacertidae I have examined the hemipenis in the genera *Lacerta*, *Acanthodactylus* and *Latastia*. They are bifurcate and bilobate. In each division and proximad to it is an oval area with transverse laminæ surrounded by a welt. In *Acanthodactylus* one of the areas is marked by longitudinal folds.

Among the Gerrhosauridae, the hemipenis of *Gerrhosaurus nigrolineatus* has on its distad third, three welts opposite the sulcus, the median larger, all finely cross folded. Between one of these and the sulcus is a tract of coarse papillæ; between the other and the sulcus the surface is smooth.

Of the Scincidae I have examined the hemipenis in *Trachysaurus*, *Lepidothyris* (*fernandii*), *Euprepis* (*carinatus*), *Eumeces* and *Mabuia*. They are smooth and with more or less numerous longitudinal folds, excepting in *Trachysaurus*. Here the laminæ diverge from the sulcus proximad and turn to a horizontal direction, meeting opposite the sulcus in a chevron directed distad. In *Euprepis carinatus* and *Eumeces obsoletus* some of the plicæ are cross-ribbed. In *Lepidothyris fernandii* the organ is shortly bifurcate, and each division has a membranous welt next the adjacent division.

In the Anniellidae the genus *Anniella* has the entire surface from one side of the sulcus to the other, thrown into transverse folds or

[4] Heteroclonium bicolor gen. et. sp. nov.

Char. gen. Frontonasal plates separating nasals; prefrontals and frontoparietals absent; nostril in suture between nasal and first labial plate; no interparietal. Limbs rudimental, two pairs; digits 4–1, the anterior clawed. No femoral pores. Different from *Sesquipes* (type *Cophias heteropus* Licht. Blgr.) which has the digits 4–2; and *Microdactylus* when they are 3–3. *Char. specif.* Scales in annuli of 28 scales, which are angular at the extremities, and alternate with those of the adjacent rows. Labials 5–6; temporals 2–2–2. Three large preanal plates, longer than wide. Tail long obtuse, hind legs minute. Anterior digits short, subequal. Brown above, separated abruptly on each side from the darker brown of the sides and lower surfaces. Chin and throat yellowish. Scales of upper surface each with a bluish spot. Total length 130 mm., length to vent 78 mm. Bogota; Philadelphia Museum Coll. Two specimens.

flounces, which are so wrinkled as to be more or less pocketed, much as in *Gerrhonotus* (*Elgaria*). Organ undivided.

Of the Amphisbaenidae the only species of which I have obtained a satisfactory hemipenis is the African *Monopeltis galeatus* Hallow. The organ is bifurcate; each branch is marked with fine, close, transverse folds, while the region proximad to these has coarser folds directed transversely and obliquely.

SEPTEMBER 1.

MR. CHARLES MORRIS, in the Chair.

Eleven persons present.

The deaths of Henry C. Ford, August 17, and of George M. Conarroe, August 25, members, were announced.

SEPTEMBER 8.

The President, SAMUEL G. DIXON, M. D., in the Chair.

Fifteen persons present.

SEPTEMBER 15.

The President, SAMUEL G. DIXON, M. D., in the Chair.

Twelve persons present.

Papers under the following titles were presented for publication :—

"Fossil Bones of Birds and Mammals from Grotto Pietro Tamponi and Grève St. Alban." By R. W. Shufeldt, M. D.

"Contributions to the Zoology of Tennessee. No. 4. Mollusks." By Samuel N. Rhoads and Henry A. Pilsbry.

SEPTEMBER 22.

The President, SAMUEL G. DIXON, M. D., in the Chair.

Fifteen persons present.

SEPTEMBER 29.

The President, SAMUEL G. DIXON, M. D., in the Chair.

Twenty-three persons present.

Papers under the following titles were presented for publication :—

"Mammals collected by Dr. A. Donaldson Smith during his Expedition to Lake Rudolf, Africa." By Samuel N. Rhoads.

"The Hymenoptera Collected by Dr. A. Donaldson Smith in Northeast Africa." By William J. Fox.

The following were elected members:—J. Howard Breed, Effingham B. Morris, Curwin Stoddart, Jr. and Mrs. F. G. Dixon.

The following were ordered to be printed:—

NEW AND INTERESTING EOCENE MOLLUSCA FROM THE GULF STATES.

BY GILBERT D. HARRIS.

The following new or interesting fossils belonging to the Lea Memorial Collection of the Academy of Natural Sciences of Philadelphia have been put into my hands for description and illustration by Rev. L. T. Chamberlain, of New York City. The greater part of them were collected by Mr. C. W. Johnson during the summers of 1894 and 1895. They are not all new species; but many are in such an excellent state of preservation that it has seemed worth while to have them figured by the skilled pen-artist, Dr. J. C. McConnell, of Washington, D.C.

JACKSON STAGE.

Pecten claibornensis Con. Pl. XVIII, figs. 1 and 2.

This species has been frequently referred to, but has not heretofore been figured.

Locality, Jackson, Miss.

Leda regina-jacksonis n. sp. Pl. XVIII, fig. 3.

This fine species is the Jackson representative of *L. opulenta* Con. of the Claiborne sand. It differs, however, from that species (a) in having finer, rounder and not depressed concentric striæ; (b) in having directly below the umbo a peculiar, straight, ventral margin for some distance; (c) in being less nasute posteriorly, and (d) in having the concentric lines on the post-umbonal slope less strongly marked and less distinctly interrupted and deflected by a radiating depression.

Locality, Jackson, Miss.

Meretrix pearlensis n. sp. Pl. XVIII, figs. 4 and 5.

The general characters of the species are shown by the figures. The concentric striation is precisely that of *Meretrix perovata* var. *aldrichi* (Bull. Am. Pal., No. 1, p. 48, pl. 1, fig. 1) and the young of these two forms sometimes approach each other closely in outline, yet there is always noticeable in *pearlensis* a tendency to become elongate, like *M. lævigata* of the Paris Basin.

Instead of making this a new species, we might speak of it as a marked variety of *aldrichi*, which itself is a variety of *perovata* Con. It seems to us, however, better to designate it by a new name. A variety of this species shows concentric liræ over its entire outer surface.

Locality, Jackson, Miss.

Tellina eburneopsis Con. Pl. XVIII, fig. 6.

Locality, Jackson, Miss.

Mactra mississippiensis Con. var. Pl. XVIII, fig. 7.

Locality, Jackson, Miss.

Periploma sp. Pl. XVIII, fig. 8, 8a, 8b.

Owing to the descriptions by Lea and Meyer of two fragmentary specimens of *Periploma*, it is now unsafe to propose a new name for this specimen. It differs considerably from either Lea's or Meyer's figures and diagnoses, but Meyer has stated (Ber. über die Senck. Nat. Ges. in Frank. A. M., 1887, p. 16) that his *P. complicata* occurs at Jackson.

Locality, Jackson, Miss.

Eucheilodon creno-carinata Heilp. Pl. XVIII, fig. 9. Proc. U. S. Nat. Mus., Vol. 3, 1880, p. 150.

Several specimens of this species, of a moderate size and rather imperfect, are among the Jackson material of this collection. A specimen, perhaps the adult of this species, is shown by fig. 9, pl. XVIII. The humeral carina, instead of being simply finely crenulate, is regularly nodular; moreover, there are thin, strong, revolving ribs on the part of the whorl below the carina. It is quite possible this should be regarded as a distinct species, yet it is unsafe to propose a new name until more material is at hand.

Locality, Jackson, Miss.

Pleurotoma (Ancistrosyrinx) columbaria Ald.

Aldrich described this species (Geol. Surv. Ala., Bull. 1, 1886, p. 31, pl. 6, fig. 9) from a fragment. The Lea Memorial Collection possesses a least one perfect specimen. Hence, in continuation of Aldrich's description it may be said: aperture slightly exceeding the spire in length; from the dentate carina downward on the body whorl to the end of the canal, there are many granular spiral lines; from the dentate carina toward the suture above, two coarse granular spiral lines are found; inside of these spirals the humeral zone is smooth, save faint traces of deeply curved longitudinal lines, the retral curvature is confined to this smooth zone.

Harpa jacksonensis n. sp. Pl. XVIII, fig. 10.

Specific characterization.—Size and general form as indicated by the figure; volutions 8; 1 and 2 very minute, smooth; 3 much larger, smooth; 4 somewhat larger than 3, showing vertical costæ in its first half, then assuming the characteristic markings of the remaining whorls; costæ on the body-whorl nine in number, somewhat deflected below the suture, as in *Drillia;* between the costæ the shell is finely cancellated with a net-work of raised lines; anterior canal slightly larger than usual for the genus.

Locality, Jackson, Miss.

Fusus insectoides n. sp. Pl. XVIII, fig. 11.

Specific characterization.—Size and general outline as figured; whorls 12 or 13; apex acute; upper whorls broadly costate and with strong and weak alternating spiral lines; 5 spiral lines on the shoulder, decreasing in strength toward the suture; sides of the whorls with two or three strong, raised spiral lines, with two weaker ones above and two or three weaker ones below; longitudinal lines faint, showing only between the coarse spirals; columella twisted below; labium sharp and extending some distance away from the columella; sutures most remarkably constricted.

Locality, Jackson, Miss.

Fusus mortoni Lea, var. near *carexus* Har. Pl. XVIII, fig. 12.

We have already called attention to the variation that this species undergoes (Proc. A. N. S. Phila., 1895, p. 72) in the lower Claiborne beds. Now we have it from Jackson showing a moderately large size in many different forms. The specimen figured is unusually smooth; others show stronger spiral lines, especially below the carina.

Locality, Jackson, Miss.

Latirus leaensis n. sp. Pl. XVIII, fig. 13.

Specific characterization.—Size and general form as indicated by the figure; whorls 11; 1 and 2 smooth; 3 rather finely costate, remaining spiral whorls with eight rather low costæ, considerably wider than the interspaces, and arranged so that those on each succeeding larger whorl are a little behind those of the preceding or smaller whorl, and hence, although in line, the line falls back perhaps ¼ revolution from apex to base; spiral lines on each whorl 6, large, with an equal number of intermediate striæ. Body whorl ornamented by 8 costæ and alternate spiral lines to the end of the canal. Aperture contracted above and below; columella with 2 fairly well defined plaits.

Locality, Jackson, Miss.

Mazzalina inaurata var. Con. Pl. XVIII, fig. 14.

This is very near to, if not identical with, Conrad's *Mazzalina pyrula* from the lower Claiborne beds of Alabama. We have already shown in our report on the Tertiary of Arkansas how many forms this species assumes.

Locality, Jackson, Miss.

Murex marksi Harris. Pl. XVIII, fig. 15.

This, as well as typical *marksi* from the Eocene of Arkansas, approaches very closely to *M. engonatus*, and, when specimens enough shall have been collected, the two will doubtless be proven identical. This has seven costæ instead of six.

Locality, Jackson, Miss.

Monoceras jacksonium n. sp. Pl. XVIII, fig. 16.

Specific characterization.—Size and general form as indicated by the figure; whorls about 6; the upper 2 or 3 smooth; 4 and 5 strongly costate medially and below; spiral striæ about 8 in number; body whorl nearly smooth, with a strongly marked humeral zone on which are found about 6 spiral lines; medially smooth; basally more or less strongly spirally striate, with a depressed band across which the lines of growth arch forward, hence giving rise to a tooth like projection on the subcentral portion of the labrum; columella smooth, labrum lirate within, though the liræ do not extend far in the interior; anterior canal peculiarly truncated below.

Locality, Jackson, Miss.

Levifusus branneri Harris. Pl. XIX, fig. 1.

This species was described from a young specimen found in southern Arkansas. Fragments of larger specimens were found by the writer at White Bluff on Arkansas River, and still others in the Jackson beds of Mississippi. This is by far the most perfect large specimen yet known. Its close relationship to *Fulgur* must be evident to all.

Locality, Jackson, Miss.

Siphonalia jacksonia n. sp. Pl. XIX, fig. 2.

Specific characterization.—Size and general form as indicated by the figure; whorls 7 or 8; marked by 10 rounded, longitudinal costæ, each in width a little over one-half that of the intermediate spaces, strong from lower suture to greatest diameter of shell, and from there decreasing rapidly in size and vanishing before reaching the suture above; strong spiral striæ about 8 on each whorl, with an equal number of finer alternate lines; columella sharply bent as in *Strepsidura*.

Locality, Jackson, Miss.

Amauropsis jacksonensis n. sp. Pl. XIX, fig. 3.

Specific characterization.—Size and general form as shown by the figure; whorls 10, the upper 4 to 5 small, the other increasing in size rapidly and becoming shouldered; body whorl large, shouldered; umbilicus none or entirely hidden by a labial callosity. This differs from *A. perovata* Con. by its greater height, the well-defined shoulder on each whorl, and the absence of an umbilicus.

Locality, Jackson, Miss.

Cypræa pinguis Con. Pl. XIX, figs. 4, 4a.

The specimen herewith figured shows a few spiral whorls. Generally, however, they are covered over.

Locality, Jackson, Miss.

Cypræa dalli Ald. Pl. XIX, figs. 5a, 6a.

This was originally described from the Red Bluff horizon of Mississippi, yet it is quite abundant, and shows many varietal forms at Jackson, Miss.

Locality, Jackson, Miss.

CLAIBORNE STAGE.

Papillina staminea Con. var. Pl. XX, figs. 1, 2, 3, 4.

Fusus stamineus Con., Foss. Shells Tert. Form., 1833, p, 43, pl. 18, fig. 14, of 2d ed., 1835.

There is great confusion among the Claiborne species of *Fusus* and its allies, and here is a most typical example. *Papillina staminea* is quite fulgurate in appearance, having a row of compressed tubercles on the carina and a long beak. The specimens herewith figured show how greatly these features vary. These specimens have some parts in common with *F. irrasus* Con., and we are inclined to think all will prove to be one and the same species. The apices of this and related species are smooth and blunt.

Locality, Claiborne, Ala.

Papillina papillata Con. Pl. XX, fig. 5.

Fusus papillatus Con., Foss. Shells Tert. Form., 1833, p. 29; p. 53, pl 18, fig. 3, of 2d ed.

This large and beautiful specimen came from near Jackson, Ala., from the Claiborne sand horizon. Conrad's figure of the species does not show well some of its important characters, hence it is redrawn. Conrad remarks that it is rare at Claiborne. It is certainly so in a perfect state of preservation, but portions of its huge columella are quite common in some places.

Locality, Jackson, Ala.

LIGNITIC STAGE (UPPER).

Astarte smithvillensis var. Har. Pl. XX, fig. 6.

A. smithvillensis Har., Proc. Acad. Nat. Sci. Phila. 1895, p. 48, pl. 1, figs. 8a, 9a, b, c.

This species is extremely variable, and we have little doubt but that this Wood's Bluff specimen may be referred to it.

Locality, Wood's Bluff, Ala.

Protocardia virginiana? Con. Pl. XX, figs. 7 and 8.

This is probably a variety of the form described by Conrad as *P. lene* or *P. virginiana;* but since we have no specimens of that species, it is impossible to speak with certainty on the subject. Several species of this genus have been described from the Eocene, and it will be a serious matter to properly work out their synonymy. This form differs from *nicolletti* by its smaller umbones and smaller size.

Locality, Wood's Bluff, Ala.

Pleurotoma vaughani var. Pl. XX, fig. 9.

P. vaughani Har., Proc. Acad. Nat. Sci. Phila., 1895, p. 57, pl. 4, fig. 8.

The fine large specimens in the Lea Memorial Collection differ somewhat from typical *vaughani* as found in the lower Claiborne beds of Texas. The latter is smaller, less strongly costate, with liræ within the labrum. The upper carinal spiral whorl is slightly higher in this variety than in the type.

Cancellaria tortiplica Con. Pl. XX, fig. 10.

C. tortiplica Con., Am. Jr. Conch., 1865, p. 145, pl. 21, fig. 8.

Conrad cites this from Texas, but the Alabama specimens approach the outlines of his fig. 8, Pl. 21, more nearly than the Texan forms do. Aldrich refers this form to *evulsa* Brander (Bull. Geol. Surv. Ala., 1886, p. 52).

Cancellaria silværupis n. sp. Pl. XX, fig. 11.

Specific characterization.—General form and size as indicated by the figure; whorls about 6; 3 embryonic smooth; others with about 8 strong spiral lines between the suture above and the suture below; incremental lines especially prominent between the strong raised spirals; labrum sharp at edge but abruptly thickening and varicose a slight distance within; columella concave, two plaits on its subcentral portion and one marginal below.

This species reminds one somewhat of *C. quadrata* of England and *C. ulmula* of Texas.

Locality, Wood's Bluff, Ala.

Murex morulus Con. Pl. XX, fig. 12.

In this collection there are specimens of various sizes, and they show one marked peculiarity. When small and young the anterior canal is long but curved; afterwards it seems to grow no more in length, but becomes extremely bent or twisted, and a large umbilicus is formed.

Locality, Wood's Bluff, Ala.

Latirus imbricatulus n. sp. Pl. XXI, fig. 2.

Specific characterization.—General form and size as indicated by the figure; whorls 10; 1–4 embryonic, smooth; the remaining spiral whorls with about 7 costæ crossed by about 6 very strong revolving striæ between which there are an equal number of fine spirals. Labrum lirate within; columella very much twisted and showing signs of plications, especially at the basal angle. Umbilicus not large, but well defined. The most peculiar feature of this species is the imbricate appearance of the incremental lines. This strongly reminds one of some of the Muricidæ. The general form of the species is much like *Latirus rugatus* Dall from the Ballast Point Silex beds.

Locality, Wood's Bluff.

Pyropsis perula Ald. Pl. XXI, fig. 1a.

This is such an unusually large and fine specimen, it has seemed worth while to have it figured, although it comes from the typical locality.

Sipho ? erecta Ald. Pl. XXI, fig. 3.

We are inclined to regard this beautiful, though imperfect, specimen as an adult form of Aldrich's *S. erecta.* The punctate appearance in the indented spiral lines indicates a relationship to the

Tectibranchs. The matter can only be decided when more perfect material is at hand.

Locality, Wood's Bluff, Ala.

Cypræa smithi Ald. Pl. XXI, fig. 4.

This is broader posteriorly than typical *smithi*, and has a less conspicuous posterior termination of the labium, yet it is most likely of the same species. It seems to be the forerunner of *C. dalli* Ald.

Locality, Wood's Bluff, Ala.

Solarium huppertzi var. Har. Pl. XXI, fig. 5.

The markings on this specimen are somewhat finer than those of typical *huppertzi*, but this may be only a varietal feature. Again, *huppertzi* was described from a young, small specimen; this is more nearly full grown.

Solarium sylværupis n. sp.

Syn. *S. texanum* Dall, Tr. Wag. Free Inst. Sci., Vol. III, p. 326.

After examining the type of *texanum* in the Academy's collection, it was found to be the same as Conrad's *scrobiculatum*. Hence the larger, beautiful form described by Dall under the name "*Texanum* Gabb" from Wood's Bluff, must have another name.

Solariella sylværupis n. sp. Pl. XXI, fig. 6.

Specific characterization.—Size and general form as indicated by the figures; whorls about 6, with about 5 striæ on each; slightly shouldered at the suture, bearing there a row of beads or tubercles; nacreous within; umbilicus crenate at the periphery, granularly striate within.

Locality, Wood's Bluff, Ala.

LIGNITIC STAGE (LOWER).

Meretrix mortoniopsis var. Hp. Plate XXII, figs. 1 and 2.

The figures represent two well-preserved specimens of this species from the lower Lignitic. It seems well to have them accurately figured, since their relationship to the species of this genus described by Rogers and Conrad from Virginia is still in an unsettled state.

Locality, Bell's Landing, Ala.

Tellina lignitica n. sp. Pl. XXII, fig. 3a.

Specific characterization.—Size and general form as indicated by the figures; substance of shell very thin; smooth; 2 cardinal teeth in each valve; a furrow in the upper anterior margin of the left valve causes the same to form two obscure teeth.

Locality, Gregg's Landing, Ala.

Panopæa porrectoides var. Ald. Pl. XXII, fig. 4.

By comparing our figure with Aldrich's, it will be seen that typical *porrectoides* is much larger, more developed anteriorly, and with umbones nearer the center of the shell. Yet they both belong to the same section of the genus, and it is almost certain that the one is the ancestor of the other.

Locality, Gregg's Landing, Ala.

Lucina greggi n. sp. Pl. XXII, figs. 5 and 6.

Specific characterization.—Size and general form as indicated by the figure; marked exteriorly with concentric lines not deeply incised; interior with two diverging cardinal teeth and an anterior lateral; anterior muscular scar very large and extending from the anterior lateral tooth to the basal margin of the shell; posterior muscular scar comparatively small, rotund; interior naturally (or by disease) much thickened or calloused, a shallow channel extending from a little above the upper margin of the posterior muscular scar obliquely to near the base of the anterior scar.

A small specimen, magnified in fig. 5, and probably of this species, shows an extremely deeply excavated ligament pit, reminding one of *Lucina claytonia.* In the old type specimen this pit broadens out and the ligament seems to be attached very much as in *Dosinia.*

Locality, Gregg's Landing, Ala.

Pleurotoma nasuta Whitf. Plate XXII, fig. 7.

This species is extremely variable in ornamentation. Sometimes the spiral lines are few and coarse; at other times they are many and fine. Our figure shows a specimen of the latter type.

Locality, Gregg's Landing, Ala.

Fusus rugatus Ald. Pl. XXII, fig. 8.

The specimen figured is more perfect than the type; it shows well the characters of the anterior canal, especially its ornamentation.

Locality, Gregg's Landing, Ala.

Pseudoliva vetusta. Pl. XXII, fig. 9.

P. vetusta Con. Foss. Sh. Tert. Form., 1833, p. 44.

The large size to which certain species described originally from Claiborne often attain in the Bell's Landing Lignitic has already been the subject of various observations. Perhaps no species shows to better advantage this tendency than does the present. Note the great sutural callosity in connection with like developments on *Volutilithes petrosus* and *Rostellaria trinodifera.*

Cassidaria brevidentata Ald. var. Pl. XXII, fig. 10.

This specimen shows an unusually large number of nodules on the humeral carina. In front, the two lower carinæ are without nodules, while on the back all three carinæ are strongly nodular.

Locality, Bell's Landing, Ala.

Levifusus trabeatus Con. Pl. XXII, fig. 11.

Here is one of the largest and the most compact varieties of this species. The labral liræ are unusually well marked; the carinal nodules are very large but imperfectly defined.

Locality, Bell's Landing, Ala.

Triton (Ranularia) eocenensis Ald. Pl. XXIII, fig. 1.

Upon the whole, this is the most perfect specimen of this species yet found. Its apex is somewhat eroded and might be represented a little more acute. Strangely enough, it does not show varices on the whorls as is usual in specimens of this species.

Locality, Gregg's Landing, Ala.

Caricella podagrina Dall. Pl. XXIII, fig. 2.

The specimen herewith figured is so exceptionally fine that it has seemed worth while to have it thus specially noticed in our paleontological literature.

From the type locality, Bell's Landing, Ala.

Fusus bellanus n. sp. Pl. XXIII, fig. 3.

Specific characterization.—Size and general form of the shell as indicated by the figure; whorls 8 or 9; embryonic 3 smooth; others marked by from 8 to 10 sharp, flattened peripheral spines, at whose base or immediately at the suture a subordinate series of spines occur on the larger whorls; canal nearly closed, long, straight; labial callus thin.

At first sight this seemed like a large, well-formed *F. mohri*, but on comparing details it was found to be very distinct.

Locality, Bell's Landing, Ala.

Cyllene bellana n. sp. Pl. XXIII, fig. 4.

Specific characterization.—Size and general form as indicated by the figure; whorls about 8; embryonic 3 small, smooth, others finely costate and with fine revolving lines; costæ strongest on the central portion of the whorls (*i. e.*, on the shoulder) vanishing above, reaching the suture below; columella twisted, *Strepsidura*-like below; labrum lirate within; exterior of body whorl with extremely fine revolving lines on its central portion, and with coarser lines above the carina and near the base.

Locality, Bell's Landing, Ala.

Solarium greggi n. sp. Pl. XXIII, fig. 5, 5a.

Whorls about 5. Nuclear whorls rounded smooth; remaining whorls with three crenulate spiral lines and one smooth, strong spiral line just above the suture. Periphery above the body whorl with one deeply incised spiral line, thus rendering the periphery of the body whorl obtuse. Umbilicus small, with radii extending from its periphery about ⅓ way across the body-whorl, and having a raised spiral coarsely crenulate carina medially located.

Locality, Gregg's Landing, Ala.

MIDWAY STAGE.

Pleurotoma (Cithara ?) leania Harris. Pl. XXIII, fig. 7.

This species is rather remarkable for the extreme shallowness of the retral sinus. It seems never to attain a much greater size than that indicated by the figure ($\times$ 2½).

Type, Lea Memorial Collection, Academy of Natural Sciences of Philadelphia.

Locality, Matthew's Landing, Ala.

Pleurotoma (Surcula) ostrarupis Harris. Plate XXIII, fig. 8.

This species was described from a peculiar looking fragment from the Midway beds on Brazos River, Texas. It proves to be quite common in the upper Midway of Alabama.

Locality, Matthew's Landing, Ala.

Natica mediavia ? Harris. Pl. XXIII, fig. 8.

N. mediavia Har., Bull. Am. Pal., No. 4, 1896, p. 117, pl. 12, fig. 15.

While working over a large amount of material from the uppermost Midway limestone, as exposed on the Chattahoochee, several fragments of *N. mediavia* were found of the size indicated by the figure of the type in Bulletin 4. It was soon found that fragments, too, indicated a considerably larger size for some specimens as found 1½ miles northeast of Clayton. Fragments of the body whorl of what would seem to be the same species occur at Matthew's Landing. They certainly belong to the species herewith figured. Hence it is quite probable that this larger specimen, much compressed vertically, belongs to the same species as the smaller specimen figured in Bulletin No. 4.

Locality, Matthew's Landing, Ala.

Explanation of Plates.

Plate XVIII.

Figs. 1 and 2. *Pecten clairbornensis* Con.
Fig. 3. *Leda regina-jacksonis* n. sp.
Fig. 4 and 5. *Meretrix pearlensis* n. sp.
Fig. 6. *Tellina eburneopsis* Con.
Fig. 7. *Mactra mississippiensis* Con.
Figs. 8a. *Periploma* sp.
Fig. 8b. *Periploma,* hinge magnified.
Fig. 9. *Eucheilodon creno-carinata* Heilpr.
Fig. 10. *Harpa jacksonensis* n. sp.
Fig. 11. *Fusus insectoides* n. sp.
Fig. 12. *Fusus mortoni* Lea var. near *carexus* Har.
Fig. 13. *Latirus leaënsis* n. sp.
Fig. 14. *Mazzalina inaurata* var. Con.
Fig. 15. *Murex marksi* Harris.
Fig. 16. *Monoceras jacksonium* n. sp.

Plate XIX.

Fig. 1. *Levifusus branneri* Harris $\times \frac{4}{5}$.
Fig. 2. *Siphonalia jacksonia* n. sp.
Fig. 3. *Amauropsis jacksonensis* n. sp.
Fig. 4 and 4a. *Cypræa pinguis* Con.
Fig. 5, 5a, 6, 6a. *Cypræa dalli* Aldr.

Plate XX.

Figs. 1, 2, 3 and 4. *Papillina staminea* Con. var.
Fig. 5. *Papillina papillata* Con.
Fig. 6. *Astarte smithvillensis* Har. $\times \frac{7}{3}$.
Figs. 7 and 8. *Protocardia virginiana ?* Con. $\times \frac{5}{4}$.
Fig. 9. *Pleurotoma vaughani* Har.
Fig. 10. *Cancellaria tortiplica* Con. $\times$ 3.
Fig. 11. *Cancellaria sylværupis* n. sp.
Fig. 12. *Murex morulus* Con.

Plate XXI.

Figs. 1 and 1a. *Pyropsis perula* Ald.
Fig. 2. *Latirus imbricatulus* n. sp.
Fig. 3. *Sipho erecta* Ald.
Fig. 4. *Cypræa smithi* Ald.
Fig. 5. *Solarium huppertzi* var. Har. $\times$ 2.
Fig. 6. *Solariella sylværupis* n. sp.

Plate XXII.

Figs. 1 and 2. *Meretrix nuttalliopsis* Heilpr.
Fig. 3. *Tellina greggi* n. sp.
Fig. 4. *Panopæa porrectoides* var. Ald.
Figs. 5 and 6. *Lucina greggi* n. sp.
Fig. 7. *Pleurotoma nasuta* Whitf.
Fig. 8. *Fusus rugatus* Ald.
Fig. 9. *Pseudoliva vetusta* Con.
Fig. 10. *Cassidaria brevidentata* Ald. $\times \frac{5}{4}$.
Fig. 11. *Levifusus trabeatus* Con.

Plate XXIII.

Fig. 1. *Triton* (*Ranularia*) *eocenensis* Ald.
Fig. 2. *Caricella podagrina* Dall.
Fig. 3. *Fusus bellanus* n. sp.
Fig. 4. *Cyllene bellana* n. sp. $\times$ 2.
Figs. 5, 5a. *Solarium greggi* n. sp. $\times \frac{12}{5}$.
Fig. 6. *Pleurotoma* (*Surcula*) *ostrarupis* Har. $\times$ 2.
Fig. 7. *Pleurotoma* (*Cithara*) *leania* Har. $\times \frac{5}{2}$.
Fig. 8. *Natica mediavia ?* Har.

OCTOBER 6.

The President, SAMUEL G. DIXON, M. D., in the Chair.

Forty persons present.

The Committee on the Hayden Memorial Award reported in favor of conferring the recognition for 1896 on Professor Giovanni Capellini of Bologna.

GIOVANNI CAPELLINI was born in Spezia, August 23, 1833. He studied in the college of his native city and in the University of Pisa. While yet a student he had made important paleontological discoveries and was in correspondence with illustrious scientists, both Italian and foreign.

After obtaining his degree in science he made frequent trips in France, England, Switzerland, Belgium and Germany. In September, 1859, he was appointed Professor of Natural History in the National College of Genoa.

In September of the following year he was made Professor of Geology and Paleontology in the University of Bologna.

In 1863 he visited North America. The rich collections then made by him in Nebraska and elsewhere are now in the Geological Institute of Bologna. In 1864 he made interesting scientific discoveries in the petroleum lands of Wallachia.

As President of the Second Extraordinary Reunion of the Italian Naturalists in Spezia in 1865, he founded the International Congress of Anthropology and Prehistoric Archeology.

In 1872 he travelled in Greece, and in the autumn took an important part in the International Anthropological Congresses in Brussels. He then travelled in Switzerland, Holland, Austria, Hungary, Germany, Spain and Portugal, and returned through France and England.

He was made Vice-President of the First International Geological Congress in Paris in 1878, and obtained its assent that the second meeting should take place in Bologna in 1881. Elected actual President (in conjunction with Quintino Sella as honorary President) of this Congress, he inaugurated the commission for the unification of geological nomenclature and a commission for the production of a geological map of Europe, outlined at Berlin. Together with Sella, he founded, on that occasion, the Italian Geological Society. In 1885 he directed, in great part, the Third International Geological Congress in Berlin, and contributed not a little to its success, as also to that of the Fourth Session in London in 1888.

He had now published 140 scientific communications.

Having served as Rector of the University of Bologna at intervals from 1874 to 1888, in the latter year he organized and directed a celebration of its Eighth Century, for which he received letters of congratulation from all the universities of the world. He has been decorated by the Emperor of Germany and other sovereigns. The University of Edinburgh conferred upon him through its Rector the diploma of Doctor "Honoris Causa." The University of Moscow nominated him honorary Professor. Seventy of the principal academies of Europe and America have registered his name among their members. He was elected a Correspondent of the Academy of Natural Sciences of Philadelphia in 1863.

He is President of the International Commission for the Unification of Geological Nomenclature and President of the Royal Geological Survey of Italy.

Mica Schists of the Schuylkill River.—THEODORE D. RAND presented specimens of mica schist from the river road near Strawberry Mansion, Fairmount Park. The nodules resemble very imperfect andalusite crystals, but appear to be almost wholly quartz with a little kyanite or sillimanite, resembling closely those described by the late Dr. George H. Williams, in the Fifteenth Annual Report of the United States Geological Survey, p. 665, as occurring on Sligo Branch (probably Fairfax Co., Va.) and as suggesting contact metamorphism of included fragments.

OCTOBER 13.

The President, SAMUEL G. DIXON, M. D., in the Chair.

Twenty-three persons present.

The deaths were announced of Alexander H. Green, August 19, 1896, and Josiah Dwight Whitney, August 19, 1896, Correspondents.

OCTOBER 20.

The President, SAMUEL G. DIXON, M. D., in the Chair.

Twenty-seven persons present.

The Occurrence of Macacus leoninus (Blyth) in Eastern Burmah.—ARTHUR ERWIN BROWN stated that a young male monkey nearly allied to *Macacus nemestrinus* was purchased by the Zoological Society of Philadelphia in April, 1894, from a person who had procured it at Möngnai, in the southern Shan states, Upper Burmah. At the time this animal was received, certain peculiarities led him to refer it provisionally to *M. leoninus* (Blyth), but it is only lately that he had fully determined this identification to be correct. It has now lived in the garden two years and a half and he would suppose it to be about four years old, but it has not yet assumed the full colors of the male of this species as shown in Mr. Sclater's plate[1] the resemblance between it and the female being still close. The general color is pale brown, resulting from the yellow and brown annulation of the hairs ; the sides of the body and outside of the limbs are rather paler and somewhat grayish ; the horse-shoe mark on top of the head is well defined in a darker shade of brown which shows also along the back and upper side of the tail and slightly appears on the back of the hands and feet. The characteristic red line in the bare skin from the outer corner of the eye is well marked, and it is interesting to observe that it becomes much brighter in color when the animal is excited than at other times. It is doubtful if this mark would be at all evident in skins. The specimen is now about twenty inches in length from nose to base of tail ; the tail being about six and a half and without a tuft.

As compared with *nemestrinus* of like age *leoninus* has the muzzle shorter, the superciliary ridges more prominent, the ischial callosities smaller, the hair about the cheeks, neck and shoulders much longer, the spreading whiskers being conspicuous when looked at from in front, the face and ears are paler and the iris is distinctly hazel brown, while in *nemestrinus* it is of a paler yellowish-brown.

It would appear that *M. leoninus* has heretofore been only known to occur in the Province of Arracan, in Western Burmah, on the Bay of Bengal, and from a few localities in the Valley of the Irrawaddy, the present specimen, therefore, extends the range of the species eastward across Upper Burmah to the borders of Yunnan. Dr. Griggs, from whom the specimen was procured, fully assured the speaker as to the locality.

The characters of this monkey are very distinct and at its present age, when placed side by side with specimens of the southern form of pig-tailed monkey, *M. nemestrinus*, there is no possibility of confusing them.

OCTOBER 27.

The President, SAMUEL G. DIXON, M. D., in the Chair.

Thirty-one persons present.

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[1] Proc. Zool. Soc. of London, 1870, pl. XXXV.

Papers under the following titles were presented for publication :—

"New Species of Fresh-water Mollusks from South America," by Henry A. Pilsbry.

"Geology of the Mussel-bearing Clays of Fish House, N. J.," by Henry A. Pilsbry.

The death of Baron Ferdinand Von Mueller, a Correspondent, October 9, 1896, was announced.

The following were elected members :—

Henry A. Laessle, George C. Harlan, M. D., William M. Singerly and Henry Beates, Jr., M. D.

Prof. W. C. Roentgen of Würzburg, was elected a Correspondent.

The following were ordered to be printed :—

CONTRIBUTIONS TO THE ZOOLOGY OF TENNESSEE. No. 4, MOLLUSKS.

BY HENRY A. PILSBRY AND SAMUEL N. RHOADS.[1]

The following paper concludes the annotated lists of the animals of Tennessee, collected and observed by Mr. Rhoads, which have appeared in the Proceedings of the Academy of Natural Sciences of Philadelphia, beginning with page 376, in the volume for 1895. The reader is referred to this article for an itinerary of the journey through Tennessee, during which the collection of mollusks here enumerated was secured.

The list is restricted exclusively to the collection made by Mr. Rhoads in May and June, 1895, no attempt being made, as in previous papers of this series, to complete the list.

The literature of Tennessee mollusks is extensive, nearly all general works on the North American land and fresh water forms containing descriptions of or references to species from the state. There are, however, but few special papers on shells of this area. Dr. James Lewis published in the American Journal of Conchology, VI, 1870, p. 188–191, " Notes on the Land Shells of East Tennessee," based on specimens collected by Miss Annie E. Law. Pages 216–226 contain an article " On the Shells of the Holston River," by the same author, likewise from Miss Law's collection. Tryon, in Amer. Jour. Conch., VII, p. 86, reviews Dr. Lewis' notes on Holston River *Strepomatidæ*. A third paper by Lewis, "Shells of Tennessee (No. 2)," collected by Miss Law, appears in Proceedings of the Academy of Natural Sciences of Philadelphia for 1872, pp. 108–115. A number of other papers by Dr. Lewis, in the same Proceedings, and by Prof. A. G. Wetherby, in the Journal of the Cincinnati Society of Natural History, deal mainly with Tennessee mollusks.

In species of *Unionidæ*, Tennessee is wonderfully rich. The western part of the state, represented in the collection here recorded

[1] Prof. H. A. Pilsbry, of the Academy of Natural Sciences of Philadelphia, and his assistant, Mr. E. G. Vanatta, identified the entire collection. Chas. T. Simpson, of the National Museum, has kindly examined and reported on a number of ambiguous and difficult *Unionidæ*. All annotations are made by Mr. Pilsbry.

by the forms taken at Reelfoot Lake, has the typical northern Mississippi fauna, with a few southwestern species. The special character of the Tennessee River system is well known to conchologists; but among the species herein catalogued from middle and east Tennessee will be found a number of forms described from Alabama, Louisiana and other localities to the south and west, such as *Unio propinquus, U. pybasii, U. turgidus, U. tumescens, U. caliginosus*, etc.

PULMONATA.

AGNATHA.

Family CIRCINARIIDÆ Pilsbry.

Selenitidæ Fischer = *Macrocyclis* and *Selenites* Auct.

1. Circinaria[2] concava (Say).

Bellevue (68677)[3]; Banks of Emory Riv., Harriman (68676); Johnson City (68679); Road to Cloudland, Roan Mt., 5000 ft. (68675).

AULACOPODA.

Family ZONITIDÆ.

2. Vitrea arborea (Say).

Samburg, Reelfoot Lake (68689); Raleigh (69104); Sawyer's Springs (69105); Banks Emory Riv., Harriman (68688, 68692); Allardt (68691); 5 m. S. W. Greeneville (68693); Greeneville (68694); road to Cloudland, Roan Mt., 3500 to 5000 ft. (68690).

3. Vitrea indentata (Say).

Bellevue (68696, 68697).

4. Omphalina kopnodes (W. G. Binn.).

Samburg, Obion Co. (69106); Bellevue (69107).

5. Omphalina fuliginosa (Griff.).

Banks of Emory Riv., Harriman (68635).

6. Omphalina laevigata (Pfr.).

Raleigh (68639); bank Richland Creek ("Belle Mead"), Davidson Co. (68642); Bellevue (68637); Sawyer's Springs, Walden's Ridge (68638); bank Emory Riv., near Harriman (68641); Johnson City (68643).

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[2] *Circinaria* Beck, 1837 = *Macrocyclis* Binney = *Selenites* Fischer, 1878, not *Selenites* Hope, 1840.

[3] Braketed numbers refer to the catalogue entries of the Academy of Natural Sciences of Philadelphia.

7. **Omphalina rugeli** (W. G. Binn.).

Roan Mt., Carter Co., 4000 to 6000 ft. (69108, 69109, 69110).

8. **Vitrinizonites latissimus** (Lewis).

Rock Creek, Roan Mt., 3500 to 5000 ft. (68698).

9. **Gastrodonta acerra** (Lewis).

Roan Mt., Carter Co., 5000 ft. (69084).

10. **Gastrodonta intertexta** (Binn.).

Chattanooga (68670).

11. **Gastrodonta ligera** (Say).

Samburg, Reelfoot Lake (68673).

12. **Gastrodonta demissa** (Binn.).

Bellevue (69086).

13. **Gastrodonta capsella** (Gld.).

Belle Mead Farm, near Nashville (69089); Emory Riv., near Harriman (69090); Roan Mt., Rock Creek (69091).

14. **Gastrodonta gularis** (Say).

Sawyer's Springs (69092); Emory Riv., near Harriman (69093); Nolachucky Riv., near Greeneville (68094); Roan Mt., Carter Co., 4000 to 6000 ft. (69095, 69096).

15. **Gastrodonta collisella** Pils.

Emory Riv., near Harriman (69097); Johnson City (69098).

16. **Gastrodonta interna** (Say).

Bellevue (68666); Chattanooga (68667); Sawyer's Springs, Walden Ridge (68668); bank Emory Riv., Harriman (68669).

Family LIMACIDÆ.

17. **Limax campestris** Binn.

Reelfoot Lake (69056); Bellevue (69055); Holston Riv., near French Broad Junction (69054).

Family PHILOMYCIDÆ.

18. **Philomycus carolinensis** (Bosc.).

Reelfoot Lake (69057); Raleigh (69078); Sawyer's Springs (69059); Harriman (69058).

Family ENDODONTIDÆ.

19. **Pyramidula perspectiva** (Say).

Samburg, Reelfoot Lake (68650); "Belle Mead" farm, near Nashville (68649); Bellevue (68646); Chattanooga (68645); Sawyer's Springs, Walden Ridge (68653); bank Emory Riv., Harriman (68644); Knoxville (68651); Johnson City (68647); Roan Mt., 5000 ft. (68652).

20. Pyramidula alternata (Say).

Samburg, Reelfoot Lake (68661); Belle Mead Farm, near Nashville (69079); Bellevue (68663); Williams Isl., near Chattanooga (68664); Chattanooga (69080); Sawyer's Springs (69081); Knoxville (68662); Greeneville (68657); Johnson City (69082); Rock Creek, Roan Mt. (68655); Doe Riv., Roan Mt., 4000 ft. (68656).

21. Pyramidula alternata carinata (Auct.).

Emory Riv., near Harriman (69083).

Most Tennessee specimens of this species are more coarsely and strongly ribbed than northern and western examples, and there is often a more or less pronounced peripheral keel. The culmination of this type of shell is *P. alternata mordax*, of which, however, no specimens were taken at localities recorded above. The form called var. *carinata* contrasts with these, being very fine-ribbed and distinctly carinated, and not at all of the *mordax* type. Peculiarly depressed, but not keeled, specimens occurred at Sawyer's Springs.

22. Helicodiscus lineatus (Say).

Belle Mead farm, near Nashville (68681); bank Emory Riv., Harriman (68682).

HOLOPODA.

Family HELICIDÆ.

23. Polygyra plicata Say.

Emory Riv., near Harriman (69060).

24. Polygyra troostiana Lea.

Belle Mead Farm, near Nashville (69061).

25. Polygyra inflecta (Say).

Raleigh (68579, 69062); Belle Mead Farm, near Nashville (68581); Bellevue (68577); Williams Isl., near Chattanooga (68574); Chattanooga (68584, 68572); bank Holston Riv., above junction of French Broad Riv. (68573); Knoxville (68575); Greenville (68576); Johnson City (69583).

26. Polygyra rugeli (Shutt.).

Sawyer's Springs, Walden Ridge (68571); bank Emory Riv., near Harriman (68570).

27. Polygyra fraudulenta Pils.

Samburg, Reelfoot Lake (68565); Belle Mead Farm, near Nashville (68566); Williams Isl., near Chattanooga (68569); bank Emory Riv., Harriman (68567); bank Doe Riv., 4000 ft., Roan Mt. (68564).

28. Polygyra tridentata (Say).

Sawyer's Springs, Walden Ridge (68557); Greeneville (68561); 5 m. S. W. Greeneville, bank Nolachucky Riv. (68558); Allardt (68562); near junction Holston and French Broad Rivs. (68559); Johnson City (68560); banks Doe Riv., Roan Mt., 4000 ft. (68563).

29. Polygyra palliata (Say).

Samburg, Reelfoot Lake (68555); Johnson City (68556).

30. Polygyra obstricta (Say).

Bellevue (68553); bank Emory Riv., Harriman (68552).

31. Polygyra appressa perigrapta Pils.

Samburg (68547); Raleigh (68544); Belle Mead Farm, near Nashville (68557); Chattanooga (68542); Sawyer's Springs, Walden Ridge (68549); bank Emory Riv., Harriman (68548); Knoxville (68541).

32. Polygyra subpalliata Pils.

Roan Mt., 3000 to 6000 ft. (69064, 69065, 69066).

This is the "*Mesodon wetherbyi*" of most collections. It is a far more common species in museums than that, occurring abundantly at Roan Mt.

33. Polygyra wetherbyi (Bld.).

Emory Riv., near Harriman, Roane Co. (69067).

The specimens of this excessively rare species agree with one of the original lot collected by Prof. A. G. Wetherby. It has been found before in Whitley (and Campbell?) counties.

34. Polygyra wheatleyi (Bld.).

Roan Mt., 3000 to 6000 ft. (69068, 69069, 69070).

35. Polygyra ——— sp.?

Allardt (69071).

A single specimen, defective in the umbilical region, of an apparently new species.

36. Polygyra elevata (Say.).

Samburg, Reelfoot Lake (68606); Belle Mead Farm, near Nashville (68604); Bellevue (68619); Chattanooga (68607), faintly, broadly chestnut-banded at the periphery; bank of Emory Riv., Harriman (68605); junction French Broad and Holston Rivers (68608, 68618).

37. Polygyra exoleta (Binn.).

Samburg, Reelfoot Lake (68614); Bellevue (68613); bank Emory Riv., Harriman (68616).

38. Polygyra andrewsæ (Binn.).

Ten miles east of Allardt (68624); Roan Mt., Doe Riv. valley, 3000 ft. (68625, 66305); top of Roan Mt. (68629): road to Cloudland, 3500 to 5000 ft. (68626, 68628).

Mr. E. G. Vanatta, who dissected specimens, found that the small thin-shelled typical form agrees with the very large, solid shells in soft anatomy, confirming Binney's observations.

39. Polygyra albolabris (Say).

Belle Mead Farm, near Nashville (68621); Chattanooga (68620).

40. Polygyra albolabris major (Binn.).

Vaughan's Cave, near Bellevue (68623); Johnson City (68629).

Very large specimens. Dissections of them by Mr. E. G. Vanatta fully confirm the anatomical distinctions indicated by Mr. Binney between this species or variety and the large form of *P. andrewsæ*.

41. Polygyra thyroides (Say).

Samburg, Reelfoot Lake (68611); Raleigh (68601); Belle Mead Farm, near Nashville (68598); Bellevue (68610); Chattanooga (68603); Knoxville (68602); 2 m. E. Watauga Sta., Washington Co. (68599); Johnson City (68609).

42. Polygyra clausa (Say).

Williams Isl., near Chattanooga (68631); Johnson City (68630).

43. Polygyra downieana (Bld.).

Sawyer's Springs (69072); Belle Mead Farm, near Nashville (69073).

44. Polygyra monodon fraterna (Say).

Raleigh (69074).

45. Polygyra leai (Ward).

Belle Mead Farm, near Nashville (68596).

46. **Polygyra hirsuta altispira** Pils.

Road to Cloudland, Roan Mt., Doe Riv., 4000 ft. (68586); top Roan Mt.. 6000 ft. (68585).

47. **Polygyra stenotrema** (Fér.).

Chattanooga (68588); Sawyer's Springs, Walden Ridge (68592); bank Emory Riv., Harriman (68587); Allardt (68593).

48. **Polygyra stenotrema depilata** Pils.

Belle Mead Farm, near Nashville (68594); Bellevue (68590); Johnson City (68595).

Family BULIMULIDÆ.

49. **Bulimulus dealbatus** (Say).

Belle Mead Farm, near Nashville (68632).

ELASMOGNATHA.

Family SUCCINEIDÆ.

50. **Succinea obliqua** Say.

Samburg, Reelfoot Lake (68686).

51. **Succinea ovalis** Gld.

Samburg, Reelfoot Lake (68683); Mouth of Wolf Riv., Memphis (68684); Richland Creek, Belle Mead Farm, near Nashville (69282).

52. **Succinea avara** Say.

Samburg, Reelfoot Lake (68687); Chattanooga (69281).

LIMNOPHILA.

Family LIMNÆIDÆ.

53. **Limnæa desidiosa** Say.

Samburg (69297); Bellevue (69295); Johnson City (69298); Knoxville (69075).

54. **Limnæa columella** Say.

Knoxville (69076).

55. **Limnæa humilis** Say.

Johnson City (69299).

56. **Planorbis trivolvis** Say.

Samburg (69250, 69301).

57. **Planorbis bicarinatus** Say.

Emory River, near Harriman (69302).

58. **Planorbis dilatatus** Gld.

Knoxville, in a spring (69303).

59. **Ancylus diaphanus** Hald.

Knoxville (69334).

Family PHYSIDÆ.

60. **Physa gyrina** Say.

S. Harpeth River, 6 m. from Bellevue (69266); Knoxville (69077).

61. **Physa heterostropha** Say.

Belle Mead Farm, near Nashville (69267); Nolachucky River, near Greeneville (69269); Watauga River, near Watauga (69270); Johnson City (69268).

62. **Physa integra** Hald.

Samburg (69271); Johnson City (69272).

63. **Physa microstoma** Hald.

Belle Mead Farm, near Nashville (69275). Also taken in Kentucky, at Mammoth Cave (69276); west bluff of Kentucky River, opposite Frankfort (69277); Shelbyville, Clear Creek (68278).

This seems to be a distinct and well characterized species, readily distinguishable at first sight from all other American forms of this genus, in which specific lines are so difficult to define. Judging from the rare occurrence of this name in the literature, the species must be comparatively rare and local.

PROSOBRANCHIATA.

RHIPIDOGLOSSA.

Family HELICINIDÆ.

64. **Helicina orbiculata** (Say).

Chattanooga (68633).

65. **Helicina occulta** (Say).

Bank Emory Riv., near Harriman (68634).

This species was first found living in the West by Messrs. Pilsbry and Shimek, but has subsequently occurred to conchologists in many localities in Iowa, Minnesota and Wisconsin. In the East it occurs living in "Western Pennsylvania" (Green), near Pittsburg (Stupakoff), in Virginia, western North Carolina and eastern Tennessee. Its range is apparently interrupted by the Ohio Valley, and the special localities east and west are more or less isolated. Its distribution is, on the whole, more markedly discontinuous than that of any American land snail known to me. It probably lives in higher latitude than any other member of the *Helicinidæ*. *H. occulta* is an omnipresent, and therefore characteristic, fossil of the Mississippi Valley loess; and during the formation of that deposit was extensively diffused and excessively numerous over a large area where it is now extinct.

TÆNIOGLOSSA.

Family AMNICOLIDÆ Tryon.

66. **Somatogyrus aureus** Tryon.

Nolachucky River, near Greeneville (69284).

67. **Pomatiopsis lapidaria** (Say).

Banks of Emory River, near Harriman (69283).

Family VIVIPARIDÆ Gill.

68. **Vivipara intertexta** (Say).

Samburg, Reelfoot Lake (69249).

69. **Campeloma ponderosum** (Say).

Tennessee River, near Chattanooga (69232, 69236, 69237); Holston River, 1 mile above French Broad (69259, 69260); Tennessee River, near Knoxville (69258); Clinch River, below Patton's Ferry (69261); Indian shell heap, Williams Island (69231).

70. **Campeloma subsolidum** (Anth.).

Samburg, Reelfoot Lake (69233, 69234, 69235); Big Harpeth River, near Bellevue (69263).

71. **Campeloma geniculum** (Conr.).

Emory River, near Harriman (69262).

72. **Lioplax subcarinata** (Say).

Big Harpeth River, near Bellevue (69238).

Family PLEUROCERIDÆ Fischer.

This has long been recognized as one of the most difficult families of American mollusks. Tryon made a good beginning in the intricate study of its species in his monograph published by the Smithsonian Institution in 1872. His conclusions were based upon a study of material from all the principal collections of that time; and his extensive synonymy has proved in nearly every case which has since been tested to be singularly well judged. It was a splendid piece of work, considering the time and material available. But Tryon himself, in his later years, saw as clearly as anyone that a vastly greater reduction of species must be made. He told me, in 1888, that, as he now saw these shells, there were not more than a tenth as many good species as names. Whether the particular ratio mentioned was deliberately said or not, I do not know: but I incline to the belief that it will prove near the truth.

These shells must be collected and studied by river-systems; and it then appears that often the same species occurs in some localities sculptured throughout, in others only on the upper portion, while in still other places only the earlier whorls may show the characteristic sculpture. Some of the species described from one or two decollate examples will be recognized with great difficulty, if at all, in cases where the type locality is not known.

A cursory glance at the generic scheme in current use reveals some inaccuracies which call for correction. The genera are unequally related, and, as Tryon has shown, fall into three main groups. They are as follows:

Io Lea, 1831, type *Fusus fluvialis* Say. *Melafusus* Swainson, 1840, is a synonym.

Lithasia Hald., 1840, type *Anculosa* (*Lithasia*) *geniculata* Hald.

A section of *Lithasia* is *Angitrema* Hald., 1841, type *Melania armigera* Say; *Glotella* Gray, 1847, same type, being a synonym of *Angitrema.*

It will be observed that this reverses Tryon's usage, as he places *geniculata* in *Angitrema,* and restricts *Lithasia* to smooth species.

Angitrema is a connecting link between *Io* and *Lithasia,* and seems conchologically about intermediate between the two groups.

Pleurocera Rafinesque, 1818, type?

Synonyms: *Ceriphasia* Swains., 1840, type, *C. sulcata* Swains. (=*P. canaliculatum* Say); *Trypanostoma* Lea, 1862, type *M. canaliculata* Say, *Telescopella* Gray, 1837, type *Melania undulata* Say.

Strephobasis Lea, 1861, types *S. spillmani, cornea* and *clarkii* Lea (all =*plena* Anth.), is a section of *Pleurocera.*

Elimia H. & A. Adams, 1854, type *M. acutocarinata* Lea.

Synonyms: *Melasma* H. & A. Adams, *Juga* H. & A. Adams, *Megara* H. & A. Adams, and *Goniobasis* Lea, 1862.

The group of Adams brothers, *Elimia,* contains incongruous elements, although most of the species named are *Goniobases. E. ele-*

vata "Lea," *filum* Lea, *spinalis* Lea and *torta* Lea belong to the the prior genus *Pleurocera* Raf., and, therefore, are to be eliminated from *Elimia*. *Holstonia* Lea belongs to the prior genus *Lithasia* Hald. *Apis* Lea is a *Pachychilus*. The other species are true *Goniobases*.

GYROTOMA Shuttlew., 1845.

Synonyms *Schizostoma* and *Schizocheilus* Lea (preoc.). *Apella* Mighels, MS., 1860.

ANCULOSA Say.

73. Io spinosa Lea.

Holston River, 3 miles from Knoxville (69253); Tennessee River, near Knoxville (69252); Nolachucky River., 5 miles south of Greeneville (69251); in the Indian shell heaps, Williams Island, Tennessee River (69255); Indian mound, junction Holston and French Broad (69254); Indian mound, Patton's Ferry, Nolachucky River (69265).

74. Lithasia geniculata Hald.

Indian shell heaps, Williams Island, Tennessee River (69240); Emory River, near Harriman (69242); Tennessee River, near Knoxville (69241); Clinch River, below Patton's Ferry (69239).

75. Lithasia verrucosa (Raf.).

Tennessee River, near Chattanooga (69332); Tennessee River, near Knoxville (69247); Aboriginal shell heaps, Williams Island (69248); shell heap, junction Holston and French Broad Rivers (69264).

76. Lithasia venusta Lea.

Big Harpeth River, near Bellevue (69293, 69294).

77. Lithasia stygia (Say).

Big Harpeth River, near Bellevue (69333).

These shells, while worthy of the Styx when unwashed and black with iron deposit, are of a beautiful green with darker bands when this incrustation is removed.

78. Pleurocera undulatum (Say).

Clinch River, above Patton's Ferry (69313); Holston River, 1 mile above French Broad (69312, 69314).

Pleurocera undulatum is here understood to cover the following nominal species, all of which seem to be connected by inappreciable degrees when a large series is examined: *Melania excurata* Con., *M. rorata* Rve., *Trypanostoma spillmani* Lea, *T. moniliferum*, *Io nodosa*, *Io variabilis*, *Io nobilis* and *Io robusta* Lea. There are still other forms which will doubtless fall under *undulatum* as varieties or synonyms.

79. **Pleurocera undulatum nobile** (Lea).

Tennessee River, near Chattanooga (69317); Emory River, near Harriman (69316).

80. **Pleurocera undulatum moniliferum** (Lea).

Aboriginal shell heaps, Williams Island, Tennessee River (69315).

81. **Pleurocera canaliculatum** (Say).

Clinch River, below Patton's Ferry (69368); Tennessee River, near Knoxville (69264).

82. **Pleurocera gradatum** (Anth.).

Tennessee River, near Knoxville (69310); Holston River, 1 mile above junction with French Broad (69309).

83. **Pleurocera filum** (Lea).

Tennessee River, near Chattanooga (69306); Emory River, near Harriman (69308); Tennessee River, near Knoxville (69305).

84. **Pleurocera filum** var?

South Harpeth River, 6 miles from Bellevue (69307).

85. **Pleurocera** —— sp.?

Patton's Ferry, Clinch River (69324).

A peculiar species, not corresponding with any described form, but it may be described in a much worn or truncated condition.

86. **Pleurocera cylindraceum** (Lea).

Emory River, near Harriman (69304.)

It was described from Roane County. *Trypanostoma roanense* Lea is a synonym of *cylindraceum*.

87. **Pleurocera hastatum** (Anth.).

Watauga River, below Watauga Station (69318).

88. **Pleurocera alveare** (Con.).

Clinch River, above Patton's Ferry (69311).

89. **Pleurocera unicale** (Hald.).

Nolachucky, four and a half miles south of Greeneville (69319).

90. **Strephobasis lyonii** Lea.

Tennessee River, near Knoxville (69335); Holston River, 1 mile above French Broad (69336).

91. Strephobasis plena (Anth.).

Tennessee River, Chattanooga (69337); Clinch River, above Patton's Ferry (69338).

S. plena includes as synonyms *S. spillmani, clarkii* and *cornea* of Lea, all from the same region and in the same river system.

Strephobasis is a mere section of *Pleurocera*, and is reducible to some two or three species.

92. Goniobasis[3] **proxima** (Say).

Watauga River, Watauga Station (69290).

93. Goniobasis proxima symmetrica (Hald.).

Doe River, Roan Mountain, 2800 to 4000 ft. (69292); Rock Creek, Roan Mountain 3500 ft. (69291).

The same form occurs plentifully around Cranberry, Mitchell Co. N. C. (Dr. H. Skinner).

94. Goniobasis laqueata (Say).

Richland Creek, Belle Mead, near Nashville (69289); South Harpeth River, 6 miles from Bellevue (69348, 69286, 69347); Big Harpeth River, near Bellevue (69287, 69288).

The specimens are not typical, being more like the synonym or variety *G. deshayesiana* Lea; but there are at least ten other names, probably referable to the same species, leading terms being *plicatula* Lea, *costulata* Lea, *cinerella* Lea, *sparus* Lea, *cerea* Lea, *rugosa* Lea, *corrugata* Lea, *circinata* Lea, *athleta* Anth., *glauca* Anth., *lyonii* Lea, etc.

95. Anculosa subglobosa Say.

Nolachucky River, 6 miles southwest of Greeneville (69342); Watauga River, below Watauga Station (69343); Doe River, 2800 4000 ft. (69344).

96. Anculosa harpethensis Pils. *Sp. nov.*

Mr. Pilsbry's description is herewith given :—Shell globose, with very short spire and rounded periphery; olivaceous brown or yellowish, the surface with slight growth lines. Whorls 5, the body whorl very convex, impressed in the umbilical region. Aperture livid purplish within the outer lip but slightly sinuous, parietal wall and columella heavily calloused, purple; face of columella concave, a projecting angle at union of columellar and basal lips. Alt.

[3] The familiar generic name is used here for convenience, but it must be replaced eventually by *Elimia* H. & A. Adams.

$9\frac{1}{2}$, diam. 19 mm.: alt. 12, diam. 11mm. The globular form and angulation at base of columella separate this form from *A. subglobosa.*

Big Harpeth River, near Bellevue (69357).

97. **Anculosa prærosa** Say.

Holston River, 1 mile above French Broad (69244); Tennessee River, near Chattanooga (29246); Tennessee River, near Knoxville (69245). Indian mound, Williams Island (69248).

98. **Anculosa ornata** Anth.

Tennessee River, near Knoxville (69340); Holston River, 1 mile above French Broad (69339).

PELECYPODA.

Family CYRENIDÆ Fischer.

99. **Sphærium striatinum** (Lam.).

Big Harpeth River, near Bellevue (69325); Johnson City (69326).

100. **Sphærium fabale** Prime

Belle Mead Farm, near Nashville (69328).

101. **Sphærium transversum** (Say).

Samburg, Obion Co. (69327).

102. **Sphærium partumeium** (Say).

Samburg, Reelfoot Lake, Obion Co. (69330).

103. **Pisidium abditum** Hald.

Knoxville (69331).

Family UNIONIDÆ.

104. **Unio acuens** Lea.

Tennessee River, Williams Island (67371); Tennessee River, near Knoxville (69372); Holston River, 1 mile above French Broad (69373).

105. **Unio alatus** Say.

Tennessee River, above Knoxville (68341).

106. **Unio anodontoides** Lea.

Big Harpeth River, near Bellevue, Davidson Co. (68327). Wolf River, below Shelby Co. (68701).

107 **Unio arcæformis** Lea.

Holston River, 1 mile above junction with Tennessee River (68317).

108. Unio asperrimus Lea.

Reelfoot Lake, Obion Co. (68340).

109. Unio biangulatus Lea.

Tennessee River, above Knoxville (68361); Watauga River, below Watauga Station (69370).

Described from Caney Fork.

110. Unio caliginosus Conr.

Clinch River, above Patton's Ferry (69203).

Described from the Red River at Alexandria, La.

111. Unio capsæformis Lea.

Big Harpeth River, near Bellevue, Davidson Co. (68369).

112 Unio circulus Lea.

Big Harpeth River, near Bellevue (68381); Tennessee River, near Knoxville (68362).

An Ohio drainage species.

113. Unio conradianus Lea. (*Conradicus* Lea).

Emory River, Harriman (69222); Watauga River, near Johnson City (69226).

The specimens are, for the greater part, only very slightly plicate on the posterior slope, far less so than Lea's types.

114. Unio cooperianus Lea.

Tennessee River, near Williams Island, below Chattanooga (68375); 2 miles above Knoxville (69211); Clinch River, above Patton's Ferry (68363).

115. Unio cornutus Barnes.

Clinch River, above Patton's Ferry, Roane Co. (68330).

116. Unio crassidens Lam.

Holston River, 1 mile above junction with Tennessee River (68365); Tennessee River, near Knoxville (68327); Tennessee River, near Williams Island, Chattanooga (68347); Clinch River, above Patton's Ferry (68337).

117. Unio cuneolus Lea.

Emory River, Harriman (69201).

Described from the Holston.

118 Unio cylindricus Say.

Holston River, 1 mile above junction with Tennessee River (68342).

119. Unio dromas Lea.

Holston River, 1 mile above junction with Tennessee River (68313); Tennessee River, near Williams Island, Chattanooga (68323); Tennessee River, near Knoxville (68326).

120. Unio edgarianus Lea.

Clinch River, above Patton's Ferry (69206).

One of the specimens collected has the lateral teeth reversed.

121. Unio elegans Lea.

Reelfoot Lake (68376).

The specimens have numerous greenish rays in place of the usual V-like maculation.

122. Unio fascinans Lea (*fassinans*).

Watauga River, below Watauga Station (68387).

123. Unio gibbosus Barnes.

Tennessee River, near Williams Island, Chattanooga (68315); Tennessee River, above Knoxville (68324); Holston River, 1 mile above junction with Tennessee River (68370); Clinch River, above Patton's Ferry, Roane Co. (68314); Emory River, near Harriman, Roane Co. (68339); Watauga River, near Johnson City, Washington Co. (68325).

Shells smaller than those of the northern Mississippi Valley, and often light salmon inside, especially in the Holston River specimens.

124. Unio glans Lea.

Emory River, near Harriman (69377).

Two specimens of somewhat doubtful specific identity.

125. Unio gracilis Barnes.

Wolf River, below Raleigh, Shelby Co. (68700); Holston River, 1 mile above junction with French Broad (69200).

126. Unio haysianus Lea.

Tennessee River, 2 miles above Knoxville (69199).

Described from the Cumberland River.

127. Unio irroratus Lea.

Holston River, 1 mile above Junction with Tennessee River (68354).

128. Unio kirtlandianus Lea.

Watauga River, near Johnson City (69204).

129. Unio lawi Lea.

Emory River, Harriman (69223).

Described from the Tennessee River, Tuscumbia, Ala., and the Holston.

130. Unio ligamentinus Lam,

Holston River, 1 mile above junction with Tennessee River (68335); Tennessee River, near Williams Island, Chattanooga, (68348); Tennessee River, above Knoxville (68368); Clinch River, above Patton's Ferry, Roane Co. (68360); Harpeth River, 6 miles south of Bellevue (68699).

The shells are constantly smaller and rounder than in specimens of Illinois and Iowa.

131. Unio muhlfeldtianus Lea.

Watauga River, near Johnson City (69225).

Described from the Cumberland River.

132. Unio multiradiatus Lea.

Emory River, near Harriman, Roane Co. (68318); Clinch River, above Patton's Ferry, Roane Co. (68338); Watauga River, near Johnson City, Washington Co. (68336).

133. Unio obliquus Lam.

Holston River, 1 mile above junction with French Broad (69217); Tennessee River, near Chattanooga (69214).

134. Unio ovatus Say.

Tennessee River, 2 miles above Knoxville (69279); Holston River, 1 mile above junction with French Broad (69218).

135. Unio parvus Say.

Reelfoot Lake, Obion Co. (68359).

136. Unio phaseolus Hild.

Tennessee River, near Chattanooga (69202); Emory River, near Harriman (69369).

137. Unio pictus Lea.

South Harpeth River, 6 miles from Bellevue (68385).

This was described from Harpeth River specimens.

138. Unio pilaris Lea.

Tennessee River, 2 miles above Knoxville (69213); Holston River, 1 mile above junction of French Broad (69219); Clinch River above Patton's Ferry.

139. Unio plicatus Lesueur.

Reelfoot Lake, Samburg, Obion Co. (68377).

140. Unio propinquus Lea.

Tennessee River 2 miles above Knoxville (69212); Holston River, 1 mile above junction with French Broad (69220); Clinch River, above Patton's Ferry (68353).

This species was described from Florence and Tuscumbia, Alabama, localities far to the southwest of the above.

141. Unio purpuratus Lam.

Wolf River, near Raleigh (68702).

Characteristic specimens of this southwestern form.

142. Unio pustulosus Lea.

Reelfoot Lake, Obion Co. (68366); Holston River, 1 mile above junction with Tennessee River (68367); Clinch River, above Patton's Ferry (68363).

143. Unio pybasii Lea.

Emory River, Harriman (69196); South Harpeth River, 6 miles from Bellevue (69195); Watauga River, near Johnson City (69193).

Lea's specimens were from Tuscumbia, Ala.

144. Unio pyramidatus Lea.

Holston River, 1 mile above junction with French Broad (68364); Tennessee River, 2 miles above Knoxville (69205); Clinch River, above Patton's Ferry (69207).

145. Unio rectus Lam.

Holston River, 1 mile above junction with Tennessee River (68372).

146. Unio rubiginosus Lea.

Big Harpeth River, near Bellevue (68358); South Harpeth River, 6 miles south of Bellevue (68316).

147. Unio securis Lea.

Clinch River, above Patton's Ferry (68331).

148. Unio sphæricus Lea (?).

Tennessee River, near Williams Island, Chattanooga (68373).

149. Unio subrostratus Say.

Reelfoot Lake, Samburg, Obion Co. (69194).

150. Unio subtentus Say.

South Harpeth River, 6 miles from Bellevue (68704); Tennessee River, above Knoxville (68371).

151. Unio texasensis Lea.

Reelfoot Lake, Samburg (69215).

Much larger than the typical form from central Texas, length 56, breadth, 30 mm.

152. Unio trapezoides Lea.

Reelfoot Lake, Samburg (69216).

Two young specimens. The species has not before been reported from so far north, east of the Mississippi, so far as I know.

153. Unio triangularis Barnes.

Tennessee River, above Knoxville (68378).

154. Unio tuberculatus Barnes.

Big Harpeth River, near Bellevue, Davidson Co. (68345); Wolf River, below Raleigh, Shelby Co. (68703).

The specimens from the Big Harpeth belong to the large, densely pustulose, white nacred, northern race.

155. Unio tumescens Lea.

Tennessee River, near Knoxville (69374); Emory River, Harriman (69375); Clinch River, above Patton's Ferry (69376).

Described by Lea from Alexandria, La.

156. Unio turgidus Lea.

Wolf River, near Raleigh (68384).

Described from New Orleans.

157. Unio undulatus Barnes.

Clinch River, above Patton's Ferry (69209); Big Harpeth River, near Bellevue (68344).

On account of the prior *Unio undulatus* Say (now *Alasmodonta undulata*), the name of this well-known species must be changed.

158. Unio ventricosus Barnes.

Big Harpeth River, near Bellevue, Davidson Co. (68328).

159. Unio verrucosus Barnes.

Big Harpeth River, near Bellevue, (68343); Tennessee River, above Knoxville (68349); Holston River, 1 mile above junction with Tennessee River (68350).

160. Alasmodonta complanata Barnes.[5]

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[5] The diverse origin of various elements of the so-called genus *Margaritana* has been demonstrated by Mr. C. T. Simpson. It is practically certain that the group of *M. complanata*, *rugosa*, etc., arose from a different stock of *Unio*

Big Harpeth River, near Bellevue (68346).

161. Alasmodonta confragosa Say.

Reelfoot Lake, Obion Co. (68356).

162. Alasmodonta edentula Say.

Big Harpeth River, near Bellevue (68380); Watauga River, near Johnson City (68379).

Very large specimens, length 12.7 cm., from the Big Harpeth. Probably not specifically distinct from *A. pennsylvanica* Lam. of the Middle States.

163. Alasmodonta marginata Say.

Clinch River, above Patton's Ferry (68332); Watauga River, near Johnson City (68321).

164. Alasmodonta minor (Lea).

South Harpeth River River, 6 miles from Bellevue (69228).

165. Alasmodonta rugosa Bar.

Tennessee River, 2 miles above Knoxville (69229); Big Harpeth River, near Bellevue (68333); Watauga River, near Johnson City (68320).

166. Anodonta grandis Say.

Reelfoot Lake, Obion Co. (68382).

167. Anodonta harpethensis Lea.

Harpeth River, near Bellevue (69230).

168. Anodonta suborbiculata Say.

Reelfoot Lake, Obion Co. (68351).

169. Anodonta imbecilis Say.

Reelfoot Lake, Obion Co. (68322).

SUMMARY: *Pelecypoda*, 71 species; aquatic *Gastropoda*, 41 species; terrestrial *Gastropoda*, 54 species.

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from the *M. margaritifera* and *monodonta;* and Simpson finds numbers of other incongruous elements.

We are hardly prepared, however, to merge the various groups of "*Margaritana*" in *Unio.* Among other disadvantages, a great many specific names would require change, such as the first one of this list; and then, there is a real difference (in the hinge teeth) which would be without recognition in nomenclature. It seems to us that although there are a few forms, such as *Unio pressus,* in which this distinction is obscure, still in the great majority it holds. The subject is a complex one, which should not be decided hastily, and we can well afford to postpone wholesale changes in specific nomenclature until Simpson, von Ihering and other specialists who are now working upon the *Unionidæ* with such gratifying results, shall have arrived at a thoroughly mature classification.

FOSSIL BONES OF BIRDS AND MAMMALS FROM GROTTO PIETRO TAMPONI AND GRIVE-ST. ALBAN.

BY R. W. SHUFELDT, M. D.

For some time past the writer has had in his possession a small collection of fossil bones that were kindly submitted to him by Mr. Jno. Eyerman, of Easton, Pennsylvania, to whose cabinet they belong.

These fossil bones are from birds and mammals, and were obtained from two very different localities, the smaller lot of the two having been collected at the Grotto Pietro Tamponi, and the remainder of them at Grive-St. Alban, in France. In his letter of transmittal, Mr. Eyerman invites my attention to the fact that the celebrated locality, Grive-St. Alban, "is situated in the department of Isère, France, the deposits belonging to the upper division of the Middle Miocene. European geologists have arranged the Middle Miocene into two divisions, of which the upper is distributed principally in isolated patches throughout France, although these deposits are also found in Germany and in the Vienna Basin."

"Grive-St. Alban is justly famous for the large number and great variety of mammalian remains found in its beds, of which we have *Listriodon*, *Hyotherium*, *Palæomeryx*, *Micromeryx*, *Dicroceros* of the Artiodactyla, as well as the earliest antelope, *Protragoceros*. Of the Perissodactyla there are the hornless rhinoceros, *Aceratherium*, *Chalicotherium*. Of the Proboscidea there is the *Mastodon augustidens*. The Rodentia is represented by *Lagomys*, *Myoxus*, *Sciurus*, *Chalicomys* and the large Dormouse, *Cricetodon*. The Carnivora by *Viverra*, *Lutra*, *Dinocyon;* the sabre-tooth tiger, *Machaerodus;* the mongoose, *Herpestes*, and the disputed genus *Haplogale* of Sclosser. The Insectivores by *Plesiosorex*, *Erinaceus* and *Talpa*, and, finally, the fossil Gibbon, *Hylobates*."

In the second locality, or that of Tavolara, we find the "Grotto Pietro Tamponi, consisting of several chambers, and situated on the small Island of Tavolara, in the Gulf of Terranova, a few miles off the northeast coast of Sardinia. The upper chamber of this grotto contains numerous remains of the rodent *Lagomys sardus* (Giebel's variety *corsicanus*). The lower chamber has produced the avian remains."

Taking these specimens by their original numbers, I find them to be as represented in the following list:—

1. The left *carpo-metacarpus* of a bird.
2. The left *radius* of a bird.
3. The right *tibio-tarsus* of a bird.
4. The right *ulna* of a bird.
5. Right and left *femora;* birds.
6. Right and left *humeri;* birds.
7. The right *femur* of a mammal.
8. The right *coracoid* of a bird.
9. The right *tibio-tarsus* of a bird.
10. The right *tarso-metatarsus* of a bird; also the right *ulna* of a mammal.
11. The right *tibio-tarsus* of a bird.
12. Portion of the upper third of the right *tibio-tarsus* of a bird.
13. The distal moiety of the left *tarso-metatarsus* of a bird.
14. The proximal moiety of the *ungual phalanx* of a small mammal (carnivore).
15. The proximal third of the left *carpo-metacarpus* of a bird.
16. The distal extremity of the left *tarso-metatarsus* of a bird.
17. The left *humerus* of a bird.
18. The upper two-thirds of the right *tarso-metatarsus* of a bird (in two fragments).
19. The right *carpo-metacarpus* of a bird (not perfect).
20. Two *carpo-metacarpi* of birds, both from right side, perfect and very small.
21. The right *humerus* of a bird.
22. The right *humerus* of a bird.
23. The proximal moiety of the right *humerus* of a bird.
24. The proximal moiety of the left *tarso-metatarsus* of a bird.
25. The left *humerus* of a bird.
26. The left *ulna* of a bird.
27. The distal extremity of the left (?) *femur* of a mammal.
28. Not received.
29. Not received.
30. The distal extremity of the right *tarso-metatarsus* of a bird (two fragments).
31. The distal extremity of the left *tarso-metatarsus* of a bird (in two fragments).

These specimens are all from adult individuals of the various species they represent; they are, furthermore, thoroughly fossilized; free from any matrix, save in a few instances where a thin layer of a dark-colored incrustation spreads over the ends of some of the long and other bones. They are very light in color, and, upon the whole, quite perfect. Some are thoroughly so, as, for example, Nos. 1, 2, 3, 4, 5, 6, 7, 8, 9, 10 and 20, others exhibit a little chipping at the extremities, or have other slight imperfections, as, for example, Nos. 11, 17, 19, 21, 22, 25 and 26; while, finally, the balance are more or less fragmentary, as set forth in the above list.

No. 7 is a femur that apparently belonged to a medium-sized rodent, but as I have not the proper material wherewith to compare it, it is impossible for me to identify the species. It has a total length of 4.9 centimeters, and presents the usual characters seen in a small rodent's femur, as that, for example, of one of the Sciuridæ, or some of their near allies.

The *ulna* in lot No. 10, and the end of the *femur* in No. 27, also belong to small mammals, but, from lack of material, I am unable to identify them. The first-mentioned specimen has a length of 4 centimeters, while the last is fragmentary, and I take it to be a mammal from the fact that no fibular notch exists in the posterior aspect of the external condyle—a common avian character.

A study of specimens Nos. 1, 2, 3, 4, 5, 6, 8, 9, the tarso-metatarsus of lot No. 10 and No. 11, convinced me that they had one and all belonged to species of Shearwater (*Puffinus*). This conviction was arrived at after comparing the bones with those of a skeleton of *Puffinus borealis*,[1] and with the figures and descriptions given us by Professor Alf. Milne-Edwards in his *Recherches sur les Oiseaux Fossiles de la France*.[2] Furthermore, the tibio-tarsus No. 3 agreed exactly in length and in characters with the specimen No. 9, while in the case of the femora in lot No. 5, and the humeri in lot No. 6, although they agreed in characters, differed in either case, somewhat in length. This, however, amounted to but very little; for example, one of the femora measured 4.0 cms. in length, and the other 3.9 cms. in length, whereas, in the case of the humeri, this difference is a little greater, one having a length of 7.9 cms. and the other only 7.5 cms.

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[1] Mounted Coll. U. S. Nat. Mus., No. 17,772.

[2] Planches 49–53 incl. Atlas I, where the bones of *Puffinus cinereus* are figured. and in Texte I, p. 301, *et seq.* where they are, with others, described.

Disregarding the cnemial projection or process, and measuring the length of the bone from the summit to the lowermost point of the outer condyle, we found that the tibio-tarsus of No. 3 has a length of 6.7 cms., while a similar measurement of the tibio-tarsus No. 11 is found to be 7.4 cms. In this latter specimen the cnemial process has been broken off and lost. So great a distance as this leads me to believe that this longer bone belonged to a different species of *Puffinus*, and that the tarso-metatarsus, marked No. 10, probably belonged to the same species. Indeed, I believe that the bones Nos. 10 and 11 belonged to the same individual, inasmuch as they articulate perfectly when brought together.

So far as I have been able to discover, there have been but few remains of fossil bones of the genus *Puffinus* described. Two of these are to be found in M. Milne-Edwards's work (*Oiseaux Fossiles de la France*, T. II), where, upon page 588, he says, "Le *Puffinus conradi* provient du Miocéne du Maryland; ses dimensions se rapprochaient de celles du Puffin cendré (*Puffinus cinereus* Gmelin), de la côte occidentale d'Amérique;" and again, on page 572, in speaking of *Puffinus arvernensis* (rare à Langy), he says, "Cette espèce, ayant été découverte depuis la publication du chapitre relatif aux oiseaux fossiles de cette famille, sera décrite et figurée dans un travail supplémentaire." Upon comparing the bones before me with the figures of the corresponding ones of *Puffinus cinereus* as given us by Milne-Edwards, I find that the latter species is very considerably larger than were either of the former, so that bones Nos. 10 and 11 did not belong to a specimen of *Puffinus conradi*. In order to make certain that M. Milne-Edwards had not described *Puffinus arvernensis*, I wrote him concerning that species, and received the following reply, accompanied by the drawings he mentions (Plate XXIV, figs. 1 and 2), for both of which distinguished favors my most sincere thanks are here tendered.

MUSÉUM D'HISTOIRE NATURELLE. DIRECTION.

9 Juillet 1896.

Cher Monsieur:

Je m' empresse de vous envoyer un dessin du tarso-métatarsien du *Puffinus arvernensis* de St. Gerand le Puy. Je dois decrire cette espèce dans un supplément à mon Oiseaux fossiles mais vous pouvez faire tel usage qui vous conviendrài du dessin et le publier si vous le desirez; il est fait de grandeur naturelle.

Croyez, cher Monsieur, à mon sentiments tres distingués.

A. MILNE-EDWARDS.

Unfortunately, among the bones of the smaller species of *Puffinus* before me there occurred no specimen of a tarso-metatarsus, so that I am unable to say whether they belong to the species described by Professor Milne-Edwards as *Puffinus arvernensis*, or not. Nevertheless, upon measuring across the condyles at their lower aspects, and taking a similar transverse diameter of the summit of the tarso-metatarsus in Professor Milne-Edwards' drawing, it becomes evident that *Puffinus arvernensis* must have had a tibio-tarsus quite like the one shown in figure 9 of the plate. In other words, I believe the fossil bones of the smaller species of *Puffinus* in Mr. Eyerman's collection very probably belonged to one or two individuals of the type referred to by Professor Milne-Edwards as *P. arvernensis*, which species is based upon the tarso-metatarsus shown in figures 1 and 2. In any event, there is so much likelihood of this being the case, that I do not, at present, feel justified in describing these bones as having belonged to a species unknown to science up to the present writing. These bones have all the characters of the corresponding ones as found in the skeleton of the Shearwater (*P. borealis*) before me, with the exception of some differences in the tibio-tarsi and the humeri. In the former the cnemial crests are much produced upward, as in *Puffinus cinereus*, and call to mind this bone in the Grebes; while in the latter, there is a very remarkable flattening of the bone in the same plane in which the radial crest lies. This flattening is well-shown in figure 7 of the plate.

As has already been said above, the tarso-metatarsus in lot No. 10 and the tibio-tarsus No. 11, undoubtedly belonged to a larger species of *Puffinus*, and one probably smaller than the *P. conradi* of Marsh: in fact, to a form having a size between *P. arvernensis* and *P. conradi* and hitherto undescribed. Therefore, I propose the following for this species:—

Puffinus eyermani n. sp.

Based on a *tibio-tarsus* and a *tarso-metatarsus*, both of the right side. They belonged to adult individuals, or, what is more likely, to the one and same individual, as the bones articulate together perfectly. Disregarding the fractured remains of the cnemial crest of the tibio-tarsus, and measuring between summit and lowest point of condyle, this bone has a length of 7.4 cms, while the tarso-metatarsus is 5.2 cms. long. They both present characters agreeing in the main with the corresponding ones in *Puffinus cinereus* Gmel.

The shaft of the tibio-tarsus is somewhat flattened or compressed in the antero-posterior direction, and its distal third, to some degree, curves gently mesiad. The fibular ridge is well-marked, and occupies rather more than the upper third of the external border of the bone. Distally, we find the usual osseous bridgelet spanning the deep tendinal groove upon the anterior aspect. In the intercondylar space, posteriorly, there is a faint indication of a median longitudinal ridge, that is also visible in *Puffinus borealis* (fig. 8). The *tarso-metatarsus* (Plate XXIV, figs. 3 and 4) is straight, and is grooved for tendons the entire length of its anterior face, and faintly so upon its posterior aspect. Distally the mid-trochlear process is placed the lowest on the end of the shaft, while the internal one is the highest, and is directed backward and slightly inward. The hypotarsus is well-developed and is twice vertically pierced for the passage of tendons, while faint groovings also exist upon its postero-external surface. In the fossa at the proximal end of the bone, just below the summit, are two small foramina piercing the shaft from before backward. The sides of the shaft are flat.

These bones were discovered in the Grotto Pietro Tamponi, Tavolara, an island in the Gulf of Terranova, a few miles off the northeast coast of Sardinia.

The species is extinct, and it gives me pleasure to name it in honor of the well-known paleontologist, John Eyerman, Esq., of Easton, Pennsylvania, in whose collection the specimens, at the present writing, belong.

The specimen marked No. 12, represents the upper part of the right tibio-tarsus of a bird of some considerable size (see fig. 1 of the text). Its procnemial process is slightly broken away above, and the free margin of the summit of the bone behind is also chipped away.

We have in the National Museum a great number of specimens of the fossil bones of birds received several years ago from Professor Alf. Milne-Edwards, and among these, numerous examples of the long bones of *Palæolodus crassipes*, *P. ambiguus* and others of the genus, but this bone did not belong to a *Palæolodus*. Upon comparing with such material as I had of *Pelecanus gracilis*, it was quickly seen that it never came from a Pelican, and the fact was further confirmed by carefully comparing it with the tibio-tarsi of numerous species of existing forms of that group. In short it has been compared by me with every figure of the larger birds where the tibio tarsus has been figured, in all the works at hand, as well as with the tibio-tarsi of representative groups of existing types.

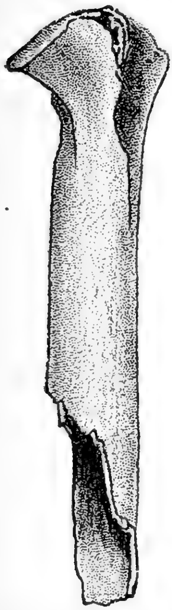

FIG. 1. Anterior aspect of the tibio tarsus of *Tantalus milne-edwardsii*, being the upper part from the right leg. Natural size; drawn by the author.[3]

By differential diagnosis, I am satisfied that its owner was a *Tantalus*, and that too, very near *Tantalus loculator*. Moreover it was a *Tantalus* of almost precisely the same size as *T. loculator*, and its tibio-tarsus presents characters agreeing very closely with that species. The agreement is so close that it would appear unnecessary to remove it from that genus, I therefore propose the following:

Tantalus milne-edwardsii n. sp.

Based upon the upper part of the *right tibio-tarsus* (nearly complete). Characters as in *Tantalus loculator*, to which latter species, the present one must have been closely related. This species I name in honor of the very distinguished French savant Professor Alphonse Milne-Edwards, who not only has assisted me in the present paper, but to whom modern science owes so much in so many departments.

The specimen was collected at Grive-St. Alban (Isère), and it is at this writing in the collection of Mr. Jno. Eyerman, of Easton, Pennsylvania, U. S. A.[4]

Specimen No. 13, (the lower half of a bird's tarso-metatarsus, from the right pelvic limb), evidently belonged to some adult, medium sized species of a falconine form, probably now extinct. As I have not the proper material in sufficient quantity to compare this specimen with, I do not feel warranted in naming it.

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[3] After this drawing was made, two other small fragments were found that, when placed in situ, simply completed the distal broken part of this fragment.

[4] In comparing this bone, the following works and the plates and figures thereto were also examined. Cuvier: Recherches sur les ossements fossiles, t. III, p. 327, pl. LXXIII, fig. 14 (*Ibis*); P. Gervais: Oiseaux fossiles, thèse, 1844, p. 39; *Idem*, Jour. l. Institut., 1844, p. 293; *Idem*, Zoologie et Palæontologie françaises, 1st edit., p. 230, pl. XLIX, figs. 2, 3, p. L, fig. 1 (*Numenius gypsorum*); 2d ed., 1859, p. 410; Giebel: Fauna der Vorwelt, 1847, t. II, p. 28 (*Tantalus fossilis*). I think the specimen here alluded to is either a *Numenius* or an *Ibis*, surely not a *Tantalus*.

For specimen No. 14, see list above; too fragmentary for correct identification. To be named with certainty, No. 15 is also too fragmentary; while the remarks about specimen No. 15, apply with equal truth to No. 16, though this last has hardly anything beyond the trochlear processes, the distal part of the shaft having been broken off, but a few millimeters above the usual foramen found in this locality.

Specimen No. 17 is a very perfect one, being the *left humerus* of an adult Partridge, *Palæortyx brevipes* of Milne-Edwards.[5] It demands no special description.

In specimen No. 18, we have the fragments of the upper two-thirds of the right tarso-metatarsus, (probably) of some small passerine bird, which my meagre material for comparison will not admit of my identifying. On this bone the *hypotarsus* is short, being composed of two lateral portions enclosing a tendinal foraminal canal between them. Both of these lateral portions are distinctly grooved in the vertical direction, upon their posterior aspects, by tendinal channels. To identify such a minute, fragmentary specimen as this, one should have before him for comparison the skeletons of a representative series of the small birds of France in its existing avifauna, as well as access to such fossil forms as have been discovered or described up to date. To appreciate the difficulty of diagnosis of this nature one has but to make the trial to distinguish the *complete* skeleton of any one of our American Warblers from those of its near allies in other genera, and my meaning will be made clear. How much more difficult is it then to name, with any hope whatever of being near the truth, the bits of bones of birds of no greater size that existed in a former geologic age of the earth. With skulls, sterna, pelvis and *perfect bones* all absent this really becomes impossible—absolutely so in the absence of the material above indicated.

These remarks apply with equal truth to specimens Nos. 19–23 inclusive; the small pair of carpo-metacarpi (No. 20) in this series are the smallest fossil bones of this part of the skeleton I have ever seen; either one of them is as small as the *unidentified* specimen of this bone in Milne-Edwards' great work, and figured on Plate 155, (Atlas 2, fig. 11); they are, however, from a different species.

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[5] See *Recherches sur les Oiseaux fossiles de la France*, Atlas 2, Plate 130, fig. 13.

The fragment of bone in specimen No. 24 is from an Owl—the extinct *Bubo arvernensis* of Milne-Edwards (see *Oiseaux fossiles*, Atlas 2, Plate 192, figs. 11 and 15).

No. 25 is the *humerus* of some medium-sized bird equal to about that of *Tringa gracilis* of Milne-Edwards, but it did not belong to that species. It is non-pneumatic, with characters in many respects agreeing with the humeri of small water birds, as plovers or sand pipers, but it lacks the *epicondyloid process* possessed by this bone in both Gulls and *Tringæ*. It has a length of 3.5 centimeters. I do not care to pronounce upon it before comparing with fuller material.

No. 26, a small bird's ulna, but 2.1 centimeters long and with a very sharp olecranon process, comes in the same category as Nos. 19–23, (see remarks above). Its shaft is distinctly marked by 6 papillæ for the quill-butts of the secondary feathers, they being about 2 mm. apart.

The bones in Nos. 30 and 31 are the distal ends of the tarso-metatarsi of small Gulls of the genus *Larus*. The first I take to have belonged to an individual of the extinct species *Larus totanoides*[6] aud the other to the somewhat smaller species *Larus elegans* both of Milne-Edwards.[7] I am the more convinced of this, inasmuch as I have compared them, at least in the case of *Larus elegans*, with a number of the fossil tarso-metatarsi of that extinct form in the palæontological collections of the U. S. National Museum, and the agreement is altogether too close to admit of any doubt.

Explanation of Plate XXIV.

Fig. 1. Left tarso-metatarsus of *Puffinus arvernensis*, anterior aspect, natural size. From a drawing by Prof. Alphonse Milne-Edwards.

Fig. 2. Left tarso-metatarsus of *Puffinus arvernensis*. Same bone as shown in figure 1. Natural size, and viewed upon its externo-lateral aspect.

Fig. 3. Right tarso-metatarsus of *Puffinus eyermani*, anterior aspect, natural size. Drawn by the author.

Fig. 4. Right tarso-metatarsus of *Puffinus eyermani*. Same bone as shown in figure 3. Natural size and viewed upon its externo-lateral aspect. Drawn by the author.

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[6] *Oiseaux fossiles*, Atlas 1, Planche 57, fig. 12.

[7] *Loc. cit.*, Planche 56, fig. 11.

Fig. 5. Right coracoid of *Puffinus arvernensis* (?), anterior aspect, natural size.

Fig. 6. Anconal aspect of the left humerus of *Puffinus arvernensis* (?), natural size.

Fig. 7. Ulnar surface of the left humerus of *Puffinus arvernensis* (?), natural size.

Fig. 8. Right tibio-tarsus of *Puffinus eyermani,* natural size and viewed upon its anterior aspect. Cnemial process restored in dotted line.

Fig. 9. Right tibio-tarsus of *Puffinus arvernensis* (?), natural size, and viewed upon its anterior aspect. Figures 5–9 inclusive, drawn by the author.

MAMMALS COLLECTED BY DR. A. DONALDSON SMITH DURING HIS EXPEDITION TO LAKE RUDOLF, AFRICA.[1]

BY SAMUEL N. RHOADS.

In the following annotated list of the mammals collected by Dr. A. Donaldson Smith during his African expedition of 1894–'95 across Somaliland to Lake Rudolf, I have included all the species coming under my observation which were brought back by Dr. Smith to Philadelphia.

The greater part of the collection was most generously given to the Academy of Natural Sciences of Philadelphia, but a large part of the skulls, mounted heads and skins of the larger game have been reserved by Dr. Smith, and at present form an exhibition at the University of Pennsylvania. Those species in the list not represented in the donation to the Academy are preceded by an asterisk.

The entire collection represents 50 genera and 77 species,[2] seven of which are here described as new.

Dr. Smith is to be congratulated on having brought to Philadelphia by far the largest, most comprehensive and best preserved faunal collection of African mammals ever acquired by an American institution, and not only many species, but several genera are for the first time made accessible to students on this side of the Atlantic.

Owing to the almost total lack of specimens in this country for comparison, and the widely scattered literature relating to African mammalogy, the author has been severely handicapped in his study of the collection, and it is hoped that the paper, as now presented, will be judged accordingly.

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[1] At the request of Dr. Smith this paper was originally prepared for publication in his forthcoming book on the Lake Rudolf expedition. Less than three months were alloted the writer for its preparation. The mss. was subsequently returned, with other papers of scientific character intended for the work, on account of lack of space and was then accepted for publication in the Proceedings of the Academy of Natural Sciences of Philadelphia.

[2] This includes four genera and five species of bats, which have been worked up by Dr. Harrison Allen in a separate paper, viz : *Megaderma frons*, *Megderma cor*, *Nycteris capensis*, *Scotophilus minimus* and *Adelonycteris* sp. ?

*1. **Hippopotamus amphibius** L. Hippopotamus.

A skull and several incisor teeth are in the University of Pennsylvania series.

*2. **Phacochoerus africanus** (Gmel.). Ælian's Wart Hog.

A skull and a mounted head are in the University of Pennsylvania exhibit.

*3. **Giraffa camelopardalis** (L.). Ethiopian Giraffe.

The skull of a female, with full head and neck skin to shoulders, was mounted at the Academy of Natural Sciences of Philadelphia. It exhibits the peculiarities defined by Mr. Thomas[3] for the northern form. The application to this form of the name *æthiopica* of Sundevall[4] is, however, incorrect, as the *camelopardalis* of Linnæus is assigned by that author to "Æthiopia and Sennar."[5] This makes Sundevall's name a synonym, the southern race remaining, so far as I can ascertain, unnamed. I would propose for the latter the name *Giraffa camelopardalis australis, Nom. nov.*

*4. **Bubalis swaynei** Scl. Swayne's Hartebeest.

Represented by five (?) skulls in the University of Pennsylvania series.

5. **Bubalis cokei** (Günth.). Coke's Hartebeest.

One pair of horns in the collection of the Academy of Natural Sciences of Philadelphia (No. 3,933), and four mounted heads in the University of Pennsylvania.

*6. **Damaliscus jimela** (Mtsch.). Topi Antelope.

One mounted head and one skull in the University of Pennsylvania represent this species.

7. **Madoqua guentheri** Thos. Gunther's Dik-dik.

A mounted male specimen, entire, with skull separate, in the Academy of Natural Sciences of Philadelphia series (No. 3,900), belongs to this very distinct species. While the colors of the back and head closely resemble those of the following (*M. phillipsi*), the tawny ochraceus tints of the belly of *phillipsi* constantly distinguish it from the white bellied *guentheri*. In the Academy's specimen of the latter, the back is quite as gray as in Thomas' and Sclater's figure of *phillipsi*,[6] not rufous, as there figured.

[3] Proc. Zool. Soc., 1894, p. 135.
[4] K. Vet. Akad. Handl., 1844, p. 175.
[5] Syst. Nat., 1758, p. 66
[6] Book of Antelopes, 1896, part V, pl. XXXI.

8. **Madoqua phillipsi.** Phillips's Dik-dik.

Six flat skins and four skulls (Nos. 3,901–3,904), the latter being in the collection of the Academy of Natural Sciences of Philadelphia.

*9. **Oreotragus oreotragus** ("Forst.," Schreb.). Klippspringer Antelope.

A mounted head and an entire skin of this antelope are in the University of Pennsylvania series.

*10. ? **Kobus ellipsiprymnus** (Ogilb.). Common Waterbuck.

One mounted head in the University of Pennsylvania exhibit.

*11. **Kobus defassa** (Rupp.). Defassa Waterbuck.

A skull is in the University of Pennsylvania series.

*12. **Cervicapra** sp.?

Two pairs of horns with portions of attached skulls indicate this genus too imperfectly to determine the species they represent.

13. **Gazella thomsoni**[7] Gunth. Thomson's Gazelle.

Two skulls of males and two skins (Nos. 3,898, 3,934, 3,935, 3,994) were given the Academy of Natural Sciences of Philadelphia. The skull of a young male agrees exactly with Peters' figure[8] of a young *granti* which Gunther made the type of *G. petersi.* A comparison with our series of *granti* and *thomsoni* convinces me that *petersi* is a young *thomsoni.*

*14. **Gazella soemmerringi berberana** (Mtsch.). Soemmerring's Gazelle.

Several specimens which adorn the University of Pennsylvania collection belong to this race.

15. **Lithocranius walleri** (Brooke). Waller's Gazelle.

Two skulls, male and female, (Nos. 3,896, 3,897), were presented to the Academy of Natural Sciences of Philadelphia. Three male heads are in the University of Pennsylvania series.

*16. **Oryx beisa** (Rupp.). Beisa Antelope.

Two mounted heads and four skulls in the University of Pennsylvania series. *O. callotis* Thos. does not seem to have been met with.

*17. **Strepsiceros strepsiceros** (Pall.). Greater Kudu.

The University of Pennsylvania contains one mounted head of this species.

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[7] Syn., *Gazella petersi* Gunth., Ann. Mag. N. H., 1884. p. 426.
[8] Monatsb. Akad. Wis. Berl., 1879, p. 832, Pl. V.

*18. **Strepsiceros imberbis** Blyth. Lesser Kudu.

A head of this animal was taken by Dr. Smith. It is now beautifully mounted.

19. **Equus grevyi** M. Edw. Grevy's Zebra.

A remarkably large skull was added to the already fine collection of zebra crania in the collection of the Academy of Natural Sciences of Philadelphia. Its greatest length, from the anterior edge of the premaxillary to the superior rim of the occiput, measured in a straight line, is 633 mm. Its greatest zygomatic width is 220 mm. The alveolar length of the upper molar series is 170 mm., and the greatest length of mandible is 507 mm. The specimen is of an old male and, compared with a skull of *E. burchelli* of same age, is 100 mm. longer, and is nearly 50 mm. longer than the largest skull of *E. caballus* in the collection of the Academy of Natural Sciences of Philadelphia. Compared with that of *burchelli* the skull of *grevyi* is remarkably long for its width, due to the great relative prolongation of the rostral and occipital regions. In *burchelli* the length of skull is 2.63 times the width, in *grevyi* it is nearly three (2.88) times the width. The lower molar series differ markedly from *burchelli* in their uniformly massive size and great width, the same series in *burchelli* becoming much narrowed posteriorly. In the last named, the postpalatal fossa reaches opposite middle of $\overline{\text{m. 2}}$, in *grevyi* it barely reaches opposite the anterior alveolus of $\overline{\text{m. 3}}$.

*20. **Rhinoceros bicornis** L. Round-eared Rhinoceros.

Of the smaller two-horned species there is a mounted head and six pairs of horns in the University of Pennsylvania collection. With the exception of one pair, the horns more closely resemble those figured by Smith[9] in his plate of *Rhinoceros simus* than those of *bicornis* figured by the same author on plate 2.

Dr. Smith informs me that while he encountered *R. simus*, no specimens were brought by him to this country.

21. **Procavia brucei somalica** Thomas. Somali Tree Hyrax.

An adult female (No. 3,818) taken at "Shebeli" September 4, 1894, and another female, two-thirds grown, taken March 3, 1894, fully confirm Dr. Thomas' diagnosis[10] of this subspecies of *brucei*. Compared with an adult female specimen of *brucei* from the Kyahn Mountains, near Mount Kilima-Njaro, kindly loaned me by the

[9] Illust. Zool. S. Afr.
[10] P. Z. S., 1892, p. 71.

Smithsonian Institution, the paler sandy cast of the Somali specimens is very noticeable, and the dorsal spot is almost white instead of ochraceus. The difference in size of skulls, between the type and the subspecies, although the Shebeli specimen is the older, is very marked, but no specific distinctions are noticeable.

*22. **Elephas africanus** Blbch. African Elephant.

Ten small, and one large pair of tusks adorn the University of Pennsylvania collection.

23. **Sciurus** sp.?

An adult male specimen (No. 3,810) from Marsabit, taken September 11, 1895, differs in many particulars from any African squirrel which I can find described. It may be characterized as follows: Colors—Upper head, back and the slender tail, dull black, grizzled with tawny brown; half the hairs of back wholly black, the remainder black-based with light brown ring and black tip. Brown-ringed hairs more numerous on sides, giving a lighter shade to those parts. Upper and lower sides of tail colored alike, blacker toward distal end; hairs at base black with one to three light brown rings, terminal hairs longer and blacker with now and then a subterminal brown ring. Upper feet and scrotum rusty haired. Whisker patch, cheeks, line around eyes, chin, throat, breast, inside of legs, and a narrow abdominal line dirty tawny white or fawn. Ears sub-triangular, colored like back. Fur rather short and harsh. Whiskers sparse, weak, black. Color of sides encroaching on abdomen.

Measurements (from skin).—Total length 320 mm.; tail vertebræ 160; pencil 43; hind foot 40. Skull—Total length 40 mm.; greatest breadth 24; length of nasals 11; length of mandible 23.5.

This squirrel apparently comes nearest *S. poensis* A. Smith, but it lacks any trace of greenish color, is smaller and the tail and body are of equal lengths. Like *poensis* the five upper molars on each side are well developed and permanent.

It appears too small and dark for *S. cepapi* A. Smith. With any of the recently described species it seems to have no close affinities.

24. **Sciurus** sp.?

A young male squirrel in alcohol, from the Ganana River (February 18, 1895), is colored somewhat like *S. annulatus* Desm. and *S. cepapi* Smith. Like *cepapi* it has five upper molars, but unlike either of the above, its tail vertebræ are more than 1½ times the length of the body without the head. The specimen is about two thirds grown; its total length is 269 mm., tail vertebræ 150, hind foot 37, tail tuft 40.

25. Sciurus ganana sp. nov. Ganana Jungle Squirrel.

Type, ad. ♀, No. 3,809; collection of Academy of Natural Sciences of Philadelphia, Dr. A. Donaldson Smith Collection; taken February 18, 1895, on the Ganana River at Bar Madu.

Description—Size smallest (?) of the East African squirrels; tail $1\frac{1}{7}$ times length of head and body; head long and very slender; ears large, rounded and somewhat pointed, without tufts. Fur soft and rather short. Above, uniform tawny ochre, faintly grizzled with black; below, tawny white.

Upper tail colored like back, lower tail with broad mesial stripe of clear, rusty ochre.

The dorsal hairs are black-based and black-tipped, with a subterminal ring of ochre, as are also those of the upper head. On the sides the hairs are black at base with long ochre tips, and on the limbs and feet and sides of neck the ochre almost obscures (externally) the darker basal color. The tawny white hairs of lips, chin, throat, breast, abdomen and inner legs are unicolor to their bases. The region just above and below eyes is of the same color. The whiskers reach to tip of recumbent ears and are sparse and black.

The hairs of upper tail are ochre and black, ringed by four to six alternating zones of equal width, the basal one being ochre, the minute terminal one black. The lower mesial tail hairs appear to be uniform rusty ochre, but a glass reveals a narrow, subterminal black ring. The outer border and tip of lower side of tail is like the upper side.

The skull is remarkably narrow and deep for its length, the postorbital process very short and blunt, the brain-case highly and narrowly arched and the audital bullæ widely separated from the pterygoid processes, owing to the strong, indented constriction of the inner anterior border of the bullæ. The auditory meatus is also compressed within the outer lateral plane of the overhanging squamosal. Upper molar series with permanent, cylindric $\underline{\text{pm. 2}}$.

Measurements (taken by collector, in the flesh)—Total length, 320 mm.; tail vertebræ, 170; hind-foot, 38; height of ear (from crown, dry), 9; tail pencil, 40.

Skull—Total length, 39 mm.; basilar length (of Hensel), 32; greatest breadth, 21·5; greatest depth (occiput to plane of bullæ and incisors), 17; length of nasals, 11; post-orbital constriction (behind processes), 12; breadth between auditory meatus (lower border), 15; greatest length of mandible, 22; greatest breadth of mandible, 14.

One specimen, a skin of an old female, with skull, in good condition, represents this distinctly marked little squirrel. So far as I am able to distinguish, it differs in size, color and cranial characters from any described species. Its relationships are with *S. cepapi*, but its smaller size, light color and high, narrow, brain case, with long compressed zygomæ, separate them.

On the accompanying label the specimen is stated to have been "shot in the thick jungle on River Ganana. Was accompanied by 4 young ones." The well-developed teats, 2 pectoral, 2 abdominal, 3 inguinal, show evidence of recent nursing.

26. Xerus rutilus (Cretzsch.). Abyssinian Spiny Squirrel.

Three adult skins, with skulls, from Hargesa, taken between the 17th and 28th days of July, 1894, are very similar in their colors, being tawny ferruginous, lined with black on crown and along middle back. The rostrum, sides of body and outer sides of limbs are a peculiar fleshy cinnamon, each hair being white tipped. Underparts white, with tawny cast due to exposed skin. Hind feet whitish above. Tail, above faded rusty, below brownish black with faded border. Hairs worn and ragged, with new, brown-black, white-tipped hairs sprouting beneath the old, but no evidences of molt on body.

In another specimen (Ad. ♀, No. 3,806), taken August 29, 1894, at Shebeli, the cinnamon of sides is almost obscured by the white hair tips, the back is clear, black-grizzled fawn and the hind head and limbs like sides. The tail in this specimen has quite recently molted and is a beautiful black above, broadly margined and tipped with glistening white. Below there is a mesial stripe of fleshy brown bordered with black and the latter is fringed with white, as above.

In a very old male, taken March 23, 1895, the back and hind head are much blacker, and the forehead, sides and limbs nearly chestnut-red; the whisker patch, throat and sides of head, neck and a narrow lateral marginal line, fulvous. The tail is in the molt to the black and white pelage and the old pelage is much darker (brown-black) than in the other specimens and lacks any sign of the mesial band.

Two, quarter-grown young, male and female, in alcohol, are colored like the adults on head and fore-limbs, the rest of the body above is sandy-brown, the outer tail hairs are dull white, the upper vertebral line of tail showing short black and rusty hairs. The tail (without hairs) is about the length of body without head. Its tip is blunt and the whole organ viewed from above is remarkably triangular, measuring across base, in the spirit specimen, about 10 mm. and tapering evenly to the point. The tail is much flattened and a strongly depressed vertebral line above and below separates the thickened, rounded fleshy sides. The external sexual organs of the young male are very strongly developed.

In adult suckling females the teats are very long (8 to 12 mm.), 2 abdominal, 2 inguinal.

Specimens in the collection of the Academy of Natural Sciences of Philadelphia.

No. 3,804	♂,	El Dere, ...	March, 23, 1895.
No. 3,805	♂,	Milmil, ...	July 27, 1894.
No. 3,806	♀,	Shebeli, ...	August, 29, 1894.
No. 3,807	♀,	Hargesa, ...	July 17, 1894.
No. 3,808	♀,	Hargesa, ...	July 18, 1894.
No. 3,859 Juv.	♀,	Hargesa, ...	July 18, 1894.
No. 3,860 Juv.	♂,	Hargesa, ...	July 18, 1894.

27. Lophiomys smithi sp. nov. Smith's Maned Rat. Plate XXV.

Type, Ad. ♂, No. 3,803, Museum Academy of Natural Sciences of Philadelphia. Collected at Sheikh Husein, West Somaliland (about lat. N. 8°, long. E. 41°), Africa, by Dr. A. Donaldson Smith, Sept. 30, 1894.

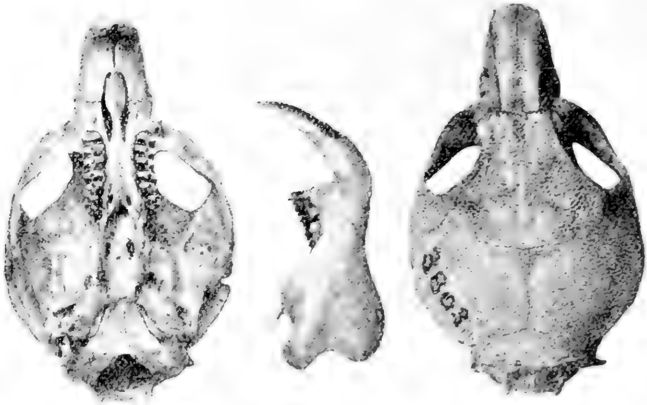
Description—Smaller than *L. imhausi;* tail shorter than body without head, not tufted. White crown and ear patch separated by a black band. Nasals narrow at base; interorbital width of frontals less than half their postorbital width. Jugal and frontal processes not separated by the squamosal.

Color—above, from neck to base of tail and down to dividing lateral band of brown, iron-gray, the fur composed of two kinds: first, a very fine silken under fur about 20 mm. long, composed of white hairs, a few of which are wholly white but about 70 per cent. are brownish-black at the basal half. Among these are evenly interspersed, in the proportion of about one to eighty, slender bristling hairs, 60 to 65 mm. long. The basal fifth of these hairs is black, followed by a similar length of white, then a much longer subterminal one of black, the tip being white. The same style of pelt and coloration is found on the sides, tail, belly and legs, except that the bristling hairs become fewer, almost disappearing on the shoulders and sides of neck and becoming obsolete on the underparts. The tail is unicolor, except a short white tip. There is a well-defined occipital band of black between the anterior bases of ears, forming a V-shaped extension into the middle of the white crown patch and connecting across the anterior base of ear with the black area of cheeks, nose, lower head and supraorbital stripe. There is a faint isolated patch of white half way up between the eye and the mouth, and a conspicuous patch of the same in front of and below each ear. The feet are sparsely clothed with coarse, black hair, becoming bristly on the toes and exceeding them in length. The whiskers reach almost to shoulders and are wholly jet-black. The backs of ears are very sparsely clothed with short brownish and white hairs, but their margins and inner surfaces are thickly set with bristly white hairs, 3 to 5 mm. long. The lateral band of short spinuous hairs, which divides the dorsal from the costal mane areas, begins broadly and sharply at the base of the neck on a line with the ear, and terminates indefinitely near the sacrum in a slender point of hairs. The larger of the hairs measure about 20 mm. long and are olivaceous brown, becoming rusty near the tips, with whitish subterminal ring and minute black tip. The median abdominal and pectoral areas are blacker than the sides.

Measurements (of body, taken in flesh before skinning, by the collector)—Total length, 380 mm; tail vertebræ, 140; hind foot 40; ear (from crown, dry skin), 12.5.

Skull—Total length, 52; basilar length (of Hensel), 46; greatest breadth, 31; interorbital constriction, 10; length of nasals, 16; greatest breadth (anterior) of nasals, 6.8; basal breadth of nasals, 5; length of upper molar series (alveolar), 12.2; length of mandible, 34; breadth of mandible, 15.2.

A fine skin of a male, with perfect skull, forms one of the most valuable treasures in Dr. Smith's collection. It was taken at Sheikh Husein, September 30, 1894, and is now mounted and deposited in the Museum of the Academy of Natural Sciences of Philadelphia. The skull forms a separate presentation (No. 3,803) in the Academy's collection.



According to Giglioli,[11] there were only four specimens of *Lophiomys* known to have been taken, up to 1881:

1. Skin, skeleton and viscera (Aden, 1866). Type in Paris Museum.

2. Skull (Maman, 1867). Type of *Phractomys æthiopicus* Peters, in Berlin Museum.

3. Mounted skin and skeleton (Keren, Bogos 1870). In the Genoa Civic Museum.

4. Skin and skull (Erkanid near Suakin, 1881). In the Florence Zoological Museum.

Dr. Smith's specimen appears to be the fifth. It is certainly the first to reach an American museum.

Compared with Milne-Edwards' illustrations[12] of the type of *imhausi*, the Smith specimen is somewhat younger and smaller, with much shorter tail, though fully adult. The pelage is more worn or naturally shorter than in the type, and consequently is appreciably lighter colored throughout, owing to the more exposed bases of the fur. The tail almost wholly lacks the white tip, and the head the small white patch under eye, of *imhausi*.

The most marked color difference in the Sheikh Husein example is seen in the division of the white of upper head by a distinct black band joining the dark area of occiput with that of the side of head

[11] Zool. Anz., IV, p. 45.
[12] Archiv. du Mus., 1867, pl. VI and VII.

at the upper anterior base of ear. There is a large white spot 25 mm. long and 10 mm. wide reaching around lower base of ear to angle of jaw, and the ears are broadly tipped and fringed with white; both these characters not being shown in Milne-Edwards plate of *imhausi*.

Cranially, the Smith specimen differs specifically in its narrow interorbital width, the less produced expansion of the occipital region beyond posterior line of the interparietal and the almost complete suppression of the forward extension of the squamosal. In the type of *imhausi* this bone forms an exterior rectangular keystone about 3 mm. square, at the junction of the frontal, parietal and jugal bones, distinctly separating the superior wing of the jugal from contact with the lateral wing (postorbital process) of the frontal; in the Smith example these bones touch each other, being only separated anteriorly by a slender, irregular extrusion of the squamosal ½ mm. wide and 2 mm. long.

The dentition of *smithi*, making allowance for the difference in age, appears to be almost identical with Edwards' figures[11] of *imhausi*, except that the posterior upper molar lies wholly outside the median longitudinal axis of the anterior molars. In the latter the nasals are broader posteriorly than anteriorly, these proportions being reversed in *smithi*. In *imhausi* the postpalatal notch is opposite anterior base of posterior molar; in *smithi* it only reaches the middle of that tooth. The paroccipital processes in *smithi* are directed forward against the audital bullæ; in *imhausi* they are directed backward and separated from the bullæ by a distinct space. The mandible of *smithi*, while exactly the same length as that of *imhausi*, is very much more slender, the greatest breadth of the latter being 4 mm. greater. The three recorded specimens[13] all came from a tract on the Red Sea north of the 15th parallel; *smithi* was taken on a mountain 5,000 feet high, in the Indian Ocean-drainage about 700 miles southeast of the most southern recorded locality of an *imhausi* specimen.

For an account of the capture of the specimen and of the nature of its habitat, the reader is referred to Dr. Smith's narrative.

28. Acomys spinosissimus Peters. Peters' Acomys.

A series of Spiny mice, taken between the 12th of March and the 17th of April, 1895, and preserved in alcohol, seem to correspond

[13] Milne Edwards' type was purchased alive at Aden. Its locality was apparently near that of the others, as they are regarded as the same species.

most closely to *spinosissimus*. One specimen (No. 3,872), a young adult male, resembles Peters' figure,[14] except that it wholly lacks any rufous tinge on the uniformly olive-black upper pelage. The skull of this specimen is so like that of several others taken about the same time that I am induced to consider them the same species. Two very old adults (Nos. 3,868, 3,873), ♂ and ♀, are blackish-chestnut on back and upper head, and bright rusty cinnamon along the sides, the under parts and feet white. The total length of the old male is 195 mm.; length of the tail, 93; of hind foot, 17. The length of the skull is 29 mm., while that of the dark specimen (*l. c.*) is 2 mm. shorter. Two other hardly adult specimens (Nos. 3,863, 3,864) are somewhat intermediate in color between the dark and light examples, with which their cranial characters affiliate them. Their bellies and feet, however, are as white as in the old adults.

Briefly stated, this series, if representing one species, as I am inclined to think it may, indicates an animal, which in the old adult stage, is much redder above and whiter below than Peters's description of *spinosissimus*, which corresponds with the more immature forms. It is possible that the dark specimen only is referable to Peters's species and the others to some undescribed form.

The adult female contained three large embryos. As the animal grows older the tubercles on the feet become more prominent and interspersed with granulations. The two specimens from Finik near Webi Shebeli (Nos. 3,877, 3,878) are not different from the other rusty specimens. The young one is pale fawn and seems to show that the dark olive coloration is not a character of immaturity.

Specimens in alcohol; collection of the Academy of Natural Sciences of Philadelphia:

No. 3,863	♂,	Aimola, ...	March, 12, 1895.
No. 3,864	♀,	Lake Abaya, . . .	May 10, 1895.
No. 3,865	♀,	Aimola, ...	March, 12, 1895.
No. 3,866	♂,	Ber Madu, ...	February 16, 1895.
No. 3,867	♂,	Aimola, ...	March 14, 1895.
No. 3,868	♀,	Aimola, ...	March 14, 1895.
No. 3,869	Foetal,	Aimola, ...	March 14, 1895.
No. 3,870	Foetal,	Aimola, ...	March 14, 1895.
No. 3,871	Foetal,	Aimola, ...	March 14, 1895.

[14] Reise n. Mossamb., 1852, pl. XXXIV, fig. 1.

No. 3,872	♂,	Argasa, ...	April 17, 1895.
No. 3,873	♂,	Aimola, ...	March 14, 1895.
No. 3,877	Juv.	Finik, ...	December 14, 1894.
No. 3,878	♀,	Finik, ...	December 14, 1894.

29. Acomys sp.?

A male specimen, (No. 3,862), the only one of this genus from Sheikh Husein, is lighter colored than any of the foregoing listed under *spinosissimus,* and the tail is not longer than the body. The ears are much larger than in any *Acomys* I have examined. The skull differs in the great width of the audital bullæ and the abrupt compression of the jugal at its squamosal insertion.

The total length of this mouse is 150 mm.; the tail, 60; the hind foot, 16.5; the ear from crown, 11.

30. Acomys wilsoni Thos. Short-tailed Spiny Mouse.

A spirit specimen of an old male, (No. 3,861), corresponds so exactly with Oldfield Thomas's description[15] of *wilsoni* as to leave no doubt of its identity. The tail is only 47 mm. long; the body, 182; the hind foot, 13. The skull is 24.5 mm. long by 11.2 in breadth. The coronoid process is well developed as compared with the other *Acomys* in the collection.

This specimen was taken at Burga Camp, Amara.

31 Steatomys parvus sp. nov. Lesser Fat Mouse.

Type, No. 3,879, ad. ♀; collection of the Academy of Natural Sciences of Philadelphia. Collected by Dr. A. Donaldson Smith, July 14, 1895, at Rusia, Lake Rudolf, Africa.

Description—Size small, tail short and slender, less than one-third the length of head and body. Colors similar to *Steatomys pratensis* Peters (=*S. edulis* Ptrs.).

Above, uniform tawny brown, lined with black, slightly darker on back and hind head; sides more tawny. Underparts, including feet, uniform soiled white. Upper and lower tail, colored like corresponding parts of body. A white spot at base of ear.

Measurements—Total length, 107 mm.; tail vertebræ, 33; hind foot, 13; ear, from crown, 8.

Skull—Total length, 20 mm; basilar length (of Hensel) 17; greatest breadth, 11; interorbital constriction, 3.4; length of nasals, 7.8; length of upper molar series, 3.2; length of mandible, 11.3; breadth of mandible, 6.6.

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[15] Ann. Mag. N. Hist., 1892, p. 22.

Only one specimen of this genus is in the collection. It is an adult female with teeth well worn and showing plainly three pairs of teats, pectoral, abdominal and inguinal.

The specimen is in spirit. It differs decidedly from *S. pratensis* and *S. krebsi,* as figured and described in Peters' work on the mammals of Mozambique, in its diminutive size. Its tail is also relatively much shorter and the ears smaller than in either of these species. Its colors resemble those given in Peters' plate (*l. c.*) of "*edulis,*" but lack the fawn tint of that species.

32. Mus barbarus L. Greater Striped Mouse.

Six specimens, all in alcohol, except an adult female, are in the collection of the Academy of Natural Sciences of Philadelphia. They may be tabulated as follows:

No. 3,846	Ad. ♀,	Dumbola Kalta, . .	April 20, 1895.
No. 3,913	Juv. ♂,	Lake Abaya, . . .	May 10, 1895.
No. 3,914	Juv.	Higo, ...	April 8, 1895.
No. 3,915	Juv.	Higo, ...	April 8, 1895.
No. 3,916	Juv.	Higo, ...	April 8, 1895.
No. 3,817	Juv.	Higo, ...	April 8, 1895.

33. Mus microdon Peters?

One specimen, (No. 3,908), a female, taken April 24, 1895, agrees very well with the figures of Peters' types, and the measurements also coincide very closely with his. The tail is unicolor, naked, shiny brown, tessellated with geometrically arranged scales. The belly and feet are whitish, the lateral stripe fulvous, the back dark, grizzled, brown-black.

34. Mus sp.?

Two immature males, (Nos. 3,884, 3,891), with plumbeous body, white feet and naked tail of the length of the body without head, comes from Sheikh Husein; October 12, 1894. They differ from any other species in the collection.

35. Mus sp.?

A series of four skins with skulls, and five specimens in alcohol, represent a pretty large rat which was only seen and taken on grassy hills at Sheikh Mahomet.

They correspond closely to the *Mus albipes* of Rüppell.

No. 3,848	♀, ...	
No. 3,849	♀, ...	November 9, 1894.
No. 3,850	♂, ...	November 4, 1894.

No. 3,851	♀, ...	November 7, 1894.
No. 3,883 Juv.	♀, ...	
No. 3,892 Juv.	♀, ...	November 1, 1894.
No. 3,893 Juv.	♀, ...	November 1, 1894.
No. 3,906	♂, ...	
No. 3,908	♀, ...	

Pseudoconomys Subgen. nov. Type *Mus proconodon* (infra).

Subgeneric characters. Alveolar length of anterior upper molar nearly thrice the greatest width of tooth. The two posterior sets of transverse tubercles of this tooth as in the genus *Mus*, but the anterior base of the median anterior cusp is remarkably produced forward one-third the whole length of the tooth, and terminates anteriorly just above the descending tooth root in a false, rounded tubercular cone, which lies so far below the grinding plane of the molars as never (?) to become functional.

36. Mus (Pseudoconomys) proconodon sp. nov. False-cusp Mouse.

Type, No. 3,880, ad. ♀. ; collection of the Academy of Natural Sciences of Philadelphia. Collected by Dr. A. Donaldson Smith at Sheikh Husein, Western Somaliland, Africa, October 13, 1894.

Description—Size small, tail minutely and sparsely haired, as long as body without head, unicolor, very slender and finely annulated. Pelage fine, silky, tricolor, mouse brown above, ochraceous-fawn along sides, beneath white. Anterior soles of feet thickly set with granulated points, the hind foot with two anterior, two median and two posterior tubercles, the fore foot with three anterior and two posterior tubercles. Ears very small and rounded.

Color above, including head and tail, almost exactly as in *Mus musculus*, the sides slightly tinged with fawn. A well defined reddish-fawn stripe along sides, from shoulder to hip-joint, distinctly separates the color of back from the pure white of belly. Whole of under side, including upper lips, pure clear white to the bases of the hairs. Feet whitish-brown ; soles naked to heel. Mammæ, 2 pectoral, 2 axillary, 2 abdominal, 2 inguinal. Skull characters as above defined for the subgenus.

Measurements—Total length, 128 mm.; tail vertebræ, 56 ; hind foot, 16 ; ear, from crown, 6.

Skull—Total length, 22 ; basilar length, 19 ; greatest width, 11 ; interorbital constriction, 4 ; nasal length, 8.8 ; alveolar length of upper molar series, 4.2 ; length of mandible, 13 ; greatest width of mandible, 6.4.

One specimen in alcohol represents this distinctly marked species. Should it prove that its peculiar tooth pattern is shared by some previously named but imperfectly described species, the propriety of its subgeneric (if not generic) value certainly justifies the possible synonym. The specimen is an old adult with the teeth well worn, but not enough so to destroy the pattern of tuberculation exhibited by earlier maturity.

37. Mus minutoides Smith. Smith's Lesser Mouse.

I follow Oldfield Thomas[16] in applying Smith's earlier name to a small, fawn colored mouse which corresponds to Peters' admirable figures of *Mus minimus* in his Mammalia of Mozambique.

Specimens (in alcohol):

No. 3,910 Juv. ♀, Sogida Volcano, . . April 7, 1895.
No. 3,911 Juv. ♂, Sogida Volcano, . . April 7, 1895.
No. 3,912 Ad. ♂, Jire, Sakuyu, ... March 20, 1895.

38. Mus mahomet sp. nov. Sheik Mahomet Mouse.

Type, No. 3,881, ad. ♂; collection of the Academy of Natural Sciences of Philadelphia. Collected by Dr. A. Donaldson Smith at Sheikh Mahomet, Western Somaliland, Africa, Nov. (?), 1895.

Description—Size small, slightly larger than *Mus minutoides* (*l. c.*). Tail well haired, slender, nearly equal to length of head and body. Ears small, rounded and thickly haired; pelage dense, slightly hispid, tricolor.

Color above, dark, black-brown, becoming dark fulvous brown on sides and lower cheeks. Lower parts grayish-white, tinged with fulvous on breast, neck and throat. A distinct lateral band of deep fulvous extends along sides from shoulder to hip and along ham almost to heel, separating the colors of upper and lower body. Feet hoary brown; tail above, like back, below, like feet. Basal halves of body hairs everywhere bluish-black. Hind feet with three pairs of tubercles, fore feet each with three anterior and two posterior tubercles. Whiskers medium, black.

Skull as in typical *Mus musculus*, except that the inner anterior face of upper incisors is flattened and the bases of nasals extend some distance beyond the upper posterior sutures of the premaxillaries. Coronoid process of mandible strongly hooked.

Measurements—Total length 103 mm.; tail vertebræ, 49; hind foot, 14.5; ear, from crown, 6.5.

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[16] P. Z. S., 1888, p. 13.

Skull—Total length, 19.3 mm.; greatest breadth, 9.8; interorbital constriction, 3; length of nasals, 7.2; length of mandible, 11.5; width of mandible, 5.7.

Two specimens of this minute mouse, both males, taken at Sheikh Mahomet, appear to be undescribed. In some respects they resemble the characters given by Rüppell for *Mus imberbis*, but they are much smaller with relatively longer tails and have well developed whiskers.

The so-called whiskerless character of Rüppell's animal appears to me to be an anomaly due to abnormal rather than natural circumstances. In any event, this question in no wise affects the status of the mouse which owes to an accident of birth and locality, rather than to its possession of whiskers, the august specific name which I have imposed upon it.

39. ? Mus arborarius Peters. Long-tailed Wood Mouse.

Two specimens, both females, (No. 3,847, ad. skin and skull; No. 3,890, juv. in alcohol), from River Darde, September 12, 1894, are of interest.

Mr. Oldfield Thomas considers[17] *M. arborarius* of Peters synonymous with *M. dolichurus.* If this is the case, the River Darde mice are perhaps, a good subspecies characterized by the excessively long tail and smaller size. In our oldest specimen (No. 3,847), with molars more worn than in the adult type skull of *arborarius* figured by Peters,[18] the skull is markedly smaller and shallower.

After examining their descriptions it seems to me that Peters has plainly set forth good distinctions between his *arborarius* and Smuts' *dolichurus.* The most marked character of *arborarius* is the pure white feet and belly, which in *dolichurus* are fulvous. The absence of a preocular spot in *arborarius* is also to be considered. In these respects the Smith specimens resemble *arborarius.* The feet and under parts are immaculate white to the roots of the hairs.

In the adult, the total length is 100 mm., that of the tail vertebræ being 150 mm. In the younger one, contrary to the general rule in young murines, the proportional size of tail to head and body is even greater than in the adult, the former being 122 mm. long and the latter 76 mm.

In the type of *dolichurus* the length of head and body is 125 mm. and the tail 145 mm. In *arborarius* the head and body of the female

[17] P. Z. S., 1891, p. 186.
[18] Reise n. Mossam., 1852, pl. XXXV, fig. 7.

is given by Peters as 120 mm., of the tail, 160 mm. These figures, combined with the color differences, convince me of the propriety of separating *arborarius* from *dolichurus*, and at the same time classing the River Darde specimens with the former species. The character of the tail in the alcoholic specimen seems to indicate clearly its use as a prehensile organ.

40. Lophuromys sikapusi (Temm.). Sikapusi Rat.

Making allowance for the change of color likely to occur in spirit specimens, there is no doubt that two hispid rats taken by Dr. Smith at Sheikh Mahomet are specifically the same as the animal minutely described by Peters[19] as *Lasiomys afer.*

The upper pelage of No. 3,909, a very old female, is like that of the younger one (No. 3,894, ♀), a grizzled, black, reddish-brown, the under parts light ochraceous sharply defined against dark color of sides. The tail of the older specimen is wanting; in the other one it is deep black above and rusty below. The basal half of upper pelage is colored like belly, the belly hairs being unicolor. The older specimen is very large, the head and body being 130 mm. long.

The skull, compared with Peters' illustration (*l. c.*), differs in the shape of the pterygoid fossa which, in our examples, is widest at the postpalatal notch and contracts at the pterygoid processes, widening again in a vase-shaped outline as viewed from above.

The semi-spinous character of the pelage in this species is intermediate between that of *Mus* and *Acomys.*

41. Golunda reichardi (Noack). Reichard's Bush Rat.

Six fine skins and one specimen in alcohol, of a "grass or bush rat," were taken at Sheikh Mahomet. They answer Noack's description of *reichardi*,[20] as contrasted with that of Peters for "*Pelomys fallax*," so well that I cannot hesitate to assign them to the former and confirm the correctness of Noack's separation of the two. The entire absence of a sulcus from the incisors of any of our specimens instantly distinguishes them from *fallax.* The black dorsal streak is plain in some, in others nearly absent.

The general body color may be said to be ochraceous to tawny brown, grizzled coarsely with black. Sides of nose and eye-ring pure ochraceous.

A note on one of the labels states this rat "makes a prehensile [*sic.*] nest in bush; habitat in thick grass."

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[19] Monatsb. Akad. Berl., 1866, p. 409.

[20] Zool. Jahrb., 1887, p. 235.

Specimens: Nos. 3,820, 3,821, 3,822, 3,823, 3,824, 3,825, 3,920: = 5 ♂s, 2 ♀s.

42. Dendromys mesomelas (Brants). Long-tailed Tree Mouse.

Three *Dendromys*, all apparently taken at Sheikh Mahomet, were presented to the Academy of Natural Sciences of Philadelphia by Dr. Smith. Two of these, a half-grown young (No. 3,876) and an adult male (No. 3,874), are in spirits; the third, an adult male (No. 3,853), is a finely prepared skin with skull, and field measurements taken by the collector. The two adults correspond so exactly with Smith's beautiful plate[21] of *D. typicus*, in both color and dimensions, I am unable to note any differences of even subspecific value. The fact that *typicus* is a South African species would lead to the supposition that the Galla animal differed therefrom. In the absence of specimens for comparison, these will be classed under *mesomelas*, Wagner, Heuglin and Trouessart agreeing that *typicus* is a synonym of that species. Matschie[22] names the long-tailed *Dendromys* of East Africa *D. pumilio* Wagner, quoting "*Munch. gel. Anz.*, XII, 1820, p. 437." I am unable to find this publication, but would suppose some mistake, as Wagner states three times in his description of *pumilio* in Weigmann's *Archiv. fur Naturgeschichte*, 1841, p. 135, that it is a "new species," no reference being made to a previous description. The chief distinction between *pumilio* and *mesomelas* (if any, Trouessart and Heuglin considering them the same) is the absence of the dark dorsal stripe in the former.

From *D. mystacalis* Heugl.,[23] of Abyssinia, the Sheikh Mahomet specimens are distinguished by greater size, relatively longer and less hairy tail and the presence of the dark dorsal stripe.

In No. 3,853 (*l. c.*) the total length is 177 mm.; tail, 100; hind foot, 21. In No. 3,874 these measurements are respectively 163, 92 and 22; the ear from crown is 11.5.

43. Dendromys sp.

A young spirit specimen (No. 3,876), whose skull shows it to be about two-thirds grown, differs so markedly in the black color of the ears and orbital region and the white spot at the bases of ears and the tail being only equal to the head and body in length, that there is little doubt of its belonging to a different species from the

[21] Illust. Zool. S. Afr., 1849, pl. 34, fig. 1.
[22] Die Saug. Ost Afr., 1895, p. 49.
[23] Nov. Act. Acad. Cæs. Leop., 1863 (Sept. 1862), p. 5.

foregoing. Its date, November 12, 1894, would show it to have been taken at Sheikh Mahomet.

44. Gerbillus sp.?

Two examples (No. 3,858, 3,929), both females of early maturity, the former taken on the route to, and the latter at, Lake Rudolf, come nearer *G. schlegeli* than to *G. böhmi* or *G. leucogaster*, with which they also seem closely allied. They are darker and smaller than *leucogaster*, and have much larger audital bullæ than *böhmi*.

A. Smith considers *G. afer* of Gray a synonym of *G. schlegeli*. In this connection I may remark that the above specimens correspond almost exactly to Smith's plate (pl. 35) of *afer* in the *Illustrations of the Zoology of South Africa*.

45. Gerbillus (sp. nov ?).

So desperately involved is the nomenclature and classification of the numerous African members of this genus, I hesitate to impose a name on what appears to me an undescribed form, No. 3,857, Ad. ♀, from Hargesa, taken July 18, 1894. While resembling, in general characters of skull and skin, Peters' *leucogaster*, it is essentially different from any *Gerbillus* I have examined, in the entire absence of the posterior cusp of $\underline{\text{m. }3}$, that tooth consisting merely of the normal semicircular loop with anterior curve and single posterior crenation. The tooth is not much worn, so that any trace of the posterior cusp would be easily distinguished, neither is there the faintest indication of it at the base of the tooth, the posterior crenation nearly reaching the alveolus.

The specimen is a dry skin; the upper body colors are a rich, dark fawn, becoming tawny along sides and lined along upper back and head with coarse black-tipped hairs. The ears and upper tail are blackish-fawn, the latter becoming nearly black toward tip and ochraceous white on the lower side. The feet and under side of body, including lower cheeks and upper lips, white to the bases of hairs. Shorter whiskers white, longer ones blackish. Bases of upper body hairs light slate.

The measurement of the dry skin gives the total length 280 mm.; the tail, 155; the hind foot, 37; the ear from crown, 14. The skull is 60 mm. long and 20 wide, the nasals 16 long and very slender, the supraorbital bead very strong and with an anterior flange. The ascending ramus of the lower jaw is longer and more erect than in *leucogaster* and its allies. The audital bullæ are large, as in *leucogaster*, but the auditory meatus is compressed.

46. Gerbillus sp.?

Three young specimens (Nos. 3,854, 3,855, 3,928), two in skins and one in alcohol, all taken at Sheikh Husein, October 12, 1894. I am unable to even conjecture about, except to say they differ specifically from any others in the collection.

They are about two-thirds grown; the tail is just equal to head and body in length, and the size of skull and hind foot would indicate a species smaller than *leucogaster*. This species is remarkable for the blackness of the ears, back, rump, upper tail and soles of the feet. The upper ground color is brownish-fawn fading to purer fawn on the sides. The underside and feet are clear white.

No. 3,855 measures 180 mm. in length; tail, 90; hind foot, 30. The skull is 27 mm. long.

47. Gerbillus pulvinatus sp. nov. Cushioned Gerbillus.

Type, No. 3,930, ad. ♂; collection of the Academy of Natural Sciences of Philadelphia. Collected by Dr. A. Donaldson Smith at Rusia, Lake Rudolf, Africa, August 5, 1895.

Description—Size medium, tail with pencil nearly $1\frac{1}{2}$ times length of head and body. Soles and toes of fore and hind feet cushioned throughout with hairs like those of the upper surfaces of the feet.

Color (from type alcoholic specimen) above, from hind nose to tail, fawn, sparingly lined with black tipped hairs, much blacker across hind rump and thighs. Upper tail fawn, becoming blackish-brown toward penicillate tip, the underside white almost to tip. Hind feet, including lower portion of hind leg, white; forelegs and feet, lower parts, including sides, lower cheeks, upper lips, to eyes, nose, hinder bases of ears, superciliary stripes and spots between eyes and ears, white, the white greatly encroaching on the paler fawn of upper sides and lower outer half of hams. Ears fully and coarsely haired on outer surface with golden fawn anteriorly, becoming darker on the hinder parts.

Skull (teeth worn, 3 anterior cusps of $\underline{\text{m. 1}}$ yet distinct); first section of $\underline{\text{m. 1}}$ consisting of a single rounded oval cusp, without fold or division and distinct from its neighbor; second (median) transverse section of same tooth consisting of two distinct circular cusps of equal size; third (posterior) section of same is a single elliptic transverse cusp forming the widest portion of the tooth. Audital bullæ large, tumid, widely separated from the slender basi-occipital. Incisive foramina not reaching anterior plane of molars.

Measurements—Total length, 234 mm.; tail vertebræ, 135; hind foot, 26.5; ear, from crown, 10.

Skull—Total length, 30.6 mm.; basilar length, 25; greatest width, 16; interorbital constriction, 6; length of nasals, 12; length length of upper molar series, 4; length of mandible, 16; width of mandible, 7.8.

An old adult male, in spirit, which I have made the type, two immature specimens, male and female (Nos. 3,926, 3,925) also in spirit, and another immature specimen, a skin with skull (No. 3,856) fully represent a species which was collected on the route to and from Lake Rudolf between June 2d and August 5, 1895. The more pallid pelage of the dry skin would indicate it either to be a desert race of the type or that the specimens in alcohol of same age have become darkened by their immersion. In either case the species is lighter colored than any other in the collection. I have ventured its separation because of the remarkable and apparently unique character of the hairy-soled feet. This is quite as marked in the old as in the young. These sole hairs form a sort of cushion on and just behind the anterior tuberculated part of the hind and fore feet, and even the plantar excrescence of the heel is furnished with scattering bristling hairs. The toes are almost as fully haired beneath as above. The character of the tuberculation of $\underline{\text{m. 1}}$, as above given, is also strongly diagnostic.

48. Gerbillus ruberrimus sp. nov. Little Red Gerbillus.

Type, No. 3,927, ad. ♂; collection of the Academy of Natural Sciences of Philadelphia. Collected by Dr. A. Donaldson Smith at Finik near Webi Shebeli, Somaliland, Africa, December 14, 1894.

Description—Size smallest (?) of the African species of the genus. Tail nearly 1½ times the length of head and body; color above brilliant red-brown to orange-yellow. Ears relatively very small and round.

Color (of type) above, clear rich reddish-cinnamon with slight admixture of black tipped hairs. Sides scarcely paler, a strong line of demarkation between red of upper and white of lower parts. Base of ear, patch over eye, upper lips, feet and under parts pure white; ears well haired and colored like upper head. Tail unicolor, reddish-fawn throughout, becoming blackish on the distal, penicillate hairs and terminal tuft.

Skull—Basi-occipital and audital bullæ but slightly separated; incisive foramina not reaching the anterior plane of molar series.

Anterior cusp of $\underline{\text{m. 1}}$ strongly indented by an enamel fold on the anterior inner face and connected by a continuous enamel wall with inner median cusp of the same tooth. Outer median cusp of $\underline{\text{m. 1}}$ isolated. Inner and outer cusps of transverse sections of $\underline{\text{m. 2}}$ and $\underline{\text{m. 3}}$ coalescent. Single anterior and median pair of cusps of $\overline{\text{m. 1}}$ forming a coalescent trefoil.

Measurements—Total length 160 mm.; tail vertebræ, 95; hind foot, 20; ear, from crown, 6.

Skull—Total length, 24 mm.; greatest breadth, 12.5; interorbital constriction, 4.5; length of nasals, 9.8; length of mandible, 12; with of mandible, 5.

The type above described, is in alcohol and is a well-aged individual with teeth worn half way to the cusp bases. Another specimen (No. 3,852) a dried skin with skull, taken on the same day as type is an adult, but less aged, female. It differs only in being deep ochraceous instead of being reddish above.

Compared with *G. pusillus* Peters,[24] to which it appears most nearly allied, the type of *smithi* is distinguished by its splendid red color, by the very small ear, relatively longer tail and smaller body. The skull is of the same length as that of the type of *pusillus*.

49. Otomys irroratus Brants. Brants' Otomys.

A young specimen, labeled from Sheikh Mahomet, was brought back in alcohol. It is a female and apparently about two-thirds grown. It is light brown, darkly grizzled with black, the tail deep black above, its underside being grayish. The hind feet are black with brownish hairs along the outside near heel. The upper incisors have two distinct (median and inner) anterior grooves and a slightly concave flattening of the convex intervening space. The lower incisors present one deep groove dividing the face of the tooth into an outer third and an inner two-thirds; along the inner edge of the tooth face is a faint sulcus, and the intervening convexity is faintly flattened medially. Owing to the immaturity of the tooth these sulcations are less strongly developed than would ensue with greater age, the fainter grooves only appearing at the alveolar surface.

50. Heterocephalus glaber Rüpp. Hairless Mole Rat.

An old adult female (No. 3,923) in perfect condition, preserved in alcohol, is included in the exceptionally fine collection of small

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[24] Monatsb. Acad. Berl., 1878, p. 201.

rodents brought back by Dr. Smith. It was taken at Milmil, Somaliland, July 24, 1894. It appears to be the third recorded specimen in existence and the second belonging to the type species of this remarkable genus. Rüppell's type of *glaber* came from Shoa and was described[25] in 1845. It now exists in the Senckenburg Museum in the form of a mounted skin with the skull separate, the mandibles missing. In 1885 E. Lort Phillips sent another specimen of *Heterocephalus* in spirits to the British Museum from Central Somaliland. This was made the subject of a communication by Mr. Oldfield Thomas before the London Zoological Society, and in the *Proceedings* of that Society[26] was described as new under the name *phillipsi*, after its discoverer. Subsequently Mr. Thomas published[27] a more complete account and description, with figures, of the new animal, and made detailed comparisons with *glaber*.

It was with no small curiosity that, after having a photograph made of Dr. Smith's specimen, I removed the skull and compared it with the figures of Rüppell and Thomas. Except in its greater age and size there are no differences between the animal from Milmil and the Shoa type.

The color of the skin is pale ochraceous with a fleshy tinge, becoming pale livid on the upper sides of head, neck, belly, rump and tail. The scattered hairs are a silvery, transparent white. The underparts are somewhat lighter than the upper. The skin of head is very thick and tough, more so for example than that of the oldest and toughest *Mus decumanus* that I ever dissected. The inner finger of manus is much shorter relatively than figured by Thomas for *phillipsi*. Two mammæ 15 mm. apart are faintly indicated at the sternum immediately between the fore legs when they are drawn down at right angles to the body. A series of seven pairs of teat-like excrescences, each bearing in its pitted center a bristling hair 5 mm. long, extend along the sides to the groin in the position of the regular teat series.

The "wrinkled, warty" appearance of the skin, which Mr. Thomas thinks may be due to the action of spirits on the specimen of *phillipsi*, I am confident is perfectly normal, as our specimen plainly indicates in many ways, and it will be seen that these pits, warts and furrows are closely correlated with the anatomy of the animal

[25] Abhand. Mus. Senckenb., p. 99.
[26] P. Z. S., 1885, pp. 611, 612.
[27] Ibid, 1885, pp. 845–849.

as it exists in life and with the skin coloration and the distribution of the pelage.[28]

The skull of the Milmil animal is from $1\frac{1}{2}$ to 2 mm. larger in its exterior dimensions than that of the type of *glaber*. It belongs to a much older animal, and on this account the differences in dimensions and formation of the teeth are, perhaps, largely attributable. Among these the most noticeable are found, 1st, in the upper incisors each bearing upon their inner anterior surfaces a distinct shallow sulcus, bordered on the inner side by a sharp ridge and merging outwardly into the convexity of the lateral two-thirds of the face of tooth. Rüppell states clearly that his animal had unchanneled incisors; Thomas says the incisors of *phillipsi* are "somewhat flattened and bevelled on their interior halves," but does not define a sulcus. The upper molars of the specimen in the Academy of Natural Sciences of Philadelphia number six, as in *glaber*. Unlike those figured for *glaber* their crown surfaces are of unequal dimensions, $\underline{\text{m. 2}}$ being one-third larger than $\underline{\text{m. 1}}$ and $\underline{\text{m. 3}}$ considerably smaller than $\underline{\text{m. 1}}$. In the two first upper molars the crowns have worn down until the enamel folds are obliterated. In the last, which evidently erupted at a much later date than the anterior pair, the crown shows a trifoliate surface, due to the impinging of the enamel walls of the lateral and posterior sides of the tooth nearly to its center. Of the three mandibular molars, $\overline{\text{m. 2}}$ and $\overline{\text{m. 3}}$ are about equal in size, $\overline{\text{m. 1}}$ being about half as large; the latter is circular in outline and shows no enamel folding; in $\overline{\text{m. 2}}$ there is a pretty deep indentation on the outer wall and a shallow curve of the inner; in $\overline{\text{m. 3}}$ these indentations are exaggerated, nearly equal, and nearly divide the tooth into two sections, the anterior section being rectangular, the posterior hemispherical in outline. If we were to apply the standard of specific separation generally recognized to-day as governing the classification of rodents, it would be consistent, perhaps, to make the third specimen of *Heterocephalus* a third species on the dental characters above defined, and on similar grounds establish a new genus for the light-molared *H. phillipsi*, but I fully agree with Mr. Thomas that the known individual variations in other species of the *Bathyergince* are quite as marked as any yet attributed to *Heterocephalus*.

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[28] A plate of the specimen is being prepared for Dr. Smith's book on the Expedition.

The measurements of Dr. Smith's specimen are as follows—Total length, 143 mm.; tail vertebræ, 42; hind foot, 24[29]; fore foot, 16.

Skull—Basilar length (of Hensel), 23.5 mm.; end of nasals to occipital ridge, 23; zygomatic width, 20.5; interorbital constriction, 6.5; length of nasals, 9.8; base of upper incisors to $\underline{\text{m. }1}$, 9; length of mandible, 22.2; breadth of mandible, 15.

52. **Rhizomys splendens** (Rüpp.). Lesser African Mole Rat.

A specimen (No. 3,924) of a male Mole Rat, from "Gineer," (Gineh?) preserved in alcohol, is in the collection. Its size and coloration place it with the first species described by Rüppel from Dembea.

53. **Pectinator spekei** Blyth. Brush-tailed Rat.

A pair of these interesting rodents, male and female, (Nos. 3,921, 3,922) taken at Sheikh Mahomet, December 4, 1894. They correspond closely to Blyth's original diagnosis of the type taken in eastern Somaliland.

The female, a full aged adult, measures (from spirit specimen) 190 mm. in total length; the tail, 30; the hind foot, 36; the ear, from crown, 10.

54. **Lepus** sp.?

An apparently young hare (No. 3,811) without skull, and labeled "The Haud," July 22, 1894, is the only representative of this genus. Its alliance seems to be with *L. ochropus* Wagner, as quoted by Matschie in the Mammalogy of East Africa.

*55. **Felis leo somaliensis** Noack. Somali Lion.

Two very fine skins of male and female are in the University of Pennsylvania exhibit.

*56. **Felis pardus nimr** (Ehrenb.). Steepe Leopard.

Five leopard skins in the University of Pennsylvania exhibit may be classed with the form designated by Ehrenberg and revived by Matschie.

57. **Felis caracal nubica** (Fitz.). African Caracal.

A half grown specimen (No. 3,931) of a male taken October 2, 1895, is in the collection of the Academy of Natural Sciences of Philadelphia.

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[29] The hind foot of *glaber* is given as 21.2 mm., but the fact of its being taken from a dried specimen would largely account for the difference in size.

58. Felis maniculata Rüpp. Manacled Cat.

A flat skin, (No. 3,812) with accompanying skull, of a fully adult animal, corresponds exactly with Rüppel's[30] figure of *maniculata*, of which name I consider *caligata* a synonym. It would appear that *F. cafer* (" *caffer* " Auct.) of Desmarest is a distinct species.

*** 59. Cynailurus jubatus guttatus** (Herm., Hamm.). African Cheetah.

A flat skin is in the University of Pennsylvania library donation.

60. Helogale undulata (Peters). Undulated Mongoose.

An adult and a young female (Nos. 3,815, 3,816), the latter from Hargesa, July 21, 1894, the former taken March 3, 1895, are similar in their deep chocolate tints as compared with Peters' plate and Thomas'[31] diagnosis of the typical form. The young animal is grayer and more tawny than the adult above, but the lower parts of the two are very similar.

61. Herpestes gracilis ochraceus (Gray). Abyssinian Mongoose.

The skin and skull of an old male *Herpestes* (No. 3,817), taken November 25, 1894, shortly after leaving Sheikh Mahomet, evidently belong to the Abyssinian animal, which Mr. Thomas considers a variety of *gracilis*. Compared with Gray's plate of *ochraceus*, the Smith specimen is redder and more darkly annulated with black. The form and color pattern of the tail is very similar to Gray's in our specimen, except that the slender portion adjoining the black tip is bright rusty. The black tip is about 35 mm. long.

The following legend appears on the label attached to this skin: "Shot in amongst bushes. It eats insects, and had a dragon-fly in its mouth when shot. Irides yellow."

62. Genetta tigrina (Schreb.). Tiger Genette.

Accepting Matschie's identification[32] of Mr. True's diagnosis[33] of a Genette from Kilima-Njaro to belong to *tigrina* instead of *pardina*, I am induced to place a skin and skull from Milmil under the former name. The black of posterior hind legs and feet and the bristling black dorsal mane and rufous-centered body-markings place it with *tigrina*. The specimen is an old female, No. 3,844. The skull is 86 mm. long and 40 broad.

***63. Hyæna crocuta** Erxl. Spotted Hyaena.

A mounted skull is among the University specimens.

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[30] Reis. N. Afr. Zool., 1826, p. 1, pl. 1.
[31] P. Z. S , 1882, p. 80.
[32] Saugeth. Ost Afr., 1895, p 74.
[33] Proc. Nat. Mus., 1892, p. 454.

64. Canis mesomelas Schreb. Black-backed Jackal.

A skin of this species in the University of Pennsylvania is represented by a skull (No. 3,845) in the collection of the Academy of Natural Sciences of Philadelphia. Locality not given.

65. Mellivora ratel (Sparrm.). Ratel.

A skin with skeleton (No. 3,814) was received by the Academy of Natural Sciences of Philadelphia. Another skin was retained by Dr. Smith. They both came from Gebas near the Shebeli, and were taken January 6, 1895.

66. Erinaceus albiventris atratus subsp. nov. Galla Hedgehog.

Type—No. 3,831, Yg. Ad. ♂; collection of the Academy of Natural Sciences of Philadelphia. Collected by Dr. A. Donaldson Smith at Ngare Nocbor, Lake Rudolf, Africa, August 26, 1895.

Description—Similar to *E. albiventris* Wagner, as defined by Dobson,[34] but with hoary black limbs, feet, tail, ears and face-patch, the remaining pelage pure, clear white. Extreme tips of spines sooty black.

Color—Spinous region covered evenly with spines 20 mm. long, whose extreme tips are dusky, followed by a subapical zone of dull white 5 mm. wide, then by a horn-black zone 8 mm. wide, fading into a lighter zone and darkening again into a black base. Facial area, bounded by edges of upper lips and lines drawn from corners of mouth to eyes and thence connecting across forehead, thinly-haired anteriorly by sooty black, more thickly and lengthily haired posteriorly, and with a decided moustache below eye across cheeks, of pure black. A triangular spot of black on lower lips and chin, to corners of mouth. Region between dark facial patch and spines of hind-head and ears, cheeks, throat, breast, belly and sides nearly to ventral region, pure silky white with an occasional black hair. Fore-legs from body to feet black, well intermixed with white, especially on inner side of arm. Fore-feet and soles black with a few gray hairs. Hind-limbs and feet colored like fore-limbs, with a decided whitish patch on inner side of pes near heel. Tail and vent hoary black. Formation of feet as is minutely described by Dobson for *albiventris* (*l. c.*). The rounded, thickly-haired ears, grayish, sooty black, inside and out.

Measurements (of type by collector in field)—Total length, 118 mm.; tail vertebræ, 10; hind-foot 23; ear from crown (dry) 13.5.

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[34] Monog. Insectiv., 1882, p. 11.

Skull: total length, 35; zygomatic breadth, 22; interorbital constriction, 10.6; length of nasals, 11.8; length of mandible, 27; breadth of mandible, 12.

The immaturity of the specimen which I have made to represent this newly-described race of *albiventris* can in nowise account for its color characters as contrasted with the typical form, whose habitat Dobson places as "northern tropical Africa." In appearance, as well as in habitat, this race may be said to show some approach to the South African *E. diadematus* Fitz., but closer examination shows its affinities to be with the northern animal.

The single skin and skull brought back by Dr. Smith indicate an individual closely approaching maturity, the posterior molar and the canine just cutting through the gums.

67. Macroscelides rufescens Peters. Rufescent Jumping Shrew.

This shrew, whose cranial characters so closely ally it to *M. intufi* Smith, is represented by an adult female and an immature male (Nos. 3,829, 3,830), taken respectively at Ehrer and Lammo on the 12th and 16th of August, 1894. The adult is somewhat blacker and less ruddy than Peters' specimens, but the measurements and color pattern are identical. Both specimens are skins with skulls, full data and measurements.

68. Macroscelides sp.?

A half-grown individual (No. 3,828), labeled Walenso, October 26, 1894, is so dark and has such a short tail compared with body that it is probably distinct. Its skull, however, shows near relationship to *rufescens*. It is preserved in alcohol.

69. Crocidura doriana Dobson. Shoa Shrew.

An alcoholic specimen of an adult shrew (No. 3,826) in the collection was taken at Sheikh Mahomet, October 28, 1894. The skull and dentition are identical with Dobson's Shoa species as figured in the Monograph.

70. Crocidura sp.?

A rather young example (No. 3,827), in alcohol, from Lake Rudolf, the skull of which, unfortunately, was lost after being extracted for examination, is of interest. The skin and sparse hairs of tail and feet are white. Tail about half the length of head and body. Color of body dark bluish-gray, lighter beneath. Total length about 100 mm., hind-foot, 12.5. Ears conspicuous. The small size of this specimen makes it improbable that it is *C. leucura*

Matschie, its immaturity not being sufficient to account for the different measurements.

71. ? Cercopithecus rufoviridis Is. Geoff. Reddish-green Guenon.

A skin with skull (No. 3,932) separate, of a not fully-mature monkey, agrees somewhat with the species above-named. Its resemblance to *C. flavidus* Peters, from Mozambique, which Forbes[35] considers a synonym of *rufoviridis*, is quite close. On the label is written: "Skin, pale Prussian blue; face skin brown; irides light brown."

72. Colobus guereza Rüpp. Mop-tailed Guereza.

Three skins and one skull (No. 3,899), taken at Lake Rudolf, were brought to America. One of these was subsequently mounted for the University of Pennsylvania. Another skin (No. 3,905) is in the Academy of Natural Sciences of Philadelphia series. They are all typical *guereza*, as described and figured by Rüppell.

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[35] Allen's Nat. Lib., II, 1894, p. 65.

THE HYMENOPTERA COLLECTED BY DR. A. DONALDSON SMITH IN NORTHEAST AFRICA.

BY WILLIAM J. FOX.

The following list includes only the Aculeate Hymenoptera brought home by Dr. Smith. The collection includes, besides these, perhaps thirty species of ants and parasitic forms which I am obliged to pass unnoticed for the present. Inasmuch as I have had to rely entirely on descriptions in classifying the collection, I beg to offer that fact as an apology for any erroneous identifications that may have been made.

The specimens were collected on a journey from Berbera through Somaliland to Lake Rudolf, thence to a point on the east coast,[1] and, with many other specimens, have been presented to the Academy of Natural Sciences of Philadelphia by Dr. Smith.

MUTILLIDÆ.

Apterogyna Latreillei Klug.

One specimen (♀). Berbera, July 6, 1894.

Mutilla pedunculata Klug.

Two male specimens. Berbera, July 4, 1894, and Shebeli, September 1.

Mutilla sinuata Oliv. (=*villosa* Klug.).

One specimen (♀). Sheikh Husein, October 22, 1894.

Mutilla tricolor Klug.

One ♀ specimen. Sheikh Husein, October 29, 1894.

Mutilla guineensis Fabr.

One ♀ specimen from Sheikh Husein, October 1, 1894.

Mutilla mephitis Sm.

One specimen (♀). Laga, November 30, 1894.

Mutilla leda n. sp.

♀.—Head, legs and abdomen black, the latter velvety; thorax obscure rufous; head, except a longitudinal medial streak and the

[1] See an article by Dr. Smith in *The Geographical Journal* for August and September, 1896.

cheeks, medially, sides of thorax, legs, transverse spot at apex of first dorsal, three spots on second dorsal (one anteriorly in the middle somewhat ovate, and two larger ones placed transversely near the apical margin of the segment), a medial spot on the third, fourth and fifth coalescing more or less, the second segment along the extreme sides, a small spot on the apical margins of the second, third and fourth at the sides and the apical margins of ventrals 2–4 entirely, of silvery pubescence; above the body is clothed with long, erect, sparse black hairs, which, on the ventral surface, are pale; head about as wide as the broadest part of the thorax, with deep, coarse punctures; eyes subovate; mandibles furrowed longitudinally and toothed within before the apex; flagellum strongly acuminate, the first and second joints about equal in length; occiput not cristate; thorax long, somewhat pyriform, broadest a little anterior to the middle, the lateral borders not dentate; the thorax above scabrous; evidently no scutellar scale present, or else it is indistinguishable from the coarse sculpture of the upper surface of thorax; spines of the legs black, calcaria pale testaceous, those of the hind and medial tibiæ pectinate within; first segment of abdomen constricted at apex, not continuous with the base of the following; in the middle transversely cristate, the portion before the crista very flat, ventrally with a short and strong carina, which is somewhat emarginate medially; second segment with very large punctures, ventrally shining with the punctures more distinct and at the base with a short, central, longitudinal carina; last dorsal smooth and shining, at least medially, without a pygidial area. Length, 12 mm.

One specimen. Near Gelani, October 27, 1894.

This species is apparently close to *M. doriæ* Magr., but differs in the non-cristate occiput and absence of scutellar scale.

Mutilla somalica n. sp.

♀.—Head ———?; thorax obscurely rufous; legs and abdomen black, the latter red beneath; the second dorsal segment in greater part with reddish-orange pubescence forming a maculation as shown in the figure; a spot in the center of dorsals 3–5, a narrow transverse one on the apical margins of dorsals 2–5 at the sides, and apical margins of ventrals 2–5 with silvery pubescence; legs with pale pubescence, the rest of the body clothed with long, erect hairs, those above dark, those below pale; thorax robust, not twice as long as it is broad at base, coarsely cribrose above, the lateral margins irregular; scutellar scale wanting; tibiæ and tarsi strongly spinose, the spines black; calcaria white, pectinated within; first segment of abdomen constricted at apex, beneath with a strong, bidentate or emarginate carina; second ventral with a short, median, longitudinal carina basally and together with the sides of its dorsal moiety with large separated punctures, those of the remaining ventrals much finer and closer, pygidial area large, convex, longitudinally striato-punctate, the sculptures strongest basally and becoming obsolete at apex. Length (without head) 10 mm.

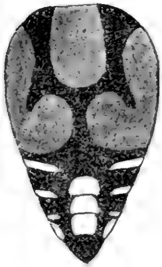

FIG. 1.
Abdominal markings,
Mutilla somalica.

One specimen, from which the head is, unfortunately, missing. The maculation of the second dorsal segment is apparently so different from any of the African Mutillids that I have thought it well to describe the species, even though the specimen be in poor condition.

From Finik, December 15, 1894.

SCOLIIDÆ.

Scolia ruficornis Fabr.

Two ♀ and two ♂ specimens. Hargesa and The Haud, July 21; Sheikh Husein, October 3, 1894.

Elis aureola Klug.

Two females from Sheikh Husein, collected on September 21 and 27.

Cosila Donaldsoni n. sp.

♀.—Deep black, shining, the last two abdominal segments rufous; wings black, strongly violaceous; pubescence grayish; head strongly punctured, closely so on the front, sparsely on the vertex and occiput; clypeus more finely punctured than the front, somewhat carinate down the middle, its anterior margin tridentate; mandibles scarcely punctured, scape and pedicellum shining, sparsely punctured, the flagellum opaque, the joints slightly prominent at apex beneath; ocelli deeply pitted, indistinct; pronotum scabrous; dorsulum with irregular, coarse punctures, transversely smooth just behind the pronotum, and a little shorter than the scutellum; scutellum scabrous, somewhat triangular, truncate posteriorly; middle segment above very finely striato-punctate, becoming more coarsely so posteriorly; posterior face with shallow punctures and indistinct striations, sides obliquely striated, the central longitudinal furrow of the middle segment is wider by far on the upper surface, fore tarsi distinctly combed; tarsal claws cleft; hind femora somewhat angular beneath; third submarginal cell larger than the second, the third transverso-cubital nervure received by the marginal cell at its apex; abdomen with strong, sparse punctures, those at the apex of 2, 5, and bases of 3, 5 closer; punctures of ventral segments larger: pygidial area striato-punctate; first dorsal truncate anteriorly, not carinate; spines of the legs and calcaria whitish. Length, 18 mm.

Sheikh Husein, October 8, 1894. Easily distinguished by the red tip of abdomen. In the cleft claws and pectinate fore tarsi this species appears more closely allied to the American than to the Australian species of *Cosila.*

POMPILIDÆ.

Pompilus dimidiatus Fabr.

Berbera, June 5; Laga, November 30. Two specimens.

Pompilus viaticus Fabr.

One specimen. Daro Mountains, November 19.

Pompilus pulcher Fabr.

One specimen. Terfa, August 13.

Pompilus umbrosus Klug.

Berbera, July 4; Lafarug, December 7. Three specimens.

Pompilus Tamisieri Guér.

One specimen. Aimola, March 16, 1895.

Pompilus (Pedinaspis ?) somalicus n. sp.

♀.—Head, antennæ, thorax and legs ferruginous; mandibles at tip and abdomen black; wings yellow, a slender black fascia crossing the anteriors in the region of the basal vein and a very broad fascia just before the apex; the apex pale; head rather flat, the occiput bearing a sharp, transverse ridge; frontal impressed line feeble; clypeus flat, shining, its fore-margin slightly emarginate or incurved, as is likewise the labrum, which projects a little and is fringed sparsely with long hairs; antennæ inserted at base of clypeus, tolerably long and slender, much shorter than the thorax, however, the first joint nearly as long as the scape, which is compressed; thorax elongate; pronotum a little longer than the dorsulum, its hind margin arcuate; scutellum shorter than dorsulum, somewhat more than twice as long as the metanotum (postscutellum); middle segment subtruncate posteriorly, entire, above with a central longitudinal impressed line, posteriorly with rather coarse transverse striæ, which extend partly on the sides; legs tolerably stout, scarcely spinose; fore tarsi without comb; claws with a large, sharp tooth within, almost cleft; longer spur of hind tarsi less than one-third as long as the first hind tarsal joint; marginal cell pointed at tip; second and third submarginals about equal in size, both receiving their recurrent nervure slightly before the middle; basal vein joining the submedian cell before its apex; submedian cell of hind wings terminating before the origin of the cubital vein; abdomen not compressed, obscurely testaceous beneath; dorsals 1, 3 and 4 with a large lateral spot of pale pubescence, which is also indicated laterally on the ventral segments. Length, 17 mm.

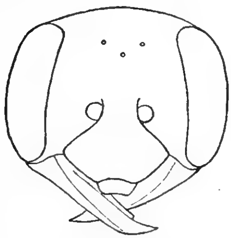

FIG. 2.
Head of *Pompilus somalicus.*

One specimen. Near Finik, December 6, 1894. Is apparently distinct from all the African species of *Pompilus* in the bifasciate fore-wings. I refer it to Kohl's subgenus *Pedinaspis* with some doubt, inasmuch as the abdomen is not compressed, and the claws rather more cleft than dentate.

Salius (Cyphonyx) flavicornis Fabr.

One specimen. Sheikh Husein, October 5, 1894. In this specimen, a ♀, only the tibiæ are reddish.

Salius (Hemipepsis) atropos ? Sm.

I refer, with some doubt, two ♂ specimens taken at Sheikh Husein, October 10, 1894. Smith only describes the female, his specimens having come from Sierra Leone.

SPHECIDÆ.

Sphex (Chlorion) xanthocerus var. **maxillaris** Pal.

One ♀ specimen. The Haud, July 21, 1894.

Sphex (Chlorion) regalis Sm. var.

Two females. Ardeh, July 14; Hargesa, July 18, 1894. In this form the thorax is entirely black; the wings black with violaceous reflections, the apex of the hind pair not pale; head, antennæ, fore-legs entirely, and the femora and tibiæ of the medial pair, reddish; abdomen metallic and purplish-blue.

Sphex (Parasphex) marginatus Sm.

Sheikh Husein, October 1, 1894. One specimen. The petiole is black in this specimen.

Sceliphron Spinolæ Lep.

Two females. Sheikh Husein, October 15, 1894.

Sceliphron spirifex Linné.

Two females. Sheikh Husein, October 1 and 15, 1894.

Sceliphron violaceum Fabr.

One specimen. Sheikh Husein, October 15, 1894.

Ammophila ferrugineipes Lep.

One ♀ specimen. Sheikh Husein, October 8, 1894.

Ammophila lugubris Gerst.

Two females. Sheikh Husein, September 20 and 28, 1894.

Ammophila holosericea Fabr.

Dabulli, September 16, 1894. Two ♂ specimens.

Ammophila insignis Sm.

Turfer. One specimen, August 13, 1894.

Ammophila beninensis ? Pal.-Bve.

I refer doubtfully to this species two specimens from Sheikh Husein, September 30 and October 5. They agree fairly well with Beauvois' description and figure of *beninensis*, but the tibiæ and tarsi and four anterior femora are reddish.

Bembex Dahlbomi Hdl.

Milmil, July 28, 1894. Four specimens.

Sphecius Quartinæ Grib.

Only the male of this species has been described, and it is not certain that the female specimen before me from Berbera, July 4, 1894, is really *Quartinæ*. I venture to describe it as such, however.

♀.—Short and stout, ferruginous, except the clypeus, labrum, mandibles, except apex (which is black), front beneath and scape and apical antennal joints beneath, which are yellow; apical margins of the dorsal abdominal segments narrowly fuscous; wings testaceo-hyaline, nervures reddish, marginal cell lanceolate and narrow; second submarginal greatly narrowed above, its width at this point slightly greater than that between the stigma and the first transverso-cubital nervure on the marginal nervure; third submarginal scarcely narrowed above; clypeus convex, transverse, its fore-margin a little incurved; antennæ scarcely as long as thorax, thickened apically, the first joint of flagellum as long as the two following united; the head, as a whole, is fairly well punctured; dorsulum and scutellum impunctate or with exceedingly fine punctures, the middle segment with more distinct punctures; legs robust, strongly spinose; abdomen finely and rather closely punctured, the apical margins of the segments smooth in a transverse sense; sixth dorsal strongly punctured, not very strongly ridged laterally, ventrals rather flat, the second feebly convex. Length, 22 mm.

Liris haemorrhoidalis Fabr.

Sheikh Husein, September 30, 1894. One male specimen.

Notogonia apicalis n. sp.

♂.—Black; last three or four abdominal segments red; mandibles and tegulæ, in part, obscurely rufotestaceous; face, clypeus, cheeks, fore-femora and thorax beneath, and apex of middle segment with dense silvery pubescence; the sides of thorax, legs and abdomen with a sericeous pile, which, when the insect is held in certain lights, appears on the abdomen to form apical bands on the segments; head finely and closely punctured; distance between the eyes above nearly as great as the length of the third and fourth antennal joints, much greater than the length of the second and third; flagellum acuminate apically, thickest toward base, the first joint a little longer than the second and somewhat curved; clypeus depressed transversely before the anterior margin, the latter a little prominent in the middle; dorsulum with tolerably strong and close punctures, the scutellum with the punctures much finer and sparser, shining; mesopleuræ with shallow, somewhat separated punctures, the episternal suture of the mesothorax distinct and strongly foveolated; middle segment truncate behind, above coarsely and transversely rugose, divided longitudinally by a strong medial carina, which terminates before the apex, sides coarsely and obliquely striated; legs simple, not peculiarly modified; wings fusco-hyaline, nervures black; marginal cell obliquely truncate at tip; second submarginal almost triangular, much narrowed above, the width at the top equal to about one-half the distance between the recurrent nervures on the cubital nervure; abdomen impunctate, the second

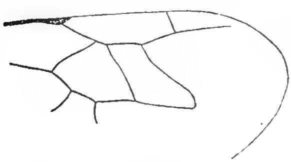

Fig. 3.
Venation (fore wing), *Notogonia apicalis.*

ventral segment with the transverse basal depression well marked. Length, 12 mm.

One specimen. Sheikh Husein, September 30, 1894. Is apparently related to *N. radamæ* Saussure, from Madagascar, and may be identical with the var. *b.*, mentioned by that author. The radial (marginal) cell of *radamæ* is said to be perpendicularly truncate, whereas in *apicalis* it is obliquely so. It also agress fairly well with the description of *Larra rubella* Smith, of which only the female is described.

Miscophus ctenopus Kohl.

Berbera, July 4, 1894. One ♀ specimem.

Tachysphex fluctuatus Gerst.

One male specimen. Same locality as the preceding species.

Helioryctus melanopyrus Sm.

One specimen, a female. Near Lake Stephanie, June 20, 1895. It is somewhat larger than the specimen described by Smith, and measures 14 mm. in length. *Helioryctus* is, perhaps, synonymous with *Sericophorus* Sm. (non Shuck.) = *Tachyrhostus* Sauss. *Sericophorus* Sm. has priority over *Tachyrhostus*, having been described on p. 33, *Ann. & Mag. Nat. Hist.*, 1851, VII.

Astatus boops Schr.

One male specimen from Sheikh Husein, October 5, 1894.

Oxybelus lamellatus Oliv.

Berbera, July 4, 1894. One specimen.

EUMENIDÆ.

Eumenes Lepeletierii Sauss.

Three specimens. Sibbe, August 2; Terfa, August 15; River Darde, September 9, 1894.

Eumenes maxillosa DeG.

One large female. Berbera, July 3, 1894.

Eumenes dimidatipennis Sauss.

One ♀ specimen without precise locality or date of capture.

Synagris calida Linné.

Luku, September 17, 1894. Two specimens.

Synagris tropidia Schlett.

Sheikh Husein, October 8, 1894. One ♀ specimen.

Rhynchium laterale Fabr.

Sheikh Husein, October 7. One male.

Odynerus metemmensis Magr.

One specimen, without date of capture or locality.

VESPIDÆ.

Polistes marginalis Fabr.

Sheikh Husein, October 5 and 9. Two specimens.

Belonogaster colonialis Kohl.

One male specimen. Terfa, August 21.

Belonogaster Meneleki Grib.

Sheikh Husein, October 1 and 5; Laga, November 30, 1894.

APIDÆ.

Colletes sp.

Two specimens of a species having the base, apex and sides of the first dorsal segment and the apex of the three following with pale ochraceous pubescence, beneath which the segments are brownish-testaceous. From Sheikh Husein, September 29, 1894.

Nomia nulpina Gerst.

A ♂ specimen which is probably this species. Sheikh Husein, October 7, 1894. Another species, perhaps new and from the same locality, has the hind-legs almost simple and the apical margin of dorsal segments 1–5, whitish.

Anthophora quadrifasciatus DeG.

Sheikh Husein, September 29, 1894. A specimen of the variety *alternans* Klug.

Anthophora concinnus Klug.

One specimen; no precise locality or date of capture.

Anthophora albigenus Lep.

One specimen, a variety, of this species. Daro Mountains. November 19, 1894.

Eucera ruficornis Fabr.

Sheikh Husein, October 7, 1894. One male specimen.

Crocisa abyssinica Rads.

One female specimen. The Haud, July 21, 1894.

Xylocopa oblonga Sm.

One specimen. Sheikh Husein, October 3, 1894.

Xylocopa fulvohirta DeG.

Two females. Meo, October 25, 1894.

Xylocopa cafra Latr.

One female specimen. Same locality and date as the preceding.

Xylocopa inconstans Sm.

One female specimen. Sheikh Husein, October 1, 1894.

Xylocopa olivacea Fabr.

One male. Near Lake Stephanie, June 20, 1895.

Xylocopa aestuans Fabr.

Berbera, July 4. One female specimen.

Xylocopa Gribodoi Magr.

Sheikh Husein, October 10; Meo, October 25, 1894. Three female and one male specimens. The latter sex is apparently undescribed.

♂.—Black; head, thorax, anteriorly and beneath, dorsal segments at the sides, particularly segments 1, 4, 5, 6, and ventrals 3–6, with pale pubescence, that on the clypeus white; the legs with black pubescence, the anterior pair in addition with a streak of white pubescence, which is more evident at first joint of tarsi; wings hyaline at base, the apical third fuscous with purplish iridescence; nervures black throughout; antennæ entirely black; eyes large; face narrow; the ocelli are an equilateral triangle; dorsulum sparsely punctured medially, as are likewise dorsal segments 2–4, which at the sides are closely punctured; dorsal 5 and 6 closely punctured throughout; the sixth segment medially, and the last at the sides with black pubescence, that on the fore-tarsi beneath slightly brownish. Length, 20 mm.

With the exception of the wings and pale color of the pubescence on anterior part of thorax, the male is, superficially, similar to the female.

Ceratina fastigiata n. sp.

♀.—Blue-green, the head and thorax slightly the darker; legs black; the base of the hind tibiæ externally and a broad oblong spot on the clypeus yellowish; head with large, deep and more or less confluent punctures, which on the clypeus are separated and rather sparse; mandibles and labrum black, the latter convex and coarsely rugose; antennæ black, the flagellum clavate and slightly testaceous beneath; pronotum not dentate laterally, rather sharply margined; dorsulum convex, its punctures larger than those of head and distinctly separated; scutellum similarly punctured, the mesopleuræ a little less strongly so; upper and posterior surfaces of middle segment separated by a ridge, above the ridge finely rugose, on the sides with large punctures, similar to those on the fourth dorsal segment, below the ridge, the punctures finer, closer and evener; abdomen with the segments rather strongly constricted at the sutures, the apical segment suddenly constricted and drawn out into a point apically, the first, second and third segments punctured about like the dorsulum, the remaining dorsals decidedly more finely punctured; the ventrals are punctured like the first dorsal, the apical margin of the second, and the base and apex of the second to fifth, smooth and black; fore legs naked and shining, the others with pale pubescence, as are likewise the ventral abdominal segments, but sparsely; wings hyaline, darker apically, nervures and stigma black; tegulæ and shoulder tubercules dark testaceous. Length, 8 mm.

One specimen from Daro Mountains, November 20, 1894.

Allodape canina Sm.

Two specimens. Tulu, November 23, 1894.

Megachile basalis Sm.

One female specimen. Ile, April 9, 1895.

Megachile colorata n. sp.

♀.—Black; scape of antennæ, tegulæ, legs except coxæ, and the first three segments of abdomen red; wing yellow at base and broadly along the costa, otherwise fuscous with purplish iridescence, the veins included in the yellow portion, reddish, those in the fuscous portion dark; head with strong confluent punctures, posteriorly deeply incurved, the occiput margined; face between the antennæ prominently convex, and meeting the clypeus so as to appear continuous with it; the clypeus slopes from its middle to apex, which is broadly truncate, the sloping portion smooth (or nearly so) and shining, otherwise the clypeus is coarsely punctured; mandibles striato-punctate, furrowed from middle to apex, slightly broader at apex than at base, narrowest medially, bearing a tooth within and four at apex; dorsulum with strong

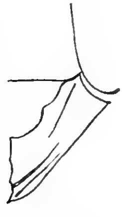

Fig. 4.
Mandible, *Megachile colorata.*

punctures, which, when the insect is held in certain positions, give the dorsulum a transversely and irregularly striated appearance; punctures of the scutellum a little closer, those of the mesopleuræ more distinct; legs robust, the hind tibiæ much thickened toward apex; abdomen sparsely punctured, the apical margins of dorsals 1–4 transversely depressed at apex, at which place the punctures are closer; front, base of clypeus, a fringe on labrum, thorax above, on center of mesopleuræ and base of middle segment, and a fringe at apex of dorsals 1–3, ochraceous; beneath the wings, extending to sides of middle segments, a spot on each side of the first three or four dorsals and the ventral scopa, whitish; on the cheeks and thorax beneath the pubescence is pale; legs and last two or three dorsals covered with a short ochraceous pubescence, that on the tarsi the longer. Length, 13–16 mm.

Two specimens. One without precise locality or date of capture; the other, the larger specimen, is marked, "From nest in insect tin, November 28, 1894," and is from near Laga. The red color on abdomen in the larger specimens is more distributed than in the smaller.

Megachile crenulata n. sp.

♂.—Black; first joint of fore tarsi whitish; head strongly and closely punctured above, more finely so on the front; mandibles longitudinally striato-punctate, tridentate at apex; dorsulum and scutellum strongly, closely and evenly punctured; mesopleuræ perhaps a little more strongly punctured; tibiæ cribrose externally; fore coxæ with a long, obtuse tooth; fore tarsi with the first joint flattened and broadened, its anterior margin sinuated medially; abdomen closely punctured above, beneath more sparsely, the apical margin of all the segments (except the last) strongly depressed and testaceous; last dorsal strongly emarginate and strongly crenulated; at the base of the last ventral on each extreme side is a strong tooth; head in front, dorsulum, middle segment and base of first dorsal with long, brownish or fulvous pubescence, which also appears to a certain extent on scutellum, apical segments and the legs, where it is more or less mixed with paler hairs; cheeks, fore tarsi, thorax beneath, first dorsal laterally, and the ventrals more sparsely, with long, pale pubescence; the first medial and hind tarsal joints have a fringe of this pubescence; apical margins of dorsals 2–5 with

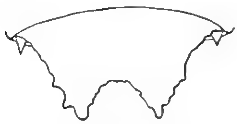

FIG. 5.
Last dorsal abdominal segment, *Megachile crenulata*.

obscurely fulvous pubescence, which above in the middle becomes paler; wings subhyaline, nervures and stigma black. Length, 13 mm.

Sheikh Husein, September 24, 1894. The only specimen obtained is somewhat the worse for wear, thereby making an accurate description of the pubescence rather difficult.

Trigona Beccarii Grib.

One specimen. Sheikh Husein, September 29, 1894.

Apis mellifica Linné.

Terfa, August 15, 16, 1894. Four specimens.

November 3.

The President, Samuel G. Dixon, M. D., in the Chair.

Twenty-three persons present.

November 10.

The President, Samuel G. Dixon, M. D., in the Chair.

Twenty-six persons present.

A paper entitled "The Bones, Muscles and Teeth of Tarsius fusco-manus," by Harrison Allen, was presented for publication.

November 17.

The President, Samuel G. Dixon, M. D., in the Chair.

One hundred and nine persons present.

Mr. Edwin S. Balch read a paper entitled "Ice Caves and the Causes of Subterranean Ice," (No abstract.)

November 24.

The President, Samuel G. Dixon, M. D., in the Chair.

Thirty-seven persons present.

R. A. Philippi of Santiago, Chili, was elected a Correspondent.

The following was ordered to be printed:—

NEW SPECIES OF FRESH WATER MOLLUSKS FROM SOUTH AMERICA.

BY HENRY A. PILSBRY.

The forms described below were encountered in the course of identifying a series of mollusks collected by Dr. Wm. H. Rush, U. S. N., in Uruguay and Argentina, a list of which will be found in *The Nautilus* for November of this year. To the forms collected by Dr. Rush have been added several others, apparently undescribed, from the collection of the Academy of Natural Sciences of Philadelphia.

To the above-mentioned paper in *The Nautilus* the reader is referred for some account of the localities represented by specimens here described, and for notes on the species associated with them.

CHILINIDÆ.

Chilina Rushii n. sp. Pl. XXVI, figs. 6, 7.

Shell oval, strong, yellowish-olivaceous with five girdles of dusky, narrow spots alternating with lighter ones. Spire produced, terraced, but flat-topped, the whorls strongly keeled around the shoulder, flat above the keel. Aperture long-ovate, white with chestnut spots inside; outer lip thin; columellar lip white, callous, with a strong, acute entering fold at the root, and a very inconspicuous fold in the middle; the parietal wall with a strong entering fold which is abrupt below, and filled in above with a heavy callus.

Alt. 16, diam. 10½ mm.; alt. of aperture 12 mm.

Uruguay River at Fray Bentos (Dr. Rush!).

The conspicuously angular spire is a peculiar feature of this shell. The apex is considerably eroded, so that the number of whorls cannot be stated.

LIMNÆIDÆ.

Planorbis castaneonitens Pilsbry & Vanatta, n. sp. Pl. XXVII, figs. 10, 11, 12.

Shell thin, chestnut brown, very smooth and glossy; growth-striæ light; right and left sides showing 4 whorls, about equally and quite shallowly concave; spire on right side less than half the diameter of shell, inner 1½ whorls more sunken; spire on left side decidedly wider than on the right. Last whorl wide on the right, narrow on the left side, the periphery very obtusely angular near the left side. Aperture quite oblique, cordate, the peristome thin and fragile, produced forward on the right side.

Alt. 1·7, diam. 7 mm.

Ponds and small streams near Maldonado, Uruguay (Dr. Rush !).

Compared with *P. heloicus* d'Orb., this species is flatter and more glossy, has the spire much narrower on the right side, the outer whorl wider and less cylindrical; the color is darker and the periphery rounded-angular.

Planorbis heteropleurus Pilsbry & Vanatta, n. sp. Pl. XXVI, figs. 1, 2, 3.

Shell moderately solid, corneous-white, rather opaque, the surface with fine, close growth-lines; earlier whorls rather deeply and about equally sunken on the two sides; convex, and strongly angular or keeled in the middle, on the right side; periphery conspicuously carinated on the left side, which is shallowly vortex-shaped, the whorls nearly flat. Last whorl slightly wider on the right than on the left side. Whorls 3½, all visible on both sides, the last wider than the spire. Aperture very oblique, rounded-pentagonal, the right margin produced forward.

Alt. 4½, greatest diam. 11½, lesser 8½ mm.; oblique alt. of aperture 5½, diam. 4 mm.

Lake Titicaca (A. Agassiz !). Types No. 69,645, collection of the Academy of Natural Sciences of Philadelphia.

This remarkable species is totally unlike *P. titicacensis* Cless.,[1] *P. montanus* d'Orbigny[2] and *P. andicola* d'Orbigny,[3] species already known from this Andean lake. It is most like *P. andicola,* but much flatter with differently placed keels, and, in fact, so diverse in characters that no profitable comparison can be made. Described from eight specimens, which are alike in all essential characters.

CYRENIDÆ.

Corbicula Coloniensis n. sp. Pl. XXVI, fig. 9.

Shell subtriangular, rather ventricose, slightly inequilateral; anterior and posterior margins obtusely angular, the slope above the rounded angles slightly convex; posterior slope decidedly longer; basal margin well curved, rounded; beaks moderately projecting. Hinge ligament very convex, short and yellowish. Surface nearly

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[1] Conchylien Cabinet, *Planorbis,* p. 147, pl. 12, f. 23–25. Clessin locates Lake Titicaca in Ecuador! On p. 175 he calls the species *P. titicacaensis.*

[2] Voy. Am. Mérid., p. 345, pl. 44, f. 5–8.

[3] *Ibid.*, p. 346, f. 1–4.

smooth in the middle, finely, irregularly striate at the ends and basal margin. Green, duskier above, with narrow, widely spaced and inconspicuous blackish rays, the eroded beaks deep purple. Interior deep purple, clouded with whitish purple within the pallial line, the teeth of the same light tint. Pallial line with a short triangular sinus; right valve with three divergent cardinal teeth, median and posterior teeth bifid at tip; median tooth wide, anterior and posterior teeth long and oblique; left valve with three cardinals, the median bifid at tip. Laterals crenulated, long, the anterior slightly curved, posterior straight; double in right, single in left valve.

Length 32½, alt. 27½, diam. 15½ mm.

Length 28, alt. 24, diam. 15 mm.

La Plata River above Colonia, Uruguay (Dr. Rush).

Larger and more triangular than *C. limosa.* The lateral teeth are unusually long, and the cardinals widely divergent.

MUTELIDÆ.

Glabaris latomarginatus Lea var. **felix** n. v. Pl. XXVI, fig. 8.

Similar in form to *Anodonta latomarginata* Lea, but epidermis light yellowish-green, closely painted with short radiating dichotomous or simple lines or narrow V's of green, and two green rays on the posterior slope. Interior pale pink within pallial line, prismatic border faint olive buff. Some black zig-zags along pallial line or outlining muscle impressions.

Length 53, alt. 38, diam. 20½ mm.

Length 49, alt. 35, diam. 18 mm.

Colonia, Uruguay (Dr. Rush).

Glabaris trapesialis var. **cygneiformis** n. v. Pl. XXVI, figs. 4, 5.

Shell similar to some forms of *Anodonta cygnea*, such as that figured by Rossmässler, Iconogr., I, fig. 280, in the elongate form, long and *up-curved* posterior end, but hinge-line straight and produced in a small wing anteriorly, terminating angularly. Very thin and fragile, even in specimens 14 cm. long. Green and smooth in middle, blackish and roughened at ends and basal margin; nacre blue-white, iridescent, dark-stained in the cavity more or less, and often with some zig-zag blackish markings around the muscles.

Length 142, alt. 75, diam. 36 cm.; alt. 52–53 %, diam. 26 % of length.

More compressed than *G. riograndensis* Iher., with the hinge-line more angular at the ends and the posterior end peculiarly up-curved, as in certain middle European forms of *A. cygnea*. The specimens are also even thinner than examples of *riograndensis* before me, of equal size.

Pond and a small creek near Maldonado, Uruguay (Dr. Rush).

The differences between this form and typical *trapesialis* are manifest when we compare the typical figures of the latter in Encycl. Méth., pl. 205, which agree perfectly with specimens before me. The divergence between the several geographic races of *G. trapesialis*, such as *riograndensis*, *exoticus* and *cygneiformis* render it necessary, in my opinion, to recognize these as of subspecific rank. The extreme "lumpers" do not seem to understand that if evolution of species by divergence is granted, "subspecies" are a necessary consequence, whether we distinguish them by name or not. Every practical zoologist knows that they exist, and are neither more nor less artificial or subjective conceptions than "species;" and it seems a truer method to recognize certain races in which more or less definite characters are correlated with geographic range, than to lose sight of the differences induced by causes acting over whole districts or river-systems by lumping unlike forms under "species" which are equally with subspecies, arbitrary groupings.

Glabaris Simpsonianus n. sp. Pl. XXVII, fig. 13.

Shell oblong-oval, ventricose, very inequilateral, thick, solid and heavy; greatest diameter about in the middle; basal margin gaping from the anterior extremity nearly two-thirds the distance to posterior end; dorsal margin gaping slightly from the end of hinge to the posterior end of shell; externally green toward the beaks, the greater part of the surface olivaceous, blackish brown at the ends and basal margin, the posterior dorsal slopes biradiate with green; the surface smooth and polished, with rather coarse, low wrinkles of growth, more crowded and somewhat lamellose at the ends and basal margin. Upper and basal outlines about equally curved; hinge margin long, wide, somewhat sloping, gently curved, rounded or hardly angular at the ends; posterior margin sloping above, rounded below; anterior end somewhat narrower, rounded; beaks wide and low.

Interior silvery or salmon-tinted, very pearly, usually showing irregular black parallel lines in the neighborhood of the muscle impressions and pallial line. Cavity of valves deep, of beaks shallow and wide; muscle-scars well impressed, the foot protractor scar unusually long; posterior adductor scar situated very near to the sinus at end of hinge line, and connected therewith by a short impression; prismatic layer at margins of valves narrow and bluish-green.

Length 14, alt. 7·8, diam. 5·4 cm.

Length 14·5, alt. 8·1, diam. 5·5 cm.

Rio de la Plata. Described from seven specimens in the collection of the Academy of Natural Sciences of Philadelphia.

This species is named in honor of Mr. Charles Torrey Simpson, whose valuable papers upon the *Unionidæ* have been of great service to students of this intricate and difficult group.

G. Simpsonianus belongs to the group of *G. trapesialis* Lam. It differs from typical *trapesialis* (Encycl. Méth., pl. 205) in being oval rather than subtriangular; the beaks are far less inflated, low and wide; the nacre is peculiarly pearly, having the luster of that of the pearl oyster; the hinge line is more nearly parallel with the basal margin and is far longer in proportion to the length of the shell; the posterior large muscle-scar is close to the sinus at end of hinge-line, not distant from it as in *trapesialis*; the foot protractor scar is of a very different shape. Finally, the shell, while smaller, is much more ponderous and thick than *trapesialis*. Well-grown specimens of *trapesialis* measure 19 cm. long, and are thinner than *Simpsonianus* 14 cm. in length.

Anodon penicillatus Gray[4] apparently resembles this species in the internal markings (which are common to many species of *Glabaris*), but it is described as "*Antice subcompressa, rotundata, subgracili*," terms applying well to some forms of *G. trapesialis* var. *exoticus*.

The great solidity of the shell for a *Glabaris* will separate the species from *G. trapesialis* var. *exoticus* Lam. and var. *riograndensis* v. Iher. It resembles *G. Forbesianus* Lea in the thickness of the shell, but is more oblong, with longer hinge-line, wider beaks, differently shaped protractor pedis scar, and wider ventral gape.

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[4] Proc. Zool. Soc. Lond., 1834, p. 57.

DECEMBER 1.

The President, SAMUEL G. DIXON, M. D., in the Chair.

Thirty-seven persons present.

DECEMBER 8.

The President, SAMUEL G. DIXON, M. D., in the Chair.

Twenty-seven persons present.

DECEMBER 15.

Mr. CHARLES MORRIS in the Chair.

Twenty-five persons present.

DECEMBER 22.

The President, SAMUEL G. DIXON, M. D., in the Chair.

Thirty-one persons present.

The death of Auguste Louis Brot, a Correspondent, August 30, was announced.

DECEMBER 29.

Rev. HENRY C. MCCOOK, D. D., Vice-President, in the Chair.

Forty-four persons present.

The following papers were presented for publication:—

"Certain Aboriginal Mounds of the Georgia Coast," by Clarence B. Moore. (By title).

"Descriptions of New South American Bulimuli," by Henry A. Pilsbry.

The following was ordered to be printed:—

GEOLOGY OF THE MUSSEL-BEARING CLAYS OF FISH-HOUSE, NEW JERSEY.

BY HENRY A. PILSBRY.

The deposit containing fresh-water mussels of the genera *Unio* and *Anodonta*, situated at Fish-house, Camden County, New Jersey, on the Delaware River, about 5 miles north of Camden, was first noticed, so far as we know, by Professor E. D. Cope, who placed a series of the fossil *Unionidæ* in the hands of Dr. Isaac Lea for description[1] in 1868. In Dr. Lea's paper the bed containing these remains is said to be "subordinate to the Green Sand * * * * belonging to that portion of the cretaceous group which furnished * * * * *Hadrosaurus Foulkii* Leidy," etc.[2]

The species of *Unionidæ*, twelve in number, were fully redescribed and illustrated in 1886 by Professor R. P. Whitfield,[3] who, relying upon the above statement in Dr. Lea's paper, considers the deposit as "from near the base of the Cretaceous series of the State." Professor E. D. Cope,[4] in a brief consideration of "The Fresh-water Clays of the Pea Shore," in 1869, gave an excellent section of the beds, which may be consulted with advantage in connection with the present communication. He held that they were "much later" than the Cretaceous, and, in fact, Pliocene; basing this conclusion largely upon the finding of a large part of the cranium of a horse believed to be *Equus fraternus* Leidy. The late H. Carvill Lewis, on the contrary, held the Fish-house clay to be "of interglacial age,"[5] and this estimate of the age of the deposit is shared by Dr. C. A. White,[6] who considers the fossils as of post-Tertiary date. This is also, I believe, the opinion of most Philadelphia geologists who have recently examined the subject.

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[1] Proc. Acad. Nat. Sci. Phila., 1868, p. 162.

[2] It is difficult to account for this statement, which finds no justification in the stratigraphy of the region in question, so far as I can see.

[3] Brachiopoda and Lamellibranchiata of the Raritan Clays and Green Sand Marls of New Jersey, pp. 243–252.

[4] Trans. Amer. Philos. Soc., XIV, N. Ser., pp. 249, 250.

[5] Professor Lewis did not, I believe, formally publish this view, but taught it in his lectures at the Academy of Natural Sciences of Philadelphia, synopses of which were published in the "Public Ledger," April–June, 1884. The above quotation is from one of these newspaper reports.

[6] A Review of the Non-Marine Fossil Mollusca of North America, 1883.

The view that the Fish-house clay is of Pleistocene age is materially strengthened by the discovery therein of several horse teeth by Mr. Lewis Woolman, and by the recognition of the identity of at least a portion of the *Unionidæ* with living species, a subject referred to below.

The fossils occur only in a layer of black clay, which is used for brick and tile making. This deposit is capped by a layer of coarse sand. Under the black clay is a much thinner stratum of yellow or reddish clay, containing considerable sand and deeply stained with iron oxide. Below this stratum, which is about two feet thick where observed, there is coarse gravelly sand, which forms the foundation of the superimposed clays. This sand deposit is of considerable thickness, and the various sections exposed show it to be distinctly stratified, the strata being obliquely laminated, as shown in the annexed diagram. The character of these strata is completely that of arenaceous deposits in river-beds. So far as I know, such a disposition of the materials is not produced by any other means. No such stratification and oblique lamination is to be seen in the coarse sand at the summit of the clays. This difference indicates a diverse origin for the two deposits. In the opinion of the writer, the peculiarities of the Fish-house clays may be explained by the supposition that the deposit has been purely a result of river-action. The phenomena are exactly paralleled by processes now in progress in the rivers of the Mississippi system, where similar deposits containing a similar fauna may be seen in every stage of formation.

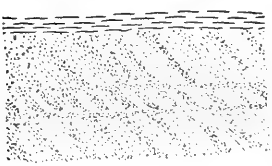

FIG. 1.
Obliquely laminated strata.

Upon this theory the sands underlying the red clay were deposited in a former Delaware River bed, the river at that time flowing in a direction practically parallel to its present course, as shown by the direction of the oblique lamination of the strata. A change in the river's course, such as cutting across the neck of an "ox-bow," or some similar shifting, left the former bed at this point a lagoon, similar to the so-called "sloughs" of the Mississippi River. A lagoon of this nature, while it quickly becomes dammed at the upstream end, for a time receives a portion of the current in time of high water. In the case under consideration, the layer of red, more or less arenaceous, clay was probably deposited during this period of partial isolation. Further separation of the slough from the stream is effected by the growth of willows and other vegetation upon the alluvial ridge at its head, which rapidly gains in height by the debris collected thereby. The lagoon of quiet water thus formed is a very favorable station for molluscan and other aquatic life, sedentary animals, or those of weak locomotive powers becoming far more numerous than in the active current of the parent stream. Such a lagoon thus gradually fills up with fine mud partly composed of organic material. In the case under consideration, the black clay represents this period. During this time the mussels flourished in the still water. Finally the lagoon or "slough" became dry land, this being the ordinary result of the process.

The naiad fauna of the Fish-house deposit is precisely similar in general character to that of the "sloughs" of the Mississippi River to-day.

The cap of sand upon the black clay may be regarded as a later deposition of more general geographic distribution, while the formations it overlies in this place are believed to be the result of strictly local causes, and antedating by a lapse of time, greater or less in duration, the overlying gravels.

As to the fossils themselves, it must be admitted that their divergence from living forms is very slight in most cases—a fact which Dr. Lea significantly indicated by his choice of specific names. Some of the species are really not distinguishable from modern shells. Thus *Unio nasutoides* has no characters which can not be readily paralleled in the living *Unio nasutus* or *fisherianus*. *Anodonta corpulentoides* is equally indistinguishable from *A. corpulenta*. The absolute counterpart of *Unio radiatoides* may be selected from any collection of *U. radiatus*, and so on. The remarkable feature of the series of fossil forms is that certain of them have no modern representatives in the Atlantic drainage south of the Great Lake and St. Lawrence system. The following "species" exemplify this statement: *U. ligamentinoides, alatoides, præanodontoides, rectoides, Anodonta grandioides* and *corpulentoides*. Although the affinities of some of these may have been wrongly estimated, owing to imperfection of the specimens, still a portion of them unquestionably bears out the relationships affirmed by Dr. Lea. The majority of these species foreign to the modern Atlantic drainage have their living allies in, or are identical with, species of the Great Lake system, extending also into the northern Mississippi drainage in which, moreover, they are better developed. Still, the characteristic Mississippi River types of *Unionidæ* are not represented in the Fish-house fauna. None of the triangular or round Unios with heavy teeth are found; no member of the great tuberculate or plicate groups occur. The Fish-house fauna is therefore to be assimilated rather with the Great Lake system than with the Mississippi or Ohio drainages. The species probably found their way into the Atlantic system in New York State, where the Lake and Atlantic waters are in close proximity. They may then have become extinct on the Atlantic slope during the glacial period when the rivers north of Delaware Bay were so profoundly affected.[7]

Summary.—The writer has attempted to show (1) that the Fish-house clay is a Pleistocene deposit, as held by Lewis, White and some others, not belonging to the Cretaceous or Tertiary as Lea, Whitfield and other geologists have claimed; (2) that it is either interglacial or preglacial, and probably the latter; (3) that it is purely local and fluviatile; and (4) that the structure of the sand underlying the clay, now first made known, gives a clue to the true explanation of the several geologic features of the deposit.

The position of this deposit in the post-Pliocene series is one of some difficulty, but materials bearing upon the question are not wanting. We know that the immediately post-glacial mollusk fauna of New Jersey was similar to the modern, except that it contained forms of more northern distribution; but there were no distinctively trans-Allegheniau types such as the Fish-house beds contain.[8] The very different character of the latter fauna would therefore indicate an earlier period. It was therefore either interglacial or preglacial, and the divergence of a part of the species from the most allied living forms, as well as the fact that the fauna was an abundant one, composed of large and well-developed individuals, point rather to preglacial than to interglacial conditions.

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[7] Those interested in the former distribution eastward of the trans-Alleghenian *Unionidæ* should consult Simpson, On some Fossil Unios from the Drift at Toronto, Canada. Proc. U. S. Nat. Mus., XVI, p. 591.

[8] White Pond, in Sussex Co., N. J , a typically glacial lake, furnishes abundant evidence in support of the above statement, and also shows the changes which have taken place from post glacial to recent times in the mollusk fauna. This evidence the writer proposes to publish as soon as engagements permit.

The following annual reports were read and referred to the Publication Committee:—

REPORT OF THE RECORDING SECRETARY.

The average attendance at the meetings of the Academy during the past year, from December 1, 1895, to November 30, 1896, was forty. Verbal communications were made by Messrs. Woolman, Goldsmith, Rand, Mercer, Brinton, Sharp, Vaux, Heilprin, Cope, Chapman, Allen, Pilsbry, Carter, Keeley, Lyman, Holman, Sangree, Egbert, Sommerville, Dixon, Leeds, Stokes, Campbell, Wistar, A. P. Brown, Willcox, Frazer, Morris, Skinner, A. E. Brown, Rothermel, Henry, Leonard, Morsell, Dolley, A. D. Smith, Rhoads, Stone, Fox, Reese, Ball, Horn, McCook, Seiss, Calvert, Balch, Hamilton, Richardson and Miss Bascom. Those that were reported by their authors were published in the *Proceedings.*

Six hundred and nine pages of the *Proceedings,* illustrated by 23 plates, and 297 pages of the *Journal,* with 53 plates, forming Parts III and IV of the tenth volume, have been issued. We are indebted to Mr. Clarence B. Moore for the illustrations of both numbers.

The publication of the *Manual of Conchology* has been continued by the Conchological Section. During the year Parts 63, 64 and 64a of the 1st Series (Marine Univalves), and Parts 39 and 40 of the 2d Series (Pulmonata) have been issued. The former consists of 157 pages illustrated by 44 plates, and the latter 121 pages illustrated by 27 plates. The first parts of Vols. XVII and XI respectively of the two series are now in press. The expense of publication of the *Manual,* copiously illustrated as it is with colored plates, is so great that the Section would be unable to continue it were it not for the support received from conchologists throughout the world.

The Entomological Section and the American Entomological Society have published, during the same period, 288 pages and 7 plates of the *Entomological News* and 386 pages and 11 plates of the *Transactions.*

This makes a total of 1,858 pages and 165 plates issued under the auspices of the Academy since the first of last December.

Forty papers have been presented for publication, as follows:— H. A. Pilsbry, 5; Harrison Allen, M. D., 3; Samuel N. Rhoads, 3; Edw. D. Cope, 3; Ida A. Keller, 2; Wm. J. Fox, 2; R. W. Shufeldt, M. D., 2 ; H. A. Pilsbry and E. G. Vanatta, 2 ; E. L. Green, 1 ; Witmer Stone, 1 ; Theo. Holm, 1 ; Thomas Meehan, 1 ; Amos P. Brown, 1 ; O. F. Cook, 1 ; J. C. Hartzell, Jr., 1 ; Fredk. P. Henry, M. D., 1 ; Chas. S. Dolley, M. D., 1 ; Frank C. Baker, 1 ; Cloudesley Rutter, 1 ; D. S. Jordan and Cloudesley Rutter, 1 ; Wm. H. Dall, 1 ; J. B. Ellis and B. M. Everhart, 1 ; Gilbert D. Harris, 1 ; S. N. Rhoads and H. A. Pilsbry, 1 ; Charles Morris, 1 ; Edw. S. Balch, 1. Four of these have been returned to the authors, two have been withdrawn, four are held for publication next year, and the others have been issued in the current volume of the *Proceedings*. In view of the occasional appearance in newspapers of communications offered to the Academy, on the recommendation of the Publication Committee a resolution was adopted declining to print papers of which more than a brief abstract had appeared elsewhere than in the publications of the society.

Thirty-five members and two correspondents have been elected. The deaths of thirteen members and ten correspondents have been reported, and the resignations of ten members have been accepted, as follows : S. Emlen Meigs, Annesley R. Govett, Eugene Delano, John C. Sims, Jos. C. Harrison, Francis B. Reeves, Theo. Presser, James Y. McAllister, Frank T. Patterson and Adele M. Fielde, leaving a gain of twelve members during the year.

The contributors to the Building Fund having made their final report setting forth the completion of the new lecture-hall and museum building, the expenditure of the fund and the discontinuance of the organization, the action was approved by the Academy and the Recording Secretary was authorized to receive all the books, papers and other assets of said contributors, and of the Board of Trustees established by them.

The resignation of Dr. Dixon as Professor of Histology and Microscopic Technology, presented in consequence of a press of official duties, was accepted January 28.

Dr. Henry Skinner was elected Professor in the Department of Insecta, March 21.

General Isaac J. Wistar was appointed the representative of the Academy at the celebration of the fiftieth anniversary of Lord Kelvin's tenure of office as Professor in the University of Glasgow.

Prof. Angelo Heilprin represented the Society at the Mining and Geological Millenial Congress at Buda Pest.

Dr. Persifor Frazer was appointed to represent the Academy at the Seventh Session of the International Geological Congress.

In response to an invitation, Dr. Charles S. Dolley was requested to contribute to the proceedings of the Congrès International de Pêches Maritimes at Ville des Sables d' Olonne.

The report of the Committee on the Hayden Memorial Award conferring the recognition for 1896 on Prof. Giovanni Capellini, having been adopted, the medal and interest on the fund were forwarded to the distinguished geologist through the Italian Consul, and their receipt has been duly acknowledged.

An important addition to the educational facilities of the Academy was formally provided for by the adoption of the following resolution, June 30:—

Resolved, That the Committee on Instruction and Lectures of the Academy be authorized to coöperate with the Ludwick Institute in the delivery of free courses of lectures on the natural sciences, primarily to the teachers in schools, and that the Academy expresses its satisfaction with the plan proposed by the Institute for the advancement of public education.

A resolution was adopted December 24, 1895, empowering the President to designate annually two members of the Academy to the electors of the Wistar Institute of Anatomy and Biology to serve as managers of the Institute under the deed of endowment until their successors shall have been appointed.

A resolution urging the Commissioner of City Property to take timely measures for the extermination of the tussock moth from squares and city trees was adopted, and the subject referred to a committee of entomologists who drew up and submitted to the Commissioner a set of suggestions which, if carried out, would undoubtedly effect the very desirable object contemplated.

The Academy's attention having been called to a bill before Congress for the prevention of vivisection, a series of resolutions prepared by a Committee consisting of Messrs. Cope, Sharp and H. F. Moore, deprecating its adoption, was ordered to be sent to Washington as an expression of the Academy's views on the subject.

The fourth Tuesday of each month has been assigned to the Anthropological Section for coöperation with the meetings of the Academy.

All of which is respectfully submitted.

EDW. J. NOLAN,
Recording Secretary.

REPORT OF THE CORRESPONDING SECRETARY.

The Corresponding Secretary respectfully reports that during the past year, commencing December 1, 1895, there have been received from eighty-seven societies, museums, libraries, etc., one hundred and eighty-two acknowledgements of the receipt of the publications of the Academy; and from forty-five societies, libraries, etc., fifty-seven notices that their publications have been forwarded to the Academy, together with eighteen applications to exchange publications for Reports, Proceedings, etc., and asking for missing numbers of the publications of the Academy.

Twenty-five letters on various subjects have been received, and twenty-six written. Twenty-one circulars and invitations extended to the Academy to participate in Congresses or meetings, and announcements of the deaths of scientific men have been received and, when necessary, acknowledged.

During the year two correspondents have been elected and notified.

The deaths of the following correspondents have been reported:—

M. S. Bebb, of Rockford, Illinois, elected in 1881, died December 5, 1895.

Don Antonio del Castillo, of Mexico, elected 1874, died October 27, 1895.

Prof. Gabriel Auguste Daubrée, of Paris, France, elected 1884, died May 29, 1896.

George Edward Dobson, of London, England, elected 1884, died November 26, 1895.

Prof. Alexander Henry Green, of Oxford, England, elected 1877, died August 19, 1896.

Dr. Juan Gundlach, of Havana, Cuba, elected 1867, died March, 1896.

Sir Ferdinand von Mueller, of Melbourne, Victoria, elected 1876, died October 9, 1896.

Auguste Sallé, of Paris, France, elected 1888, died May 5, 1896.

Charles Wachsmuth, of Burlington, Iowa, elected 1886, died February 7, 1896.

Prof. Josiah Dwight Whitney, of Boston, Mass., elected 1852, died August 19, 1896.

Seven hundred and fifty-eight acknowledgements for gifts to the library and eighty-three for gifts to the museum have been forwarded.

Respectfully submitted,

BENJ. SHARP,
Corresponding Secretary.

REPORT OF THE LIBRARIAN.

The additions to the library of the Academy since the last of November, 1895, have numbered 5,372, of which 4,357 are pamphlets and parts of periodicals, 985 volumes, 22 maps and 8 photographs.

They have been received from the following sources:—

Societies,	2,399
I. V. Williamsom Fund,	1,140
Editors,	1,084
Authors,	166
U. S. Dept. of Agriculture,	112
J. A. Meigs Fund,	62
U. S. Dept. of the Interior,	45
Pennsylvania State Library,	44
Geological Surv. of Sweden,	35
Charles P. Perot,	34
H. A. Pilsbry,	33
Wilson Fund,	16
Comité Geologique Russe,	15
Ministry of Public Works, France,	14
Thomas Meehan,	13
U. S. Dept. of State,	12
East Indian Government,	11
Geological Surv. of Canada,	10
Trustees of British Museum	10
U. S. Dept. of Labor,	7
General Appropriation,	7
Geological Survey of India,	7
Tennessee State Board of Health,	7
Department of Mines, New South Wales,	7
Stewart Culin,	6
U. S. Treas. Department,	6
Cal. State Mining Bureau,	4
Geological Survey of Missouri,	4
U. S. Fish Commission,	4
Benjamin Sharp,	3
Bentham Trustees, Kew Garden,	3
Conchological Section of the Academy,	3
Chas. E. Smith,	2
Department of Agriculture, Victoria,	2
Geological Comm. Mexico,	2
Geological Survey of Alabama,	2
Geological Survey of New Jersey,	2
Henry C. Chapman,	2
Rev. Francis Barnum,	2
Secretary of State, Mexico,	2
Secretary of Works, Mex.,	2
U. S. War Department,	2
William E. Meehan,	2
Wm. J. Fox,	2
Messrs. Appleton & Co.,	1
Messrs. C. E. Howe & Co.,	1
Cochin Government,	1
F. M. Comstock,	1
Department of Mines, Nova Scotia,	1
Geological and Natural History Survey, Minn.,	1
Geological Survey of Iowa,	1
Geological Survey of Missouri,	1
Geological Survey of Pennsylvania,	1
Geological Survey of Roumania,	1
Mrs. John Gilbert,	1
Guy Hinsdale,	1
Angelo Heilprin,	1
Harold Wingate,	1

Illinois State Board of Agriculture,	1	Minister of Education, Ontario,	1
Benj. S. Lyman,	1	Edw. J. Nolan,	1
Cyrus H. McCormack,	1	South African Government,	1
Maryland State Weather Service,	1	Geological Survey of Portugal,	1
Massachusetts State Board of Agriculture,	1	U. S. Coast and Geodetic Survey,	1
J. C. Morgan,	1	W. H. Harned,	1
Metropolitan Park Commission, Massachusetts,	1		

These accessions were distributed to the several departments of the library, as follows:—

Journals,	4,420	Ornithology,	26
Geology,	187	Mineralogy,	25
Botany,	155	Physical Science,	21
General Natural History,	127	Geography,	13
Agriculture,	73	Ichthyology,	13
Anthropology,	43	Medicine,	9
Voyages and Travels,	38	Helminthology,	8
Anatomy and Physiology,	37	Herpetology,	7
Entomology,	37	Bibliography,	5
Conchology,	33	Chemistry,	4
Encyclopedias,	31	Miscellaneous,	69
Mammalogy,	28		

As heretofore, all additions have been promptly catalogued and placed for use, the geographical arrangement of periodicals being still retained, although the crowded condition of many of the cases makes it difficult to preserve the classification, and, for the convenience of the student, it is proposed to arrange the journals devoted to special subjects in connection with the special departments of the library. A number of new cases are being prepared which will partly occupy space gained by the removal of the stock of the Academy's Proceedings and Journal to a storage-room in the basement of the new building, thus giving an opportunity for some contemplated improvements in classification.

A shelf list of the general Meigs library is nearly completed, and a card catalogue of the portions arranged in connection with the special departments of the Academy's library is proceeding as rapidly as our very scant clerical assistance will permit.

Six hundred and forty-nine volumes have been bound and sixty-nine are now in the hands of the binders. This does not half complete the work on the accumulation of unbound journals, and a much more liberal appropriation than the Academy is at present able to make is necessary to place the remainder of this most important section of the library in good working condition.

Renewed effort has been made, as the several sets of journals have been prepared for the bindery, to obtain a supply of deficiencies. In many cases the replies to applications have been gratifyingly liberal, special acknowledgment being due, in this connection, to the Imperial Academy of Science of St. Petersburg, from which 170 volumes, extending back to 1726, and not heretofore in the library of the Academy, have been received.

Important additions have been made to the collection of lantern slides, the formation of which was noted last year. Dr. Charles Schaeffer has given 163 ; Dr. Benjamin Sharp, 36 ; Wm. Stevenson, 12 ; Silas L. Schumo, 3 ; while 26 were purchased, making the entire collection 566.

We are indebted to Mr. William E. Haydock for a fine crayon portrait of Mr. John G. Meigs, whose legacy to the Academy was recorded in my last annual report.

On retiring from the Presidency at the expiration of his four years of office, General Isaac J. Wistar contributed his portrait in oil, by Vonnah, to the gallery of Presidents, thus completing a collection of much value and interest.

I am glad to again acknowledge the efficient services of my assistant, Mr. William J. Fox.

Edw. J. Nolan,
Librarian.

REPORT OF THE CURATORS.

The year just passed is especially noteworthy in the history of the Academy on account of the opening of the new museum building to the public. It has been impossible to prepare the entire building for exhibition this year; yet it was considered desirable to open a portion of it to the public without further delay, and, in accordance with this plan, the first and second floors, comprising the departments of Mineralogy, Archæology and Mammalogy, were formally opened October 20th with appropriate ceremony.

Much time has necessarily been consumed in arranging and labelling the collections in their new quarters. In addition to the Wm. S. Vaux Collections, representing Mineralogy and Archæology, and the Clarence B. Moore Archæological Collection, which were arranged on the first floor of the new building during the present year, all the other archæological material has been arranged in new cases procured for its reception, the majority of them uniform with those containing the Moore Collection. Prof. F. W. Putnam, of Cambridge, devoted some days to helping us in the general arrangement and classification of the collections, after which they were finally placed and labelled. The Peruvian and Egyptian mummies were also arranged in new cases and displayed on this floor.

The entire collection of mammals was transferred from the old building to the second floor of the new museum, the old cases being necessarily retained in use until new and more suitable ones can be substituted.

The series of mounted mammals is now displayed in a thoroughly systematic manner and carefully labelled, with the families and orders indicated in each case, an arrangement that was quite impossible in the former crowded galleries. Many recently mounted specimens have been exhibited for the first time, and a number of badly mounted duplicate specimens have been removed from the cases to the study-collection of skins. Other poorly mounted specimens are being removed as fast as new and better examples can be obtained. In this way the inferior work of the old time taxidermists is being rapidly replaced by the life-like mounts that characterize the modern art.

The large collection of mammalian osteological material, which was formerly so crowded as to render it inaccessible, has been carefully arranged in storage-cases on the first floor of the new museum, where it can be consulted with great convenience, while an exhibition series, comprising skulls or articulated skeletons of the principal types, is exhibited on the mammalogical floor. The large *Balænoptera* skeleton has been placed along the eastern end of this floor and the smaller whale skeletons from the old building mounted and placed near by.

Notwithstanding the time required to prepare the new building for exhibition, the work accomplished in other departments has been considerable. The removal of so much material from the old building has made it possible to arrange the cases containing the palæontological collections to much better advantage, while the vacant space under the south gallery has been partitioned off uniform with the Entomological room, to furnish apartments for the Biological and Geological Sections. Two additional commodious rooms have been fitted up for the Botanical Section on the library floor.

During the year the cataloguing of the mineral collection has been continued, and a series of minerals from Pennsylvania and New Jersey selected from the general exhibit, has been arranged in the department of local natural history.

Work on the invertebrate fossils has been mainly confined to the Lea Eocene Collection. Through the liberality of the Rev. L. T. Chamberlain, D. D. a third fine case has been procured for the display of the collection, and Mr. C. W. Johnson has been enabled to spend much time in arranging and labelling the specimens and in carrying on valuable exchanges, besides making a short trip to the Potomac Valley, where a large collection was made.

In the Department of Vertebrate Palæontology a valuable addition has been made to the museum by the final arrangement and labelling of the Port Kennedy Collection. Work at the cave has been actively and successfully pushed forward during the year by Dr. Dixon and Mr. H. C. Mercer.

Great progress has also been made in cataloguing and renovating the collection of birds, so that this work is rapidly nearing completion. Many valuable additions have also been received, especially to the Delaware Valley Ornithological Collection of local birds, the increase of which has necessitated the addition of a new plate-glass case for its accommodation. Further particulars of work in this department will be found in the report of the Ornithological Section.

In other departments the work has been mainly restricted to cataloguing and arranging the large additions received during the year, and looking after the general condition of the specimens, which is now excellent.

The additions to the museum during the year have been noteworthy. One of the most important of these is the archæological and zoological material obtained by Dr. Benjamin Sharp during a cruise along the coast and among the islands of Alaska and Siberia in the U. S. Revenue Cutter "Bear," during the year 1895. Besides fine series of native implements, there are valuable collections of mollusks and birds, and a Pacific walrus; also three fur seals, which now make one of the most attractive groups in the museum. Another, and one of the most valuable accessions, is a series of mammals, birds, fishes and reptiles collected in Somali-land by Dr. A. Donaldson Smith on his expedition through that country.

Valuable collections of birds, mollusks and plants were likewise obtained for the Academy by Mr. George Russell in British Guiana. Another important addition is the collection of marine invertebrates prepared in formaline by our preparateur, Mr. F. W. Walmsley. Many other donations have been received, special mention of which will be found in the appended list of accessions, including a number of rare specimens from the Zoological Society of Philadelphia.

The various collections under the care of special conservators have received careful attention during the year, and to the gentlemen who have rendered this important service the Curators would express their indebtedness—to Messrs. Thomas Meehan and Stewardson Brown of the Botanical Section; Dr. Henry Skinner of the Entomological Section, and William W. Jefferis, Curator of the Wm. S. Vaux Collections.

Valuable assistance has also been rendered in various departments of the museum by the students of the Jessup Fund: Miss Helen Higgins, Miss Jennie Letson, Messrs. H. W. Fowler, William J. Gerhard, E. G. Vanatta and S. H. Hamilton.

HENRY C. CHAPMAN,
Chairman of the Curators.

REPORT OF THE BIOLOGICAL AND MICROSCOPICAL SECTION.

The Section has held the usual number of meetings during the past year, and the attendance has been up to the average.

Communications pertaining to the subject of the Section, have been made at each meeting and usually specimens have been exhibited under the microscope. The cabinet has been enriched by 158 botanical slides, principally fungi, belonging to the late Dr. Rex and presented by his sister through Mr. Wingate.

The microscope of the late Dr. Wm. Hunt, and forty slides, were given by his widow.

A room on the second floor of the Academy has been fitted up by the Section and will soon be ready for occupancy. Aquariums and work tables will be at the disposal of the members, and it is hoped will be used for scientific investigation.

The officers of the Section are as follows:—

Director, ...	J. Cheston Morris, M. D.
Vice-Director, ...	John C. Wilson.
Treasurer, ...	Chas. P. Perot.
Conservator, ...	F. J. Keely.
Corresponding Secretary, . .	John G. Rothermel.
Recorder, ...	M. V. Ball.

M. V. Ball,
Recorder.

REPORT OF THE CONCHOLOGICAL SECTION.

The arrangement of the conchological collection remains substantially as reported last year, want of space preventing the progress of the systematic rearrangement in the exhibition cases of the families of mollusks studied and relabelled during the year, in connection with the monographic work in the Manual of Conchology. The remainder of the Tectibranch gastropods, including the *Aplysiidæ, Pleurobranchidæ* and *Umbraculidæ*, and of the land mollusks a considerable part of the *Bulimulidæ*, have been revised and prepared for arrangement in the cases. The genus *Cerion* has been studied by Mr. Vanatta and the Conservator, and the collection relabelled and arranged according to a complete catalogue of the species published in the Proceedings of the Academy. It is gratifying to state that out of seventy described species of *Cerion* we are in possession of all but seven, and have extensive series of most of the species.

A portion of the American Slugs have been studied, and large additions to the collection made; partial results being given in a paper published by the Academy, the greater part of this work being due to Mr. Vanatta's industry.

A considerable collection of mollusks from Uruguay and adjacent regions has been received from Dr. Wm. H. Rush, U. S. N., comprising many species new to the collection, and about twenty new to science.

A valuable collection of Alaskan mollusks, made by Dr. Benj. Sharp, has been presented to the Academy, but not yet wholly determined. The remainder of Prof. Heilprin's Bermuda collection has been placed in the cases, and with what we already had, forms probably the most extensive series of Bermuda mollusks in any museum.

The additions to our series of American mollusks have been very numerous, the most extensive accessions being Mr. S. N. Rhoads, collection of Tennessee shells, the series collected by Mr. C. W. Johnson and the Conservator in Florida in 1894, and a collection of marine forms from Puget Sound, which we owe to the Young Naturalist's Society of Seattle, Washington ; also, a large series of the recent and post-tertiary mollusks of White Pond, New Jersey, collected by Mr. Rhoads and the Conservator. Eighty-three persons, a list of whom is given in the record of additions to the Museum, have contributed smaller numbers of mollusks to the collection.

The Conchological Section and the Academy have purchased 291 species new to the collection during the year.

The Officers of the Section are as follows:—

Director, ... Benjamin Sharp, M. D.
Vice-Director, ... John Ford.
Recorder and Librarian, . . . Edw. J. Nolan, M. D.
Corresponding Secretary, . . . Chas. W. Johnson.
Treasurer, ... S. Raymond Roberts.

HENRY A. PILSBRY,
Conservator.

REPORT OF THE ENTOMOLOGICAL SECTION.

The Section moved into the apartments provided by the Academy, which it now occupies, February 27, 1895, and immediately thereafter work was commenced on the rearrangement of the collections and library. Owing to the crowded condition of the old rooms, it was impossible to attempt any proper arrangement, but, at the present time, all our possessions are in a very satisfactory condition, and can be properly studied and used to advantage. The members of the Section now feel that they are in a position to do good work, as they have the space for growth of the collections and library, and an incentive to advance. There has, undoubtedly, been a greatly increased interest in our study among the members of the Section which is likely to continue. During the past year important additions have been made to the cabinet. Many species have been presented to the display collection representing the fauna of Pennsylvania and southern New Jersey. The meetings have been well attended, the smallest number of persons present at any meeting being eleven, and the largest seventeen. The scientific communications have been of interest and of practical value in the advancement of entomology.

At the annual meeting, held December 17th, the following were elected officers to serve during the coming year:—

Director,	George H. Horn.
Vice-Director,	C. S. Welles.
Treasurer,	C. T. Cresson.
Conservator and Recorder,	Henry Skinner.
Secretary,	W. J. Fox.
Publication Committee,	C. W. Johnson. J. H. Ridings.

HENRY SKINNER,
Recorder.

REPORT OF THE BOTANICAL SECTION.

The Director of the Botanical Section respectfully reports that this department of the Academy is in a prosperous condition. It is free from debt, and has a small surplus in its treasury. Meetings have been held regularly at stated times when many matters of importance to botanical science were brought forward and discussed.

The progress and needs of the herbarium are well set forth in the statement of the Conservator, Mr. Stewardson Brown, which is submitted as a part of this report. It is hoped that the Redfield Memorial Herbarium Fund, efforts to enlarge which from outside sources have been held in abeyance the past year, may soon be increased. The income from this should be immediately available to aid in securing additional collections, while the principal sum is growing so as to secure the essential services of a Curator. The voluntary labors of Messrs. Crawford, Beringer, Brown and Meehan, in arranging the herbarium and preparing the specimens for fastening down, have been continuous the past two years. It will take some five or six years, at the same rate of proceeding, to complete the task, even if no additions were made to the collection. It is a question whether it is wise to depend greatly on this assistance, and it is earnestly hoped that the Redfield Herbarium Memorial Fund may secure the active interest of the Academy.

The officers for the ensuing year are:—

Director, ...	Thomas Meehan.
Vice-Director, ...	Charles E. Smith.
Conservator and Treasurer, . . .	Stewardson Brown.
Recorder, ...	Chas. Schäffer, M. D.
Corresponding Secretary, . . .	Jos. Crawford.

THOMAS MEEHAN,
Director.

In presenting this report for the year your Conservator is glad to be able to announce that the work of permanently mounting the general herbarium has been carried on steadily, and is completed nearly to the end of the Compositæ, which should be a matter of congratulation to all those interested in this very important work.

Such an advance has been made possible through the untiring efforts of the Director of the Section, Mr. Thomas Meehan, who has devoted a large amount of his time to the work during the past year.

In this connection the Conservator wishes to acknowledge the services of the Assistant in the herbarium, Mrs. E. F. Hochgesang, who has rendered most valuable aid in mounting and redistributing the plants, fully ten thousand sheets having been handled during the year.

In additions this year has not been behind former ones, as 2,450 species and varieties have been added to the herbarium, of which 803 are lower Cryptogams and 1,647 Phanerogams and Ferns. They are distributed as follows: North America, 1,500; Tropical America, 299; Asia, 241; Australia and Polynesia, 410—adding about 600 species new to the collection.

Among these may be specially mentioned the following: The unique collection of Myxomycetes, forming the herbarium of the late Dr. George A. Rex, comprising some 400 species, and presented to the Academy by his sister; 500 species of the North American Grasses from the United States Department of Agriculture, through Prof. F. Lamson Scribner; 150 species of Alaskan and Siberian Plants from Dr. Benj. Sharp; 90 species of Jamaica Ferns from U. C. Smith; Centuries 34 and 35 of North American Fungi from Dr. J. B. Ellis; 172 species and varieties of Sphagna Boreali-Americana Exsiccata from Mr. George F. Eaton; 375 species of Hawaiian

Island plants, collected in 1895 by Mr. A. A. Heller, and purchased for the herbarium; 209 species of Mexican Plants, collected by Prof. G. C. Pringle, and purchased for the herbarium; and 241 species of Asia Minor Plants, collected by Prof. Bornmüller, and purchased for the herbarium.

The attention of the Academy is respectfully called to the fact that the 825 species purchased during the past year, were paid for, not from the funds of the Section, but entirely by two of its members. Many very desirable collections were declined on account of the lack of funds; this is particularly to be regretted as regards the plants of our own country, in which we are in many cases very deficient.

The creation of a fund for the purchase of such collections is immediately desirable.

Since the last report the Academy has placed at the disposal of the Section two rooms formerly occupied by the Department of Entomology. The one on the gallery floor has been partially fitted up as a work-room.

The room on the library floor, which it is designed to use for additional herbarium space, has not as yet been occupied to any extent, owing to the lack of funds for furnishing. Additional cases for the accommodation of the herbarium are, however, an absolute necessity, as the present cases are crowded to an extent that is damaging to the specimens; it is therefore earnestly hoped, that before the close of the next year, this most pressing need will have been supplied.

Respectfully submitted,

STEWARDSON BROWN,

Conservator.

REPORT OF THE MINERALOGICAL AND GEOLOGICAL SECTION.

Ten meetings of the Section have been held during the year, with an average attendance of ten members. A notable addition to the facilities of the Section has been the laboratory erected on the first floor of the Museum by contributions from the Section and its individual members and from the Academy. This removes a serious difficulty under which we have labored, and cannot fail to facilitate its work.

Few additions have been made to the mineral collection of the Academy, except to the local collection, which has been arranged in part and displayed to advantage. It seems to have attracted the attention of visitors. It is hoped that this collection may be much increased in the near future, and that we may also have the means of displaying a representation of the rocks of the vicinity of Philadelphia of which the Academy has a fair supply, while there has been promised to the Section for the Academy a very large and nearly complete series.

Although not in the care of the Section, it may not be inopportune to call attention to the William S. Vaux Collection, which is now displayed to advantage in the new building. The Conservator of the Section holds the same relation to this collection, and to him is due much credit for its condition. As he accepts no salary the entire income of the fund has been applied to the improvement of the collection. During the year many valuable specimens have been added to it. The officers of the Section are:—

Director,	Theo. D. Rand.
Vice-Director and Conservator,	W. W. Jefferis.
Recorder,	Chas. Schäffer.
Treasurer,	John Ford.

Respectfully submitted,

THEO. D. RAND,
Director.

REPORT OF THE ORNITHOLOGICAL SECTION.

Owing to the opening of the new museum building and the work which it necessitated in other departments, the Conservator has been able to devote but little personal attention to the ornithological collections. Under his direction, however, Mr. Henry W. Fowler has carried on the work of cataloguing the collection with such success that quite as much progress has been made as in previous years, while Mr. McCadden, the taxidermist, has been enabled to proceed with the remounting of the exhibition series during several months of the year.

Since the last report, 7,386 mounted specimens have been identified and catalogued, and most of the specimens intended for the exhibition cases remounted, while the types and a part of the duplicate specimens have been unmounted and placed in the study series.

These specimens aggregated 3,192, and all of them have been carefully labeled. Besides the 7,386 specimens entered on the rough catalogue, 1,980 entries have been copied into the permanent catalogue.

The groups catalogued during the year comprised all the remaining families of the Picon Passeres, except the Trochilidæ, together with the Picariæ and Scansores. The exhibition series of all these families has been remounted except the Coccyges, Psittaci and Trochili, so that it will be an easy matter to complete the renovation of the ornithological collection during the ensuing year.

Owing to the liberality of friends of the Academy, we have been enabled to procure nineteen air-tight cases for the reception of the study series of skins similar to those already in use. This has enabled us to arrange almost all the unmounted specimens in systematic order in the Section-room where they are easily accessible to the student.

The exhibition series of Passeres, Picariæ, etc., has been arranged in order in the large cases in the middle of the ornithological gallery following the Rapacious birds, thus entirely clearing the wall cases, except a few duplicate specimens which are placed there temporarily until they can be unmounted.

The additions to the collection during the year, while not as great numerically as those of the previous year, comprise some exceedingly valuable collections containing many species not before represented.

The most important of these are the Donaldson Smith Collection of African birds from Somali-land, containing duplicates of many of the new species discovered by Dr. Smith, and the collection of Alaskan and Siberian birds obtained by Dr. Benj. Sharp, which well supplements the five series of the Arctic birds from the north Atlantic already in the Academy's collection. Other noteworthy accessions were a collection of British Guiana birds obtained through Mr. Russell, and a small collection from Nova Scotia presented by Mr. Robt. T. Young.

The general condition of the collection is excellent, and the increased facilities for study offered by the new arrangement have been taken advantage of by a number of students, while specimens have been loaned to specialists in various other institutions.

The Delaware Valley Ornithological Club has held its meetings regularly at the Academy, and aided materially in keeping up a lively interest in the Ornithological Department. The collection formed by the Club has steadily increased during the year, and now fills four large cases, one of them a handsome plate-glass case designed as a model for the cases needed for the display of the general ornithological collection in the new building. As soon as these can be procured, the entire collection of birds can be immediately transferred to its allotted position on the third floor of the new building, as the work of renovation is now practically completed.

At the annual meeting of the Section, held December 21, 1896, the old board of officers was reelected, as follows:—

Director, ...	Spencer Trotter, M. D.
Vice-Director, ...	Geo. S. Morris.
Recorder, ...	Stewardson Brown.
Secretary, ...	Wm. A. Shyrock.
Treasurer and Conservator, . .	Witmer Stone.

Respectfully submitted,

WITMER STONE,
Conservator.

REPORT OF THE ANTHROPOLOGICAL SECTION.

The Anthropological Section has been fully organized during the present year by the adoption of By-Laws and the election of officers in accordance with the requirements of the By-Laws of the Academy. It has, at present, a membership of thirty-four, and during the year has held eight monthly sessions. The principal communications received have been from Dr. D. G. Brinton on "The Relations of Race and Culture to the Degeneration of the Reproductive Organs in Woman," and on "Hybridization;" Dr. Harrison Allen on "The Prenasal Fossæ;" Prof. F. C. Kavanagh on "Right Handedness;" Prof. Lightner Witmer on "Psycho-Physical Measurements;" Dr. M. V. Ball on "Tattooing;" Dr. Chas. K. Mills on "Nerves of the Sense of Taste," and by Stewart Culin on "Divinatory Diagrams." In addition, minor communications were on various subjects.

The officers of the section are as follows:—

Director, ...	Harrison Allen, M. D.
Vice-Director, ...	Dr. Newlin Peirce.
Treasurer and Corresponding Secretary,	M. V. Ball, M. D.
Recorder and Conservator, . .	Chas. Morris.

CHARLES MORRIS,
Recorder.

REPORT OF THE PROFESSOR OF GEOLOGY.

The Professor of Geology respectfully reports that, as in former years, he has delivered the usual course of spring lectures, accompanied by Saturday field excursions. It is gratifying to be again able to state that the interest in the study of geology, as evidenced by the attendance at the lectures and participation in the excursions, shows no diminution, but the reverse. In addition to the regular Academy course, a special course of six lectures, introductory to the study of rocks and minerals, was delivered under the auspices of the Ludwick Institute, the attendance at which was significantly large.

In his capacity of Professor of Geology, the undersigned was appointed by the Council and Academy to represent the institution at the Millennial Mining and Geological Congress held at Budapest, Hungary, on September 25th and 26th. A report of this mission has been presented to the Council. The report makes reference to a special journey in the north of Africa, where a superficial study was made of the rock formations of the Atlas Mountains, with particular reference to the determination of the existence of glacial phenomena such as had been alleged to be found there. No evidences of past glaciation could be detected. As a result of this journey, a fairly extensive and representative collection of fossils was obtained from the Atlas confines of the Sahara; these, when properly studied and determined, will be placed with the collections of the Academy.

The additions to the Academy's geological collection made during the year have been neither particularly large nor important, the most noteworthy, in the department of Paleontology, being the animal remains obtained from Port Kennedy, Pa., by Mr. H. C. Mercer.

Respectfully submitted,

ANGELO HEILPRIN,
Prof. of Geology.

REPORT OF THE PROFESSOR OF ETHNOLOGY AND ARCHÆOLOGY.

I have the honor to report that, during the year 1896, I delivered a course of six lectures, public and gratuitous, on subjects connected with the study of anthropology. They were well attended and increased the general interest in this branch of science.

The ethnological collections of the Academy have been rearranged and labeled through the attention of the Curator, whose report will supply the information required on that subject.

I have the honor to remain,

DANIEL G. BRINTON,
Professor of Ethnology and Archæology.

REPORT OF THE PROFESSOR OF INVERTEBRATE ZOOLOGY.

The Professor of Invertebrate Zoology respectfully reports that during the past year he has delivered eight lectures, six on "The Action of the Environment Upon Animals," under the auspices of the Ludwick Institute, and two: "A Summer in Alaska and Siberia" and "Alaskan and Siberian Natives," in the Popular Friday Evening Course.

The additions to the Museum have been neither numerous nor important.

A course of ten lectures on "Invertebrate Zoology" will be delivered in January, February and March, in the Ludwick Institute Course, and, during the spring, a lecture on "The Sea and Its Influence on Animal Life," in the Popular Friday Evening Course.

Respectfully submitted,

BENJ. SHARP,
Professor of Invertebrate Zoology.

REPORT OF THE PROFESSOR IN THE DEPARTMENT OF MOLLUSCA.

The Professor in the Department of Mollusca respectfully reports that during the year he delivered a course of five lectures upon the morphology of Mollusca and two upon "Economic Uses of Mollusca" and "Mollusks of the Atlantic Coast."

In the Museum considerable progress has been made in the revision of the land mollusks, and many additions to the collection have been received as noted in the report of the Conchological Section.

Respectfully submitted,

HENRY A. PILSBRY,
Prof. of Malacology.

REPORT OF THE PROFESSOR IN THE DEPARTMENT OF INSECTA.

Having been elected to the Professorship of the Department of Insecta on the thirtieth day of March, 1895, I have the honor to submit this, my first report. Some idea of the field covered in this department may be derived from the fact that we have about 126,000 specimens in the collection, divided as follows:—

Lepidoptera	33,600 specimens.
Coleoptera	43,800 specimens.
Hymenoptera	36,240 specimens.
Neuroptera	2,400 specimens.
Diptera, Hemiptera, Orthoptera	10,000 specimens.

These collections are believed to be in a better state of arrangement and preservation than ever before, and museum pests have been almost annihilated. The Conservator of the Entomological Section has been greatly aided by members interested in the several orders, and much valuable work has been done by them in the departments in which they make special studies. It is hoped that the fine collection of local insects will soon be completed by the aid of the Feldman Collecting Social of Philadelphia and individual members. The department needs new cases to replace the older ones that are not absolutely safe, and, in the future, metal cases, which can be practically hermetically sealed against dust and pests, should be secured.

A course of five lectures has been delivered covering the general subject, including the classification, anatomy, orders, technic, and economic or practical entomology.

Respectfully submitted,

HENRY SKINNER.

REPORT OF THE CURATOR OF THE WM. S. VAUX COLLECTIONS.

The Curator of the William S. Vaux Collections reports that during the year there have been added to the mineralogical cabinet, by purchase, 185 specimens. A nugget of native gold from Alaska was presented by C. B. Moore, bringing the number of specimens in the collection, November 30, 1896, to 7,966. Several of the specimens thus added are new to the collection. Attention is especially called to a superb crystal of green tourmaline with pink terminations. It is probably the finest specimen yet found at Haddam, Conn. The collection is in good order. No addition has been made to the archæological section.

Respectfully submitted,

WM. W. JEFFERIS,

Curator.

The election of Officers, Councillors and Members of the Finance Committee to serve during 1897, was held with the following result:—

President, ...	Samuel G. Dixon, M. D.
Vice-Presidents, . . .	Thomas Meehan.
	Rev. Henry C. McCook, D. D.
Recording Secretary, . .	Edward J. Nolan, M. D.
Corresponding Secretary, .	Benjamin Sharp, M. D.
Treasurer, ...	George Vaux, Jr.
Librarian, ...	Edward J. Nolan, M. D.
Curators, ...	Henry A. Pilsbry.
	Henry C. Chapman, M. D.
	Arthur Erwin Brown.
	Samuel G. Dixon, M. D.
Councillors to serve three years,	Thomas A. Robinson.
	Harrison Allen, M. D.
	Chas. Morris.
	Isaac J. Wistar.
Finance Committee, . .	Charles Morris.
	Chas. E. Smith.
	Uselma C. Smith.
	William Sellers.
	Charles P. Perot.

ELECTIONS DURING 1896.

MEMBERS.

January 28.—James C. Corry, P. Calvin Mensch, M. D., Ph.D., J. Norris De Haven, Edw. Gideon, A. M., Geo. de Schweinitz, M. D., Ruth Clement, M. D., Chas. E. Hite, Henry Trimble, C. Howard Colket, Sarah Y. Stevenson.

February 25.—Arthur N. Leeds, Morris Earle, H. W. Wenzel, George L. Farnum, J. Edward Farnum, Vickers Oberholtzer, Ph.D., Homer E. Hoopes, A. Feldpauch.

March 31.—Jacob Reese, Louis S. Amonson, E. G. Conklin, Mary T. S. Schaeffer, Walter P. Stokes, Charles L. Phillips, A. Donaldson Smith, M. D.

April 28.—Wm. H. Roberts.

August 25.—Thomas Chalkley Palmer.

September 29.—J. Howard Breed, Mrs. F. G. Dixon, Effingham B. Morris, Curwin Stoddart, Jr.

October 27.—Henry A. Laessle, George C. Harlan, M. D., William M. Singerly, Henry Beates, Jr., M. D.

CORRESPONDENTS.

October 27.—W. C. Roentgen of Würzburg, Germany.

November 24.—R. A. Philippi of Santiago, Chili.

ADDITIONS TO THE MUSEUM.

1896.

ARCHÆOLOGY, ETHNOLOGY, ETC.

Alaskan Expedition (collected by Dr. Benjamin Sharp). Large collection of native implements from Alaska and Siberia.

Arthur Erwin Brown. Indian Tepee Door, Colorado.

Clarence B. Moore. Large collection of implements, etc., from the Florida Indian mounds.

Dr. W. H. McGrath. Arrow-head from the interior of Brazil.

Dr. H. C. McCook. Several Indian mortars and pestles.

MAMMALS.

Alaskan Expedition (collected by Dr. Benj. Sharp). Eighteen skins and two alcoholic mammals, Alaska and Siberia, also three skins and skulls of fur seal, *Callotaria ursina* (mounted in group).

Wm. L. Baily. *Sciurus carolinensis pennsylvanicus* (mounted), Pennsylvania.

Geo. B. Benners. Five skulls of Texan mammals.

Chas. Bradley. *Putorius noveboracensis.*

M. Corley. Desiccated specimen of rat (*Mus decumanus*).

Edmund Coxe. Mounted specimen of *Ornithorhynchus anatinus.*

Dr. H. C. Chapman. Seven skulls of mammals, and vicera of *Macrorhinus.*

I. N. DeHaven. Alcoholic specimen of *Blarina brevicauda floridana*, Florida.

Exchange. Two skins of *Peromyscus niveiventris.*

J. Edward Farnum. Three skulls of African mammals.

Fesquet Estate. Horns of chamois and whale's tooth.

Wm. J. Gerhard. Specimen of *Scalops aquaticus*, Pennsylvania.

David McCadden. *Sciurus niger cinereus* (mounted), West Virginia.

Purchased. Skin and skeleton of *Anoa depressicornis* Celebes, and *Ovis cervina* (mounted).

Purchased through Mr. Russell in British Guiana. Four skulls and three skins of mammals.

Saml. N. Rhoads. Eight rodents from Wisconsin (two mounted, six in alcohol); nine alcoholic mammals, Mammoth Cave, Kentucky;

twenty-five mammals, Clinton Co., Pa.; six mammals, Warren Co., N. J.; skull of *Putorius vison*, Maine; skull of *Felis domestica*.

Dr. Benj. Sharp. Jaw of Dolphin, Nantucket, Mass.

Dr. A. Donaldson Smith. One hundred and thirty-five mammals (alcoholic and skins) from N. E. Africa.

Tennessee Expedition, 1895 (collected by S. N. Rhoads). One hundred and twenty mammals (skins and alcoholic).

James Upton. Mounted specimen of *Pithecus satanus*.

Zoological Society of Philadelphia. Mounted: *Coelogenys paca, Tragulus meminna, Semnopithecus obscurus, Cercopithecus callitrichus, Macacus nemestrinus, Choloepus didactylus, Meles meles, Cephalophus coronatus, Belideus sciureus, Halmaturus dorsalis.* Skins and skulls: *Procyon cancrivorus, Petaurus sciureus, Macropus rufus bennetti, Sciurus badging* (2), *Dasyprocta prymnolopha, Trichosurus vulpinus, Capromys fournieri, Midas* sp. Skeletons: *Felis pardalis, Hyæna striata, Hyæna crocuta.* Viscera of *Hyæna crocuta.*

Birds.

Alaskan Expedition (collected by Dr. Benj. Sharp). One hundred and two bird skins and forty-eight eggs from Alaska and Siberia.

E. A. Barbour. Skin of *Trogon resplendens.*

G. B. Benners. Skin of *Peucæa ruficeps eremoeca*, Texas.

Dr. H. C. Chapman. Penguin and Toucan in alcohol.

Edmund Coxe. Mounted specimen of *Apteryx oweni.*

Delaware Valley Ornithological Club. Twelve mounted birds, ten nests, nine sets of eggs. Pennsylvania and New Jersey.

Mrs. B. W. Douglass. Skin of *Paradisea apoda.*

Exchange. Nine skins of Liberian birds.

Dr. Wm. E. Hughes. Seven skins of birds, Quebec.

David McCadden. *Corvus corax principalis*, Virginia (skin).

George S. Morris. *Passer domesticus* albino (skin).

Dr. Wm. Pepper. Two skins of Ptarmigan.

Purchased. *Aquila chrysætos* (mounted), Virginia; three skins of *Conurus carolinensis*, Florida.

Purchased through Mr. Russell in British Guiana. Forty-two skins of birds and skeleton of *Opisthocomus.*

Saml. N. Rhoads. Skin of *Ceophloeus pileatus*, Clinton Co., Pa.

Leander Rogers. *Ardea herodias*, New Jersey (skin).

John Siner. Three mounted birds.

Dr. A. Donaldson Smith. One hundred and thirty-eight skins of birds and twelve nests from north-eastern Africa.

Uselma C. Smith. Nest of *Trochilus colubris.*

Mrs. J. M. Thomas. Pair of mounted wood ducks.

Visitor. Twelve skins of South American birds.

R. T. Young. Sixty-two skins of birds from Novâ Scotia.

Archiclaus Willets. *Tringa maritima* for D. V. O. C. Collection (mounted).

Zoological Society of Philadelphia. Mounted: *Ibis stictipennis, Dromius novæ-hollandiæ, Penelope superciliaris, Chrysolophus amherstiæ, Phasianus reevesi, Penelope* sp. Skins: *Callœnas nicobarica, Pterocles arenarius, Ocyphaps lophotes, Aramides mangle, Chenopsis abrata, Phlogenas lugonica, Caccabis* sp., *Gennæus swinhoei, Cereopsis novæ hollandiæ, Chrysolophus amhherstiæ, Turacus buffoni, Turtur turtur.* Skeleton: *Casuarius casuarius, Olor cygnus.* Skulls and sterna: *Olor cygnus, Anhinga anhinga, Dendrocygna* sp., *Dacelo gigas.* Egg of Emu.

Reptiles and Batrachians.

H. C. Borden. Two specimens of *Rana clamitans,* Pennsylvania.

Dr. S. G. Dixon. Specimens of *Bufo lentiginosus* and *Liopeltis vernalis,* Maine.

Exchange. Ten jars of reptiles, Argentina, S. A.

E. B. Hendricks. Toad with five legs, Philadelphia.

Philip Laurent and Dr. Castle. Twelve reptiles and batrachians from Enterprise, Fla.

H. A. Pilsbry and C. W. Johnson. Specimen of *Rana pipiens* and twenty-one eggs of gopher turtle, specimen *Rana* sp.

Purchased (through Mr. Russell). Specimen of *Elaps lemniscatus.*

Dr. Benj. Sharp. *Gonatodes albogularis,* Tobago.

Fredk. Sterns. Two lizards, Japan.

S. N. Rhoads. Sixty-four reptiles, Pennsylvania; three from British Columbia.

Dr. A. Donaldson Smith. One hundred and forty-eight reptiles from north-eastern Africa.

J. S. Wills. *Amblystoma opacum,* New Jersey.

H. W. Wenzel. Seventeen reptiles and batrachians from Cranberry, N. C.

E. G. Vanatta. *Hyla* sp., *Aromochelys odoratus,* Maryland.

Zoological Society of Philadelphia. *Python reticularis, Caimon sclerops, Vipera ammodytes.*

Lt. Hugh Willoughby. Eggs of Florida crocodile.

Fishes.

Dr. H. C. Chapman, *Myxine glutinosa, Petromyzon marinus* and *Lepidosiren paradoxa.*

Seth E. Meek. Two hundred and sixty-two fresh-water fish from Iowa, Arkansas and Indian Territory.

Dr. A. Donaldson Smith. Collection of fish from N. E. Africa.

Edw. H. Williams. Dried fish from Japan.

T. W. Walmsley. One flounder in formaline.

Lower Invertebrates.

Alaskan Expedition (collected by Dr. Benjamin Sharp). A large series of marine invertebrates from coasts of Alaska and Siberia.

F. W. Walmsley. Thirty jars of specimens from the Atlantic coast preserved in formaline.

Mrs. Corlies. Case of corals.

Crustacea.

F. W. Walmsley. Very large specimen of lobster, Newport, R. I.

Insecta.

C. W. Johnson. One case of Diptera, Pennsylvania and New Jersey.

Philip Laurent. Five cases of Neuroptera, Pennsylvania and New Jersey.

Feldman Collecting Social. One case of Coleoptera, Pennsylvania and New Jersey.

Dr. William Pepper. Nest of trap-door spider.

Recent Mollusca.

Mrs. George Andrews. Twenty-two species from Tennessee and Florida.

D. D. Baldwin. Ten species Hawaiian land shells; ten bottles alcoholic mollusks.

F. C. Baker. *Bythinella* and *Vertigo* from Chicago, Ill.

W. T. Bednall. Ten species of S. Australian Polyplacophora.

Wilfred Bendall. Cerion, etc., New Providence, Bahamas.

Charles P. Berkley. Pleistocene (shell-marl) fossils from Minnesota.

Wesley Browning (in exchange). Limnæidæ from Utah.

Fred L. Button. Collection of slugs from Oakland, Cal., including types of *Aphallarion Buttoni* (see Proceedings, p. 339).

Dr. R. Ellsworth Call. *Carychium* and *Unio* from Kentucky.

Mrs. Julia E. Campbell. *Punctum pasadenæ*, types.

John H. Campbell. Two species of mollusks.

Mrs. G. W. Carpenter. Twenty-seven species marine shells.

L. T. Chamberlain, D. D. Seventy-nine trays of land and fresh water shells from Mississippi and Louisiana, collected by C. W. Johnson.

Geo. H. Clapp. *Omphalina inornata* Say (Albino) and other shells from western Pennsylvania.

T. D. A. Cockerell. Land shells from Colorado, New Mexico and Mexico (see Nautilus, X, p. 59).

Dr. J. C. Cox. Ten species of Australian mollusks.

Wm. H. Dall. Sixteen species Californian and Lower Californian land shells (alcoholic).

O. Debeaux (in exchange). Collection of N. African Helices.

W. H. DeCamp. *Bythinella* from Grand Rapids, Mich.

John Ford. Thirteen species of shells new to the collection.

Wm. J. Fox. Two species of mollusks.

A. H. Gardner. Eight species of Canadian shells.

Mrs. E. M. Gaylord. Living Helices and alcoholic slugs from Oregon.

Langdon Gibson. Six species of marine shells from Greenland.

G. K. Gude. *Corilla fryæ*, n. sp.

A. W. Hanham. Five species land and fresh water shells from Canada.

Charles Hedley. Four species Australian mollusks.

Angelo Heilprin. One hundred and fifty-seven species of shells from Morocco and Bermuda.

A. U. Henn. Specimen of *Pugnus parvus* Hedley, n. sp.

H. von Ihering. Ten species of S. American snails.

Illinois State Laboratory of Natural History. Collection of aquatic Gastropods from Havana, Illinois.

W. W. Jefferis. *Campeloma*, *Unionidæ* and *Limnæidæ* from New York.

C. W. Johnson. *Corbula* and eleven other species from Florida (see also Pilsbry and Johnson).

F. R. Latchford. Nineteen species Canadian shells.

Miss Jennie E. Letson. Two species.

H. Loomis (in exchange). Japanese mollusks.

J. G. Malone. Slugs from Oregon.

Wm. B. Marshall. *Succinea* from Cape May, N. J.

E. H. Matthews. *Ephippodonta*, *Mylitta*, etc., from S. Australia.

D. N. McCadden. Two land shells from Virginia.

Edmund S. Meany. Specimens of *Saxicava arctica* and *Littorina scutulata*.

Clarence B. Moore. Four species Georgia and Florida shells.

Geo. H. Pepper. *Limnæa bulimoides* Lea (through G. H. Clapp). See Nautilus, X, p. 96.

Miss Caroline Phœbus. *Mya arenaria* from Maryland.

H. A. Pilsbry. Seventy-eight species fresh water and marine shells from Pennsylvania and Texas.

H. A. Pilsbry and C. W. Johnson. Two hundred and fifty-three trays land and aquatic mollusks from the St. John's River, Fla.

H. A. Pilsbry and S. N. Rhoads. One hundred and sixty-eight trays fossil and recent shells from White Pond, N. J., and adjacent country.

John Ponsonby. Seven species of Helices new to the collection (in exchange). See Proceedings, p. 15, etc.

E. J. Post (in exchange). Collection of Tampa Silex beds fossils.

P. B. Randolph. Collection of slugs, etc., from Washington.

W. J. Raymond. Types of *Ischnochiton aspidaulax*.

S. Raymond Roberts. Sixteen species of land and marine shells.

Edw. W. Roper. Sixteen species of land shells.

Dr. Wm. H. Rush. One hundred and three species of mollusks from Cape Verde Is. and South America.

H. E. Sargent. Fifteen species Alabama mollusks.

Dr. Benj. Sharp. Thirteen species West Indian shells.

Morris Shick. Sixteen species local mollusks.

Miss C. A. Shepard. *Goniobasis* from Florida.

Ida M. Shepard. Collection of West Coast American shells.

Howard Shriver. Seven species land shells from Maryland.

Edw. Simpson. Two species marine shells.

Dr. Henry Skinner. Eight species of land shells from North Carolina.

Dr. A. Donaldson Smith. Seven species African shells.

U. C. Smith. Shells from Jamaica.

Frederick Stearns. Twenty species Japanese mollusks.

Dr. V. Sterki. Four species Ohio mollusks.

C. P. Streator. Three species from Cayman Is.

L. H. Streng. Bythinia, etc., from Michigan.

E. R. Sykes. Eight species of Chiton from Port Phillip, Australia.

Rev. Geo. W. Taylor. Three species British Columbian shells.

Tennessee Expedition, collected by S. N. Rhoads. Five hundred and fourteen trays of mollusks, mainly from Tennessee.

Lancaster Thomas. Five species land shells, North Carolina.

E. G. Vanatta. Thirteen species shells from Maryland.

H. D. Van Nostrand. Fifty-two species of West Indian land shells (through S. Raymond Roberts).

Dr. J. W. Velie. Thirteen species Florida shells with types of *Marginella Veliei* (see Proceedings, p. 21).

Bryant Walker. Forty-five species from Michigan.

Robert Walton Collection, 176 species.

A. G. Wetherby. Twenty-four species land shells from North Carolina.

H. W. Wenzel. Six species land shells from Cranberry, N. C.

J. J. White. Eight species Florida shells.

Joseph Willcox. Thirty-five trays of *Fulgur*, etc.

Mrs. M. Burton Williamson. Five species Californian mollusks.

B. H. Wright. Four species Florida mollusks.

Young Naturalists' Society, Seattle, Wash. Collection of marine shells.

Purchased by the Academy of Natural Sciences and the Conchological Section: Two hundred and ninety-one species new to the collection; also a small collection made by G. F. Russell in British Guiana.

Invertebrate Fossils.

Uselma C. Smith. Thirty-nine trays of fossil mollusca from Jamaica.

Vertebrate Fossils.

Dr. S. G. Dixon and Henry C. Mercer. A large collection of mammalian remains from the deposit at Port Kennedy, Pa.

Plants.

Dr. Aldridge. Seven species of North American plants.

Lucien H. Alexander. Thirty-five species of Hawaiian Island ferns.

George M. Beringer. Six species of North American plants.

Stewardson Brown. Three hundred and seventy-five species of Hawaiian Island plants and twenty species of Underwood and Cook's *Hepaticæ americanæ*.

George F. Eaton. One hundred and seventy-two species *Sphagna Boreali-Americana Exsiccati.*

J. B. Ellis. Centuries 34 and 35 of North American fungi.

Benjamin Heritage. Seven species of North American plants.

W. W. Jefferis. Five species of North American plants.

Charles Lippincott. Specimen of *Grindelia squarrosa.*.

Thomas Meehan. Forty species of North American plants, two hundred and nine species of Mexican plants collected by Pringle, and two hundred and forty-one species of Asia Minor plants collected by Bornmüller.

Miss Rex. Five hundred species of Myxomycetes, Collection of Dr. G. A. Rex.

Benjamin H. Smith. Specimen of *Rhamnus smithii.*

Uselma C. Smith. Ninety species of Jamaica ferns.

Baron Ferdinand Von Müller (through Mr. Meehan). Thirty-five species of Australian plants.

Minerals, Etc.

Alaska Expedition (collected by Dr. Benjamin Sharp). Five specimens of minerals, Alaska.

Fesquet Estate. Fourteen boxes of minerals and ores.

German Kali Works. Salts from Strassfurt Mine.

L. A. Gettys. Monagite.

Geographical Club. Twenty-three trays of rocks from Greenland.

E. A. Groth. Two specimens of minerals.

John C. Johnson. Kaolinite and limonite.

Benj. Smith Lyman. Jade.

Gibson H. Prindle. Meteorite and small collection of minerals.

Theo. D. Rand. Singing sand, Massachusetts.

J. E. Richardson. Thinolite, Nevada.

Dr. H. A. Slocum. Small collection from Nova Scotia.

Joseph Walton. Marcasite and galena, Kansas.

Chas. J. Wister. Collection of minerals from various localities.

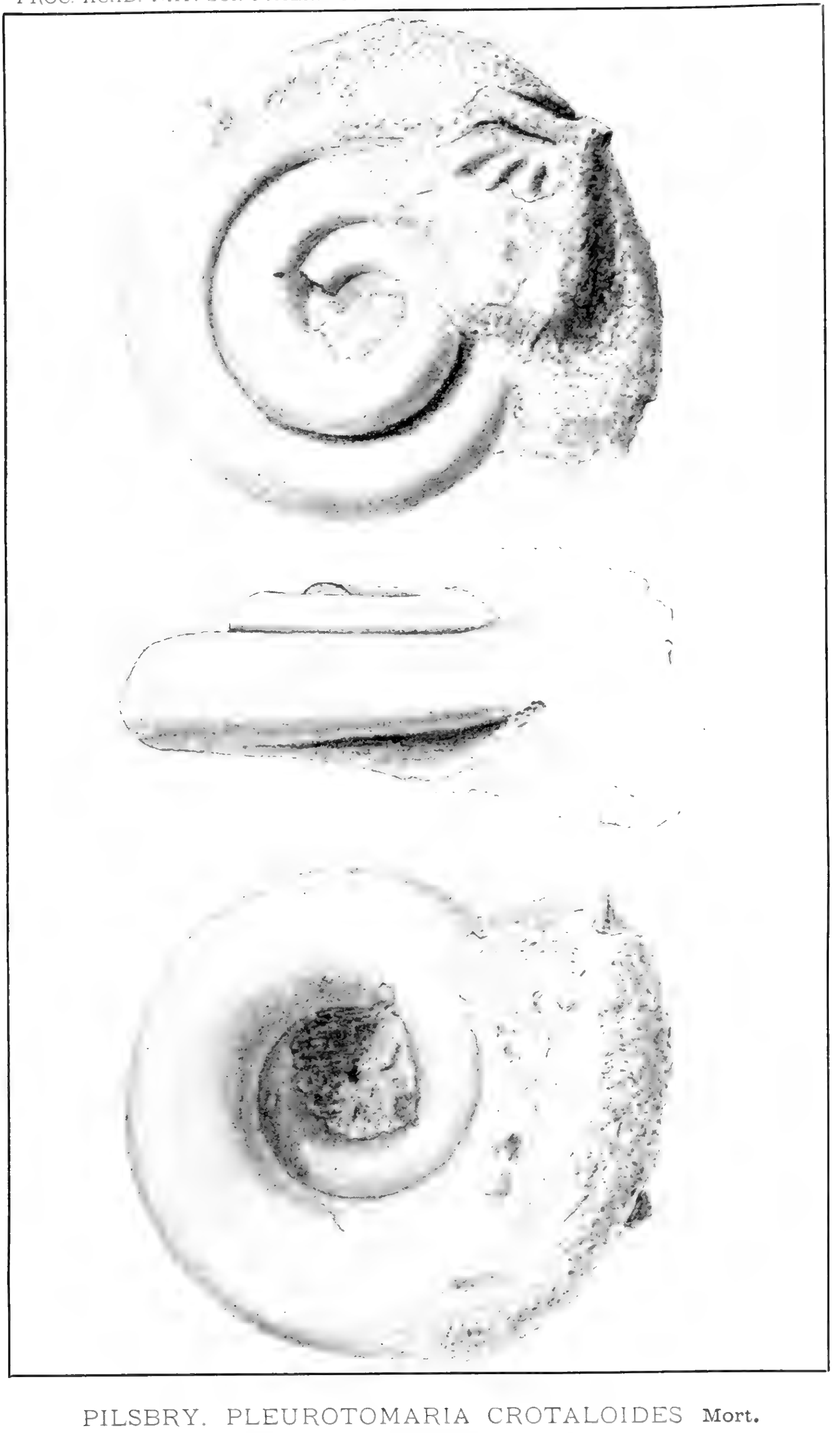
Wm. S. Vaux Fund. One hundred and eighty-five specimens of minerals for the William S. Vaux Collection.

INDEX TO GENERA, ETC.

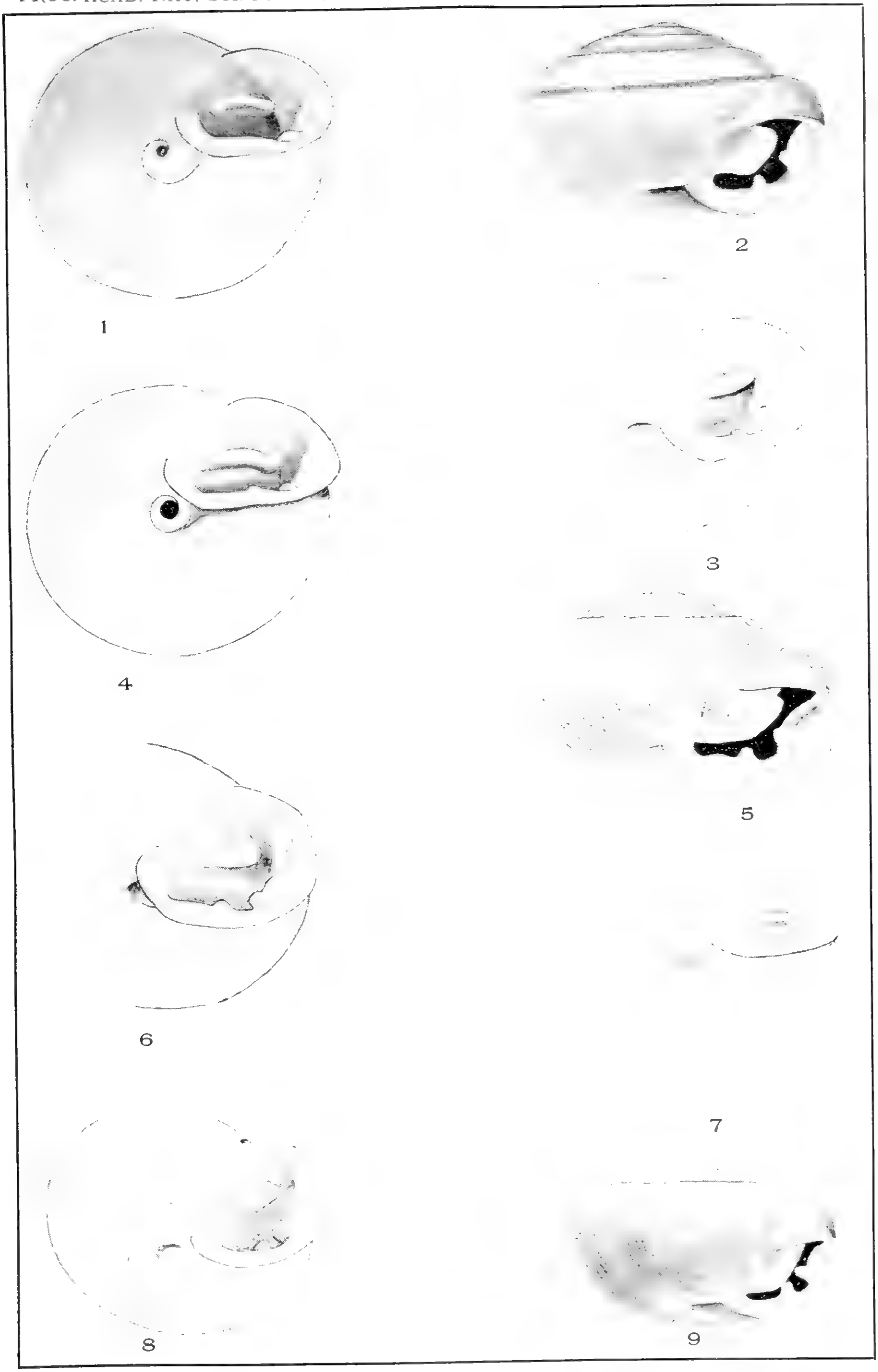
1896.

GENERAL INDEX.

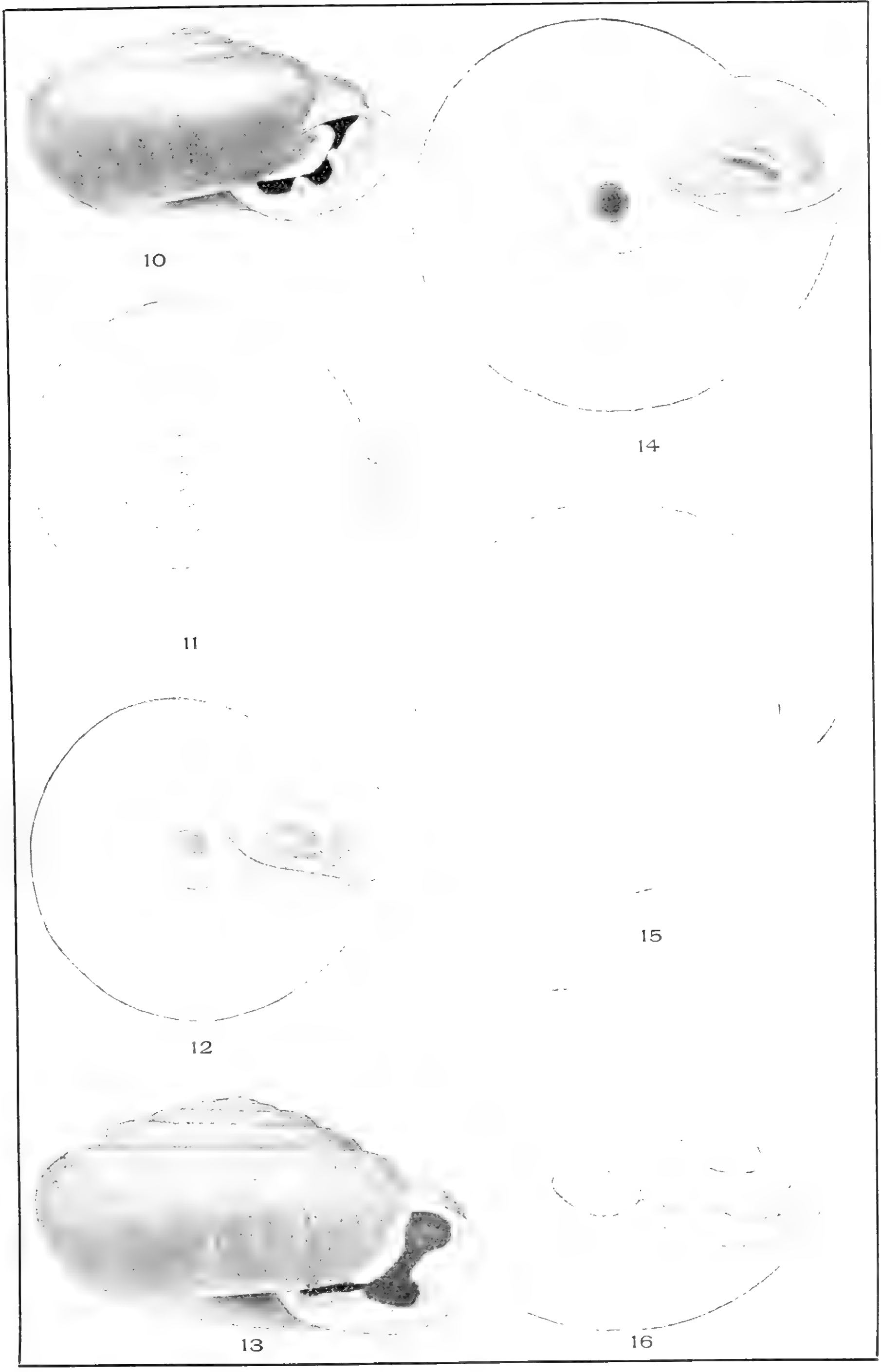
1896.



PILSBRY. PLEUROTOMARIA CROTALOIDES **Mort.**



PILSBRY. NEW SPECIES OF POLYGYRA.



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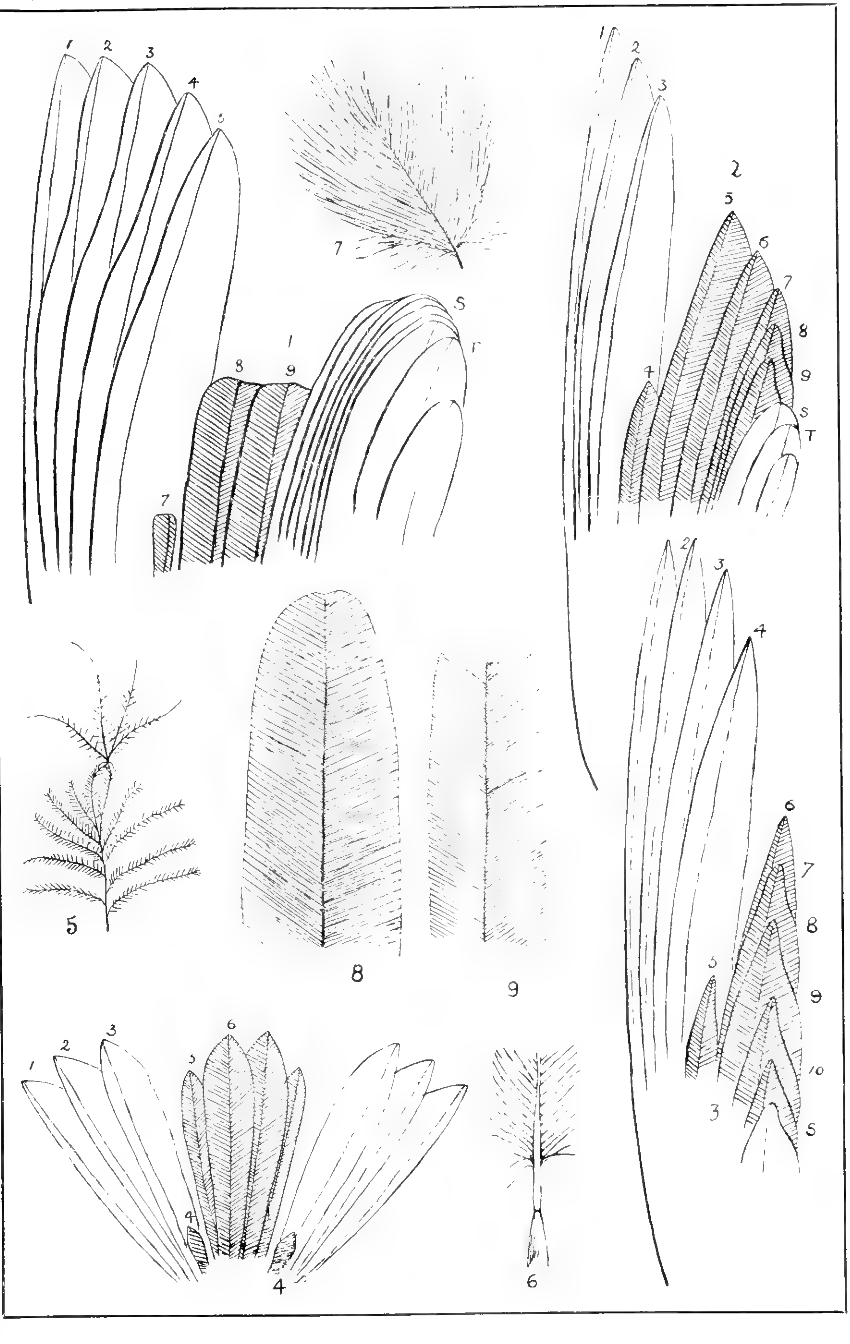
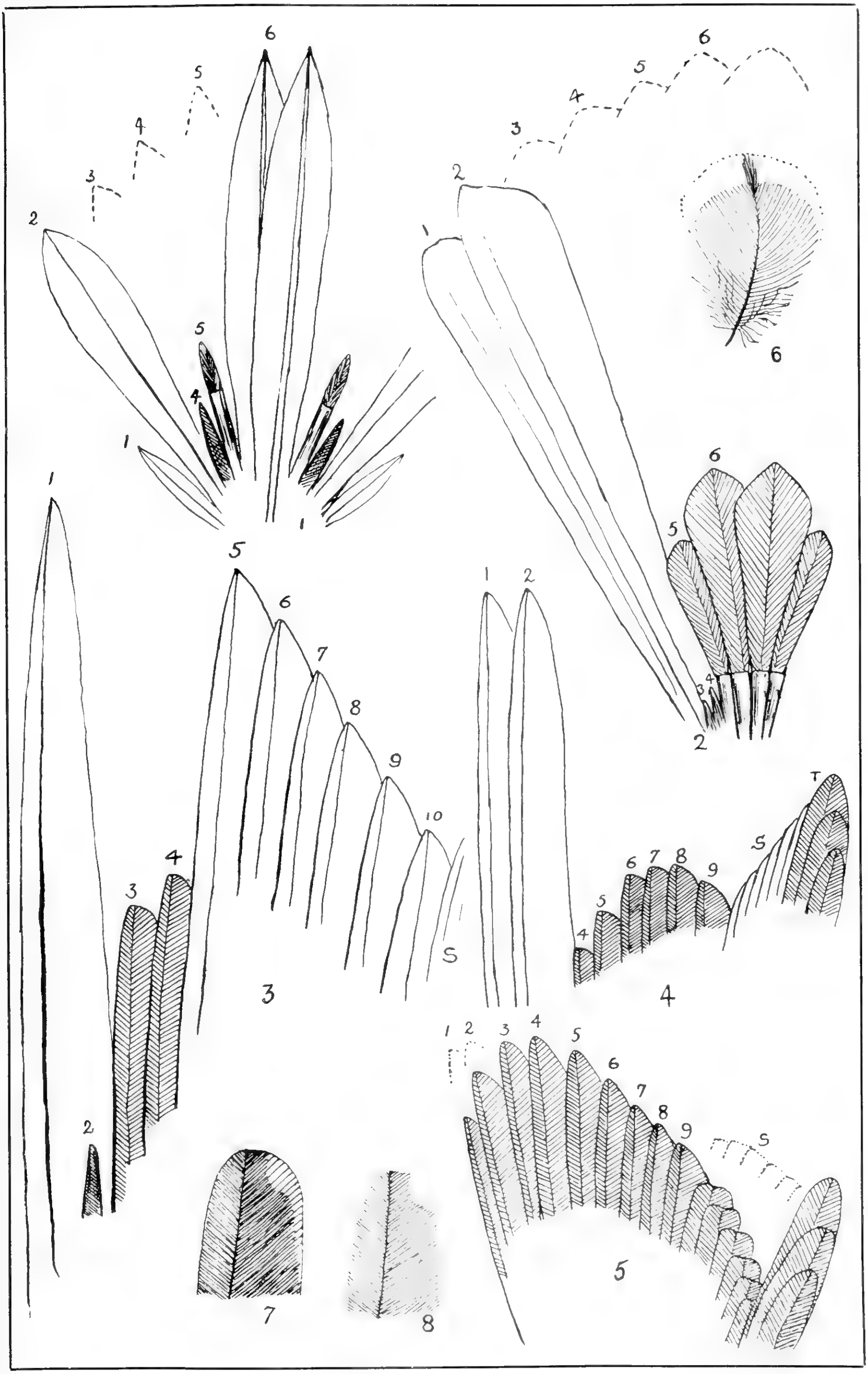


STONE. MOLTING OF BIRDS.



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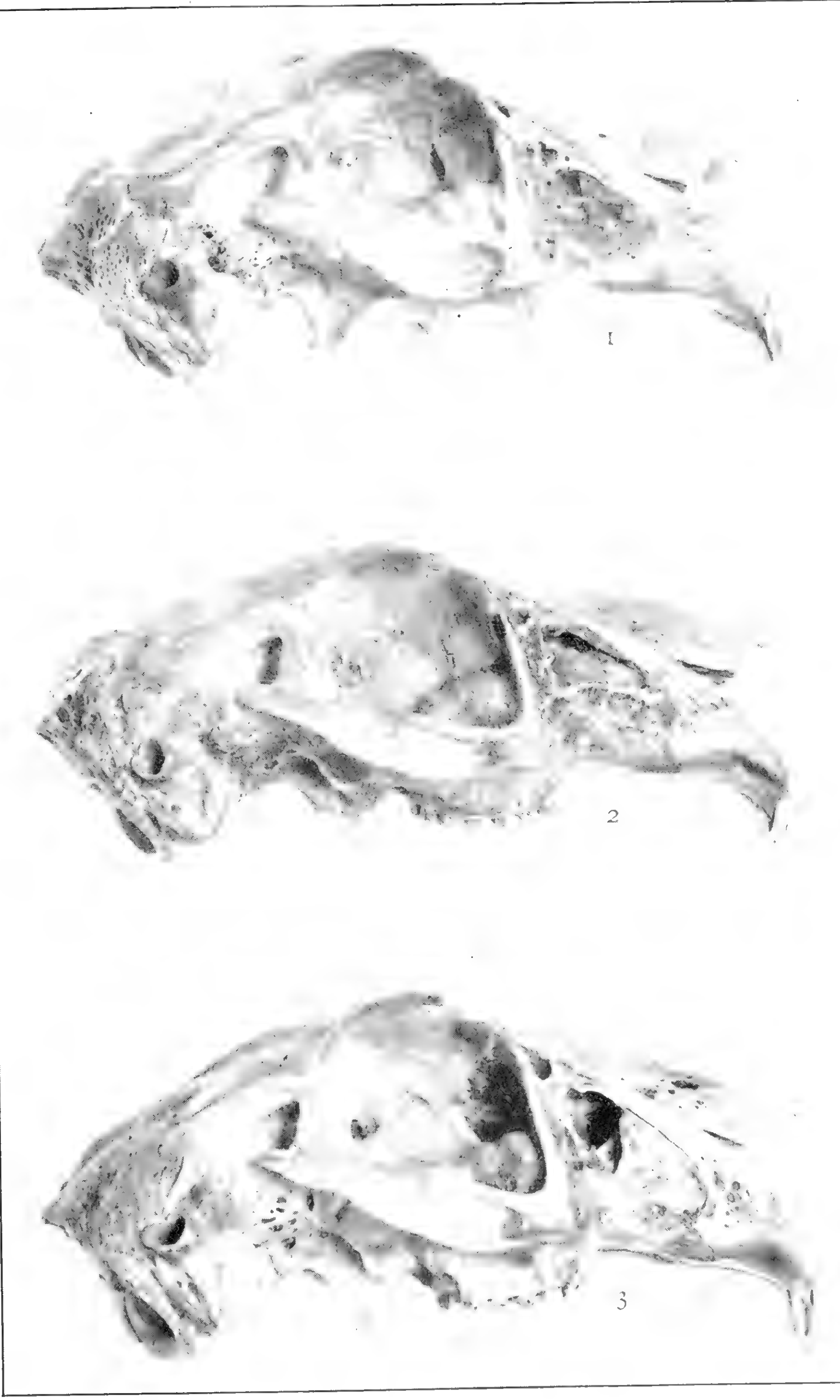
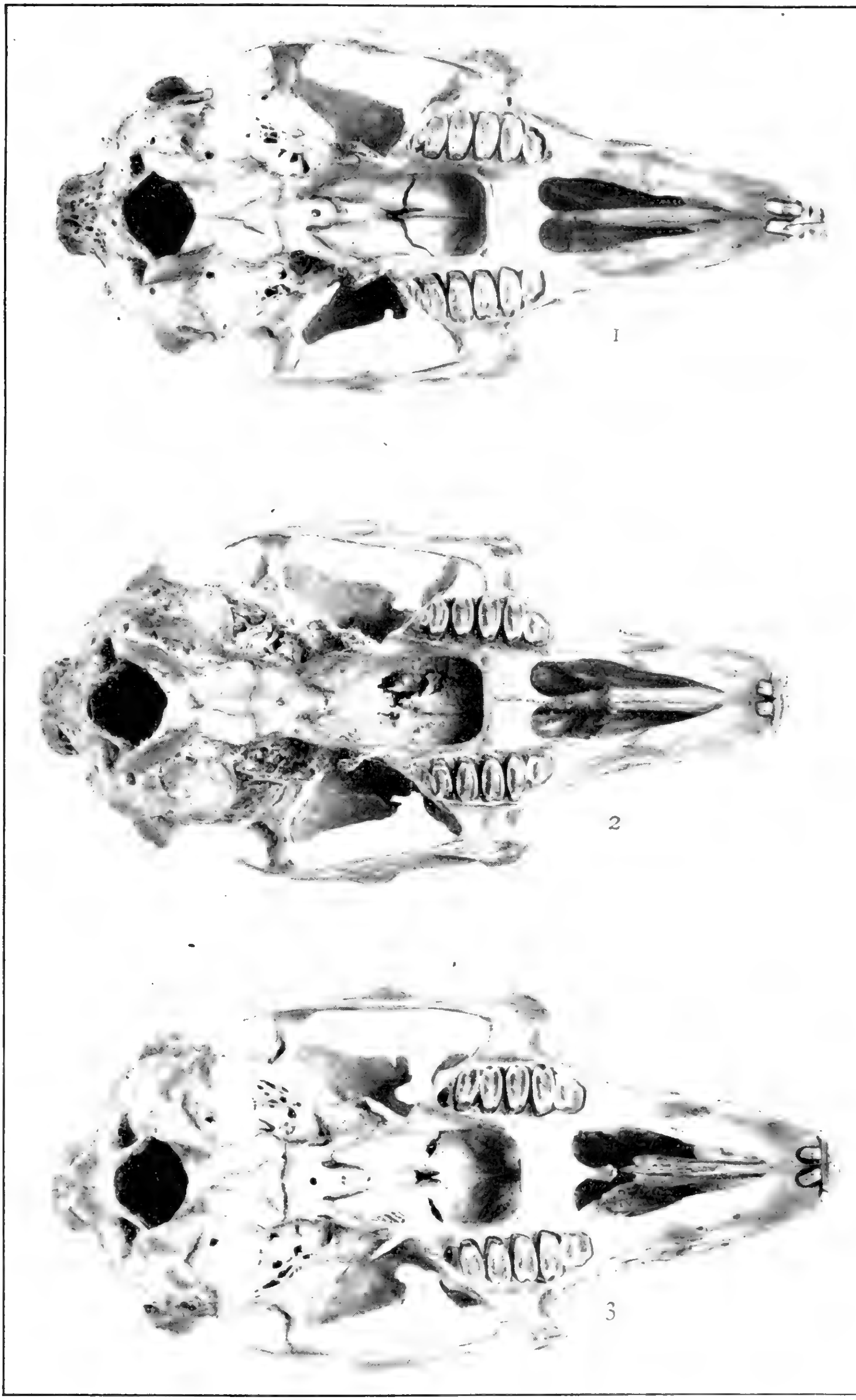


RHOADS ON AMERICAN POLAR HARES.



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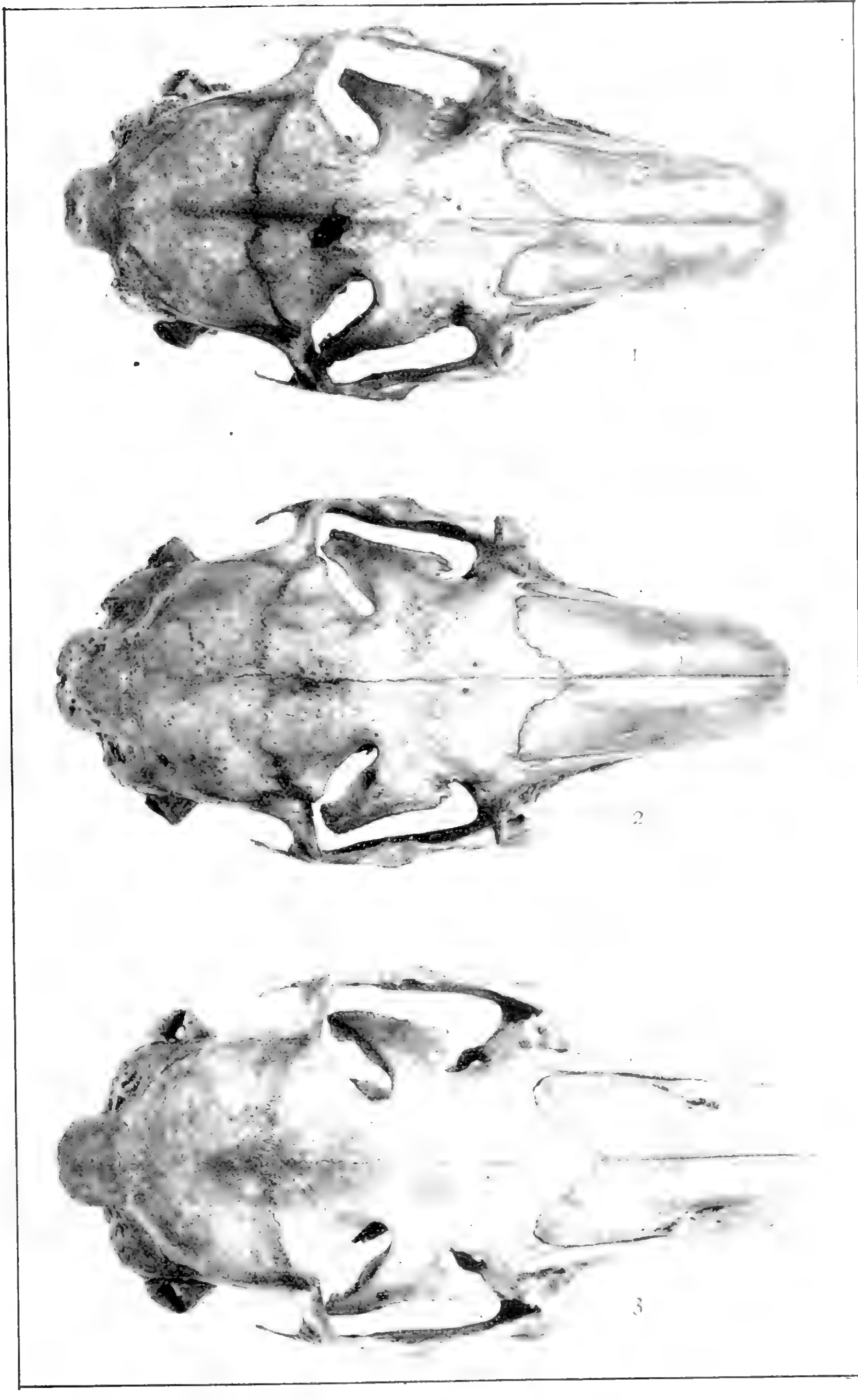

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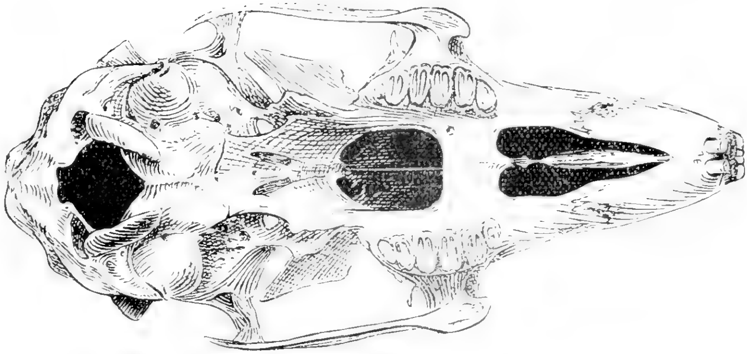

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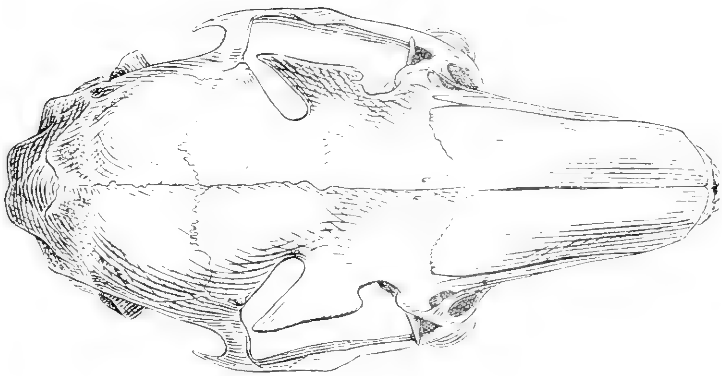

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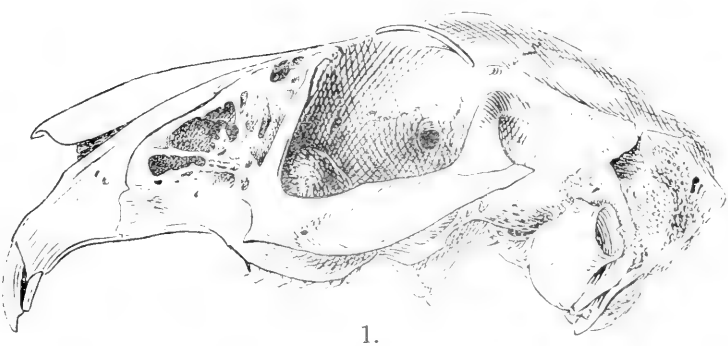

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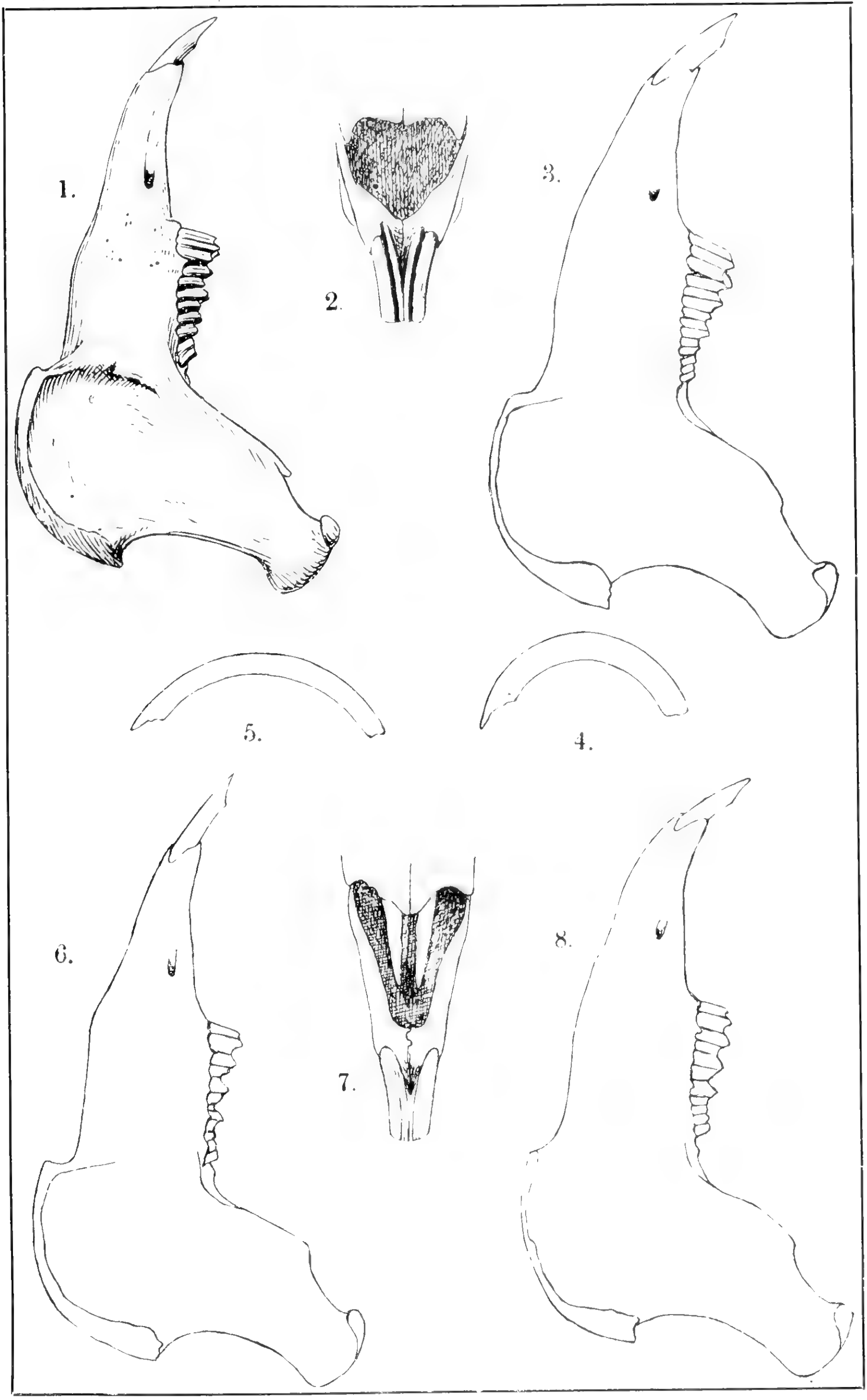

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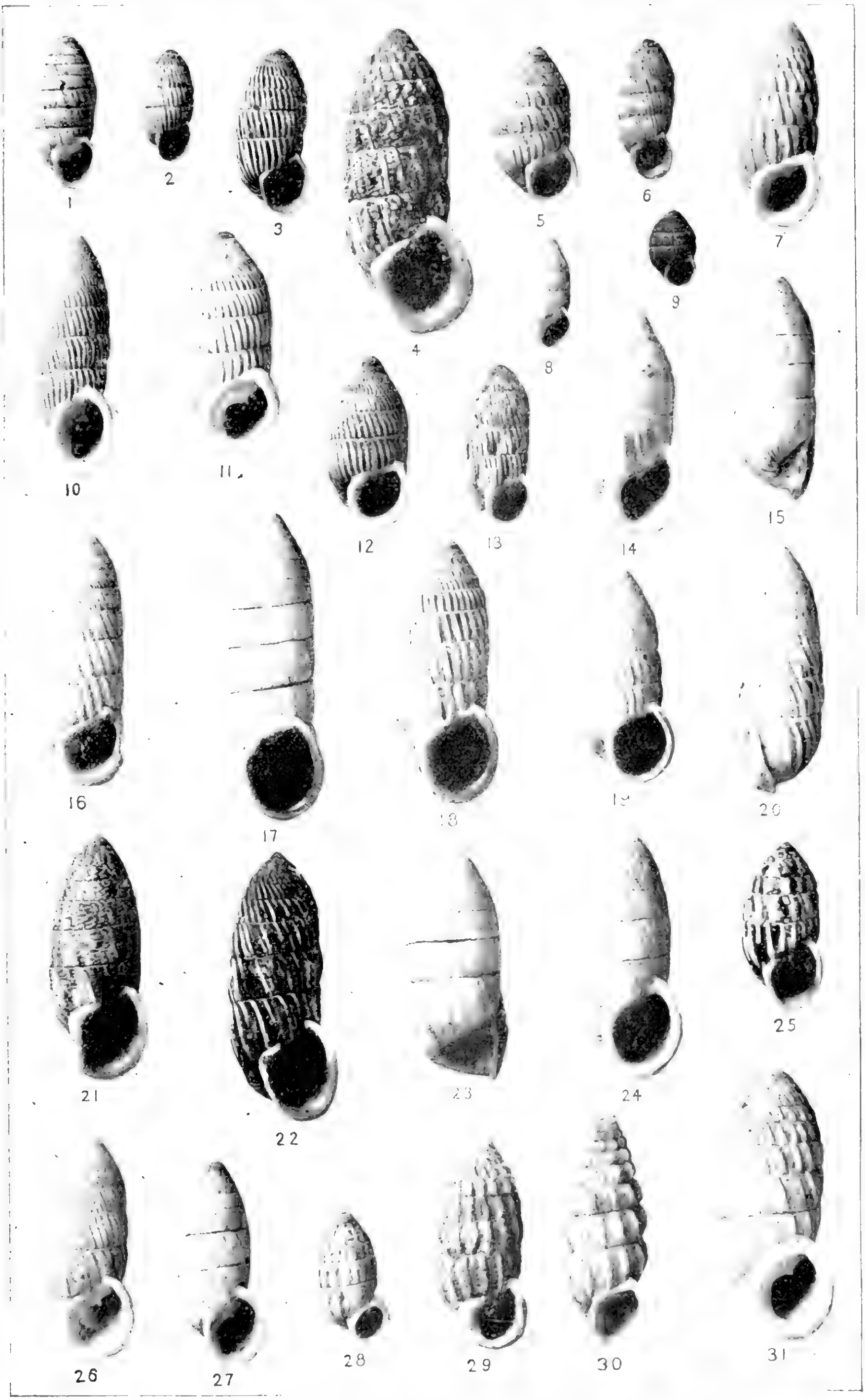
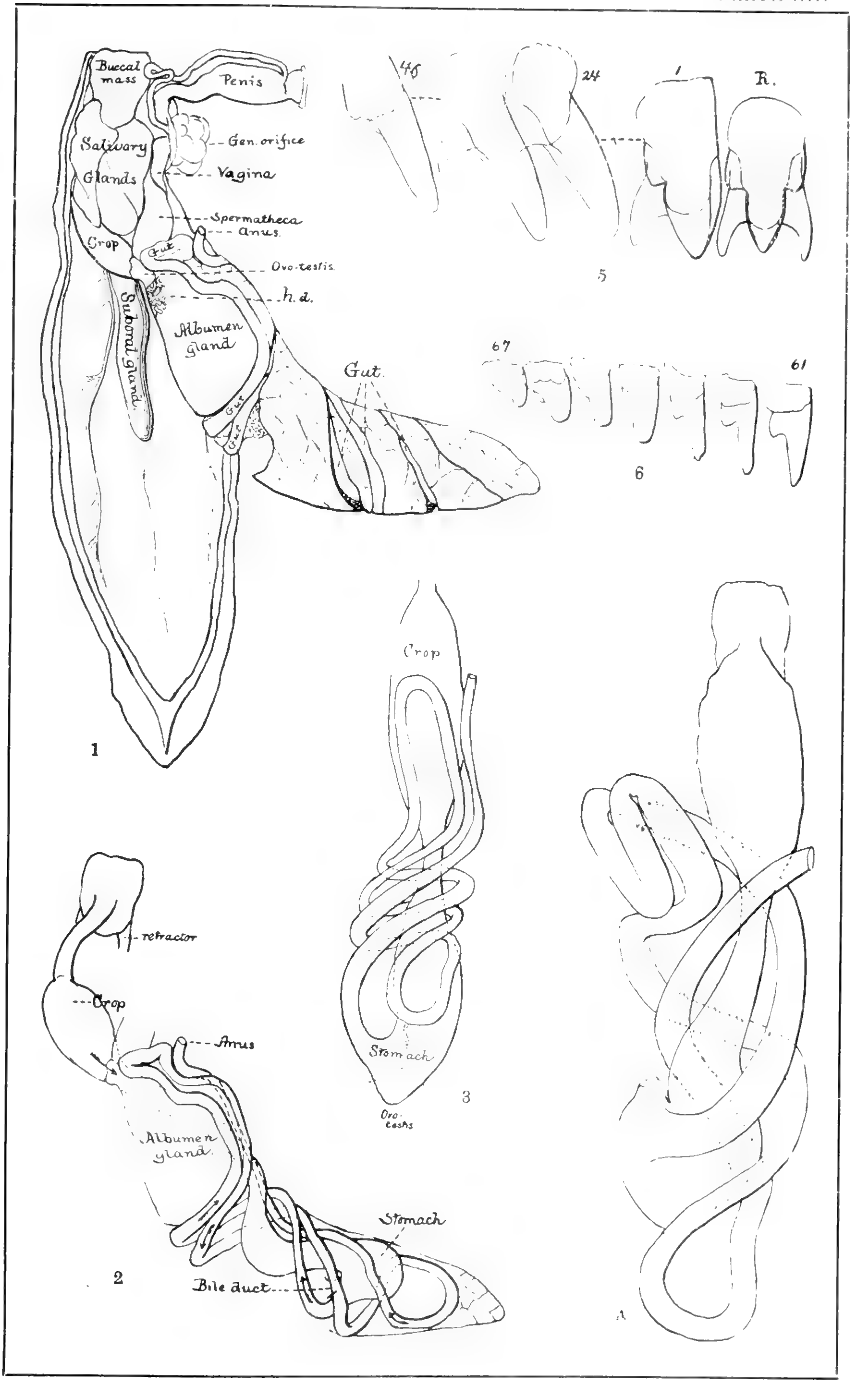


PILSBRY AND VANATTA ON CERION.

PILSBRY AND VANATTA: ARIOLIMAX AND APHALLARION.



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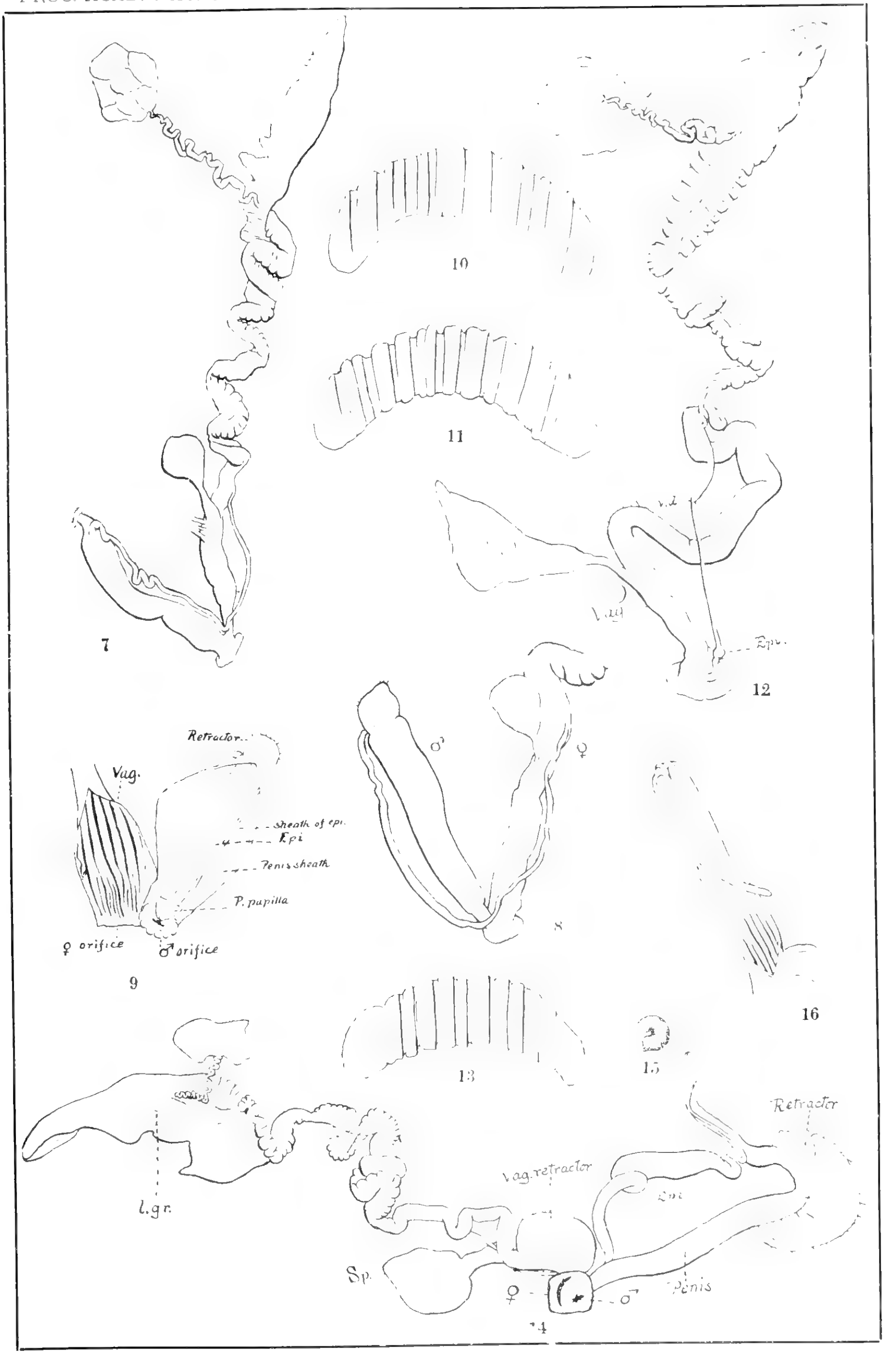

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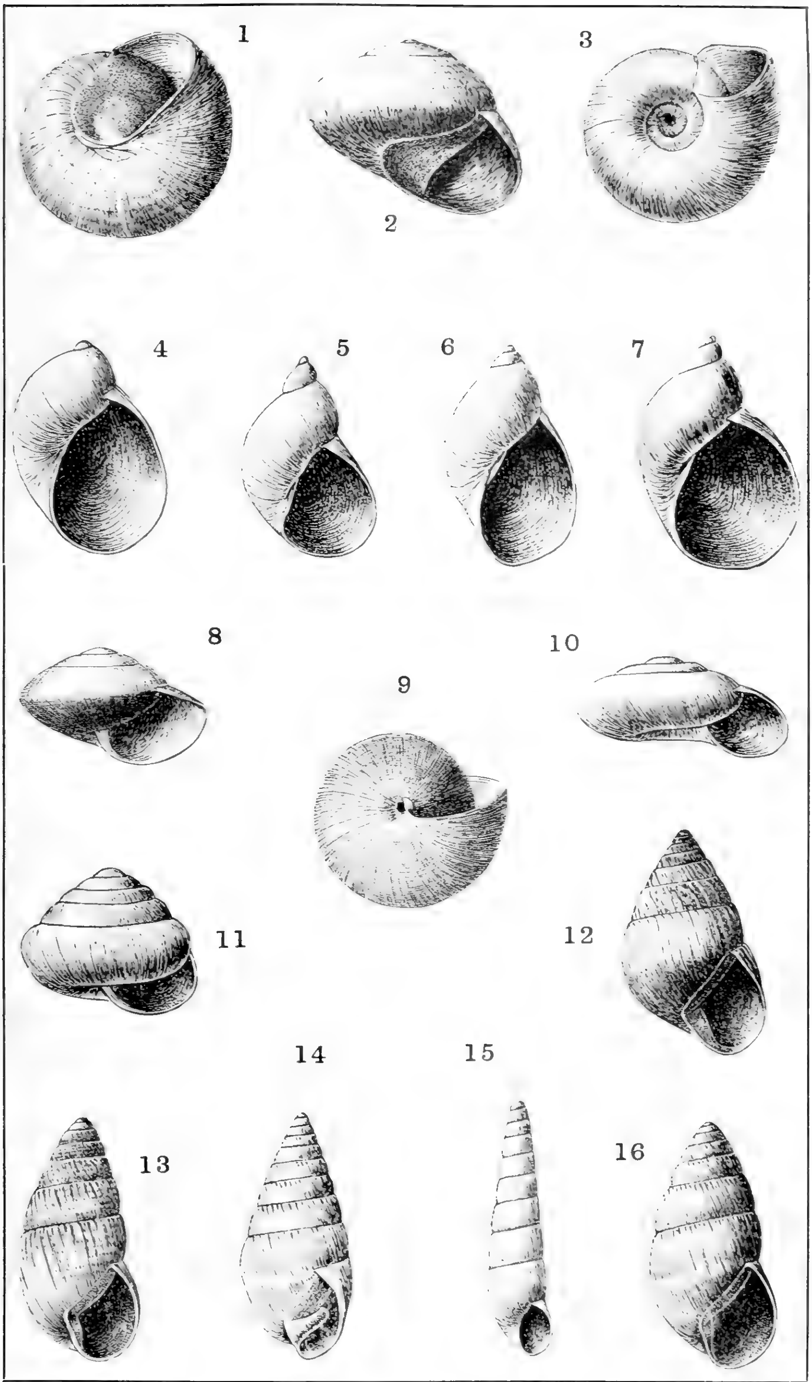
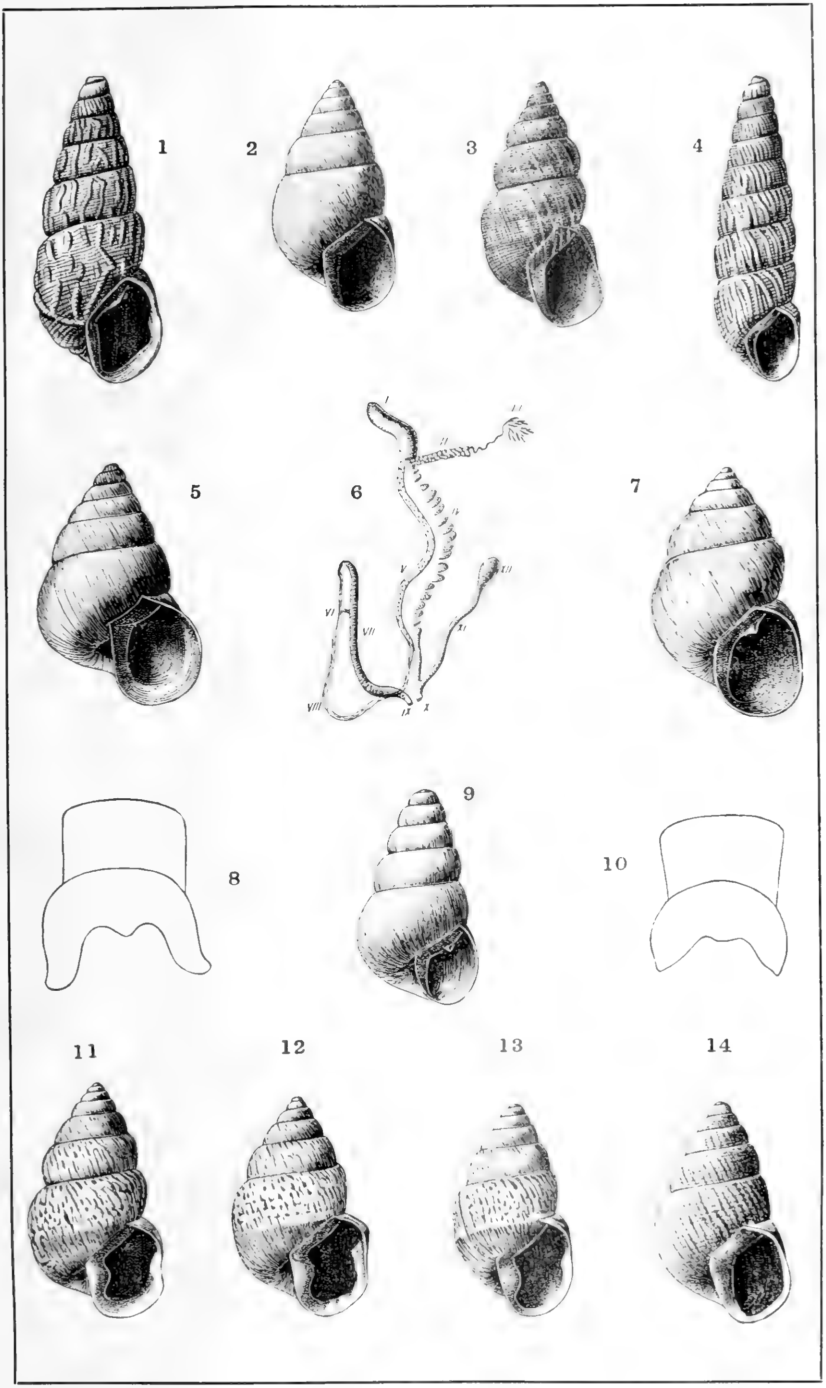


DALL. INSULAR LAND SHELL FAUNAS.



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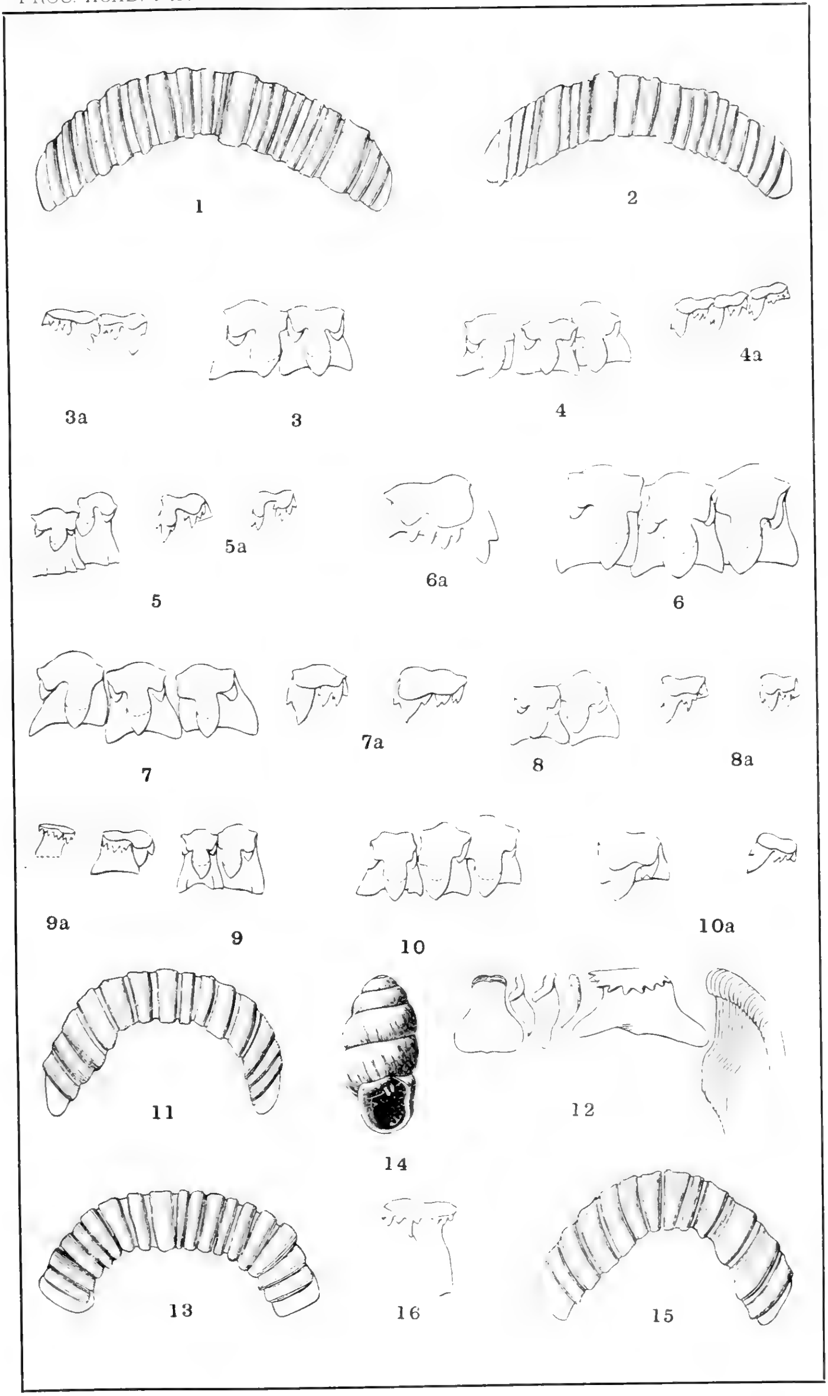

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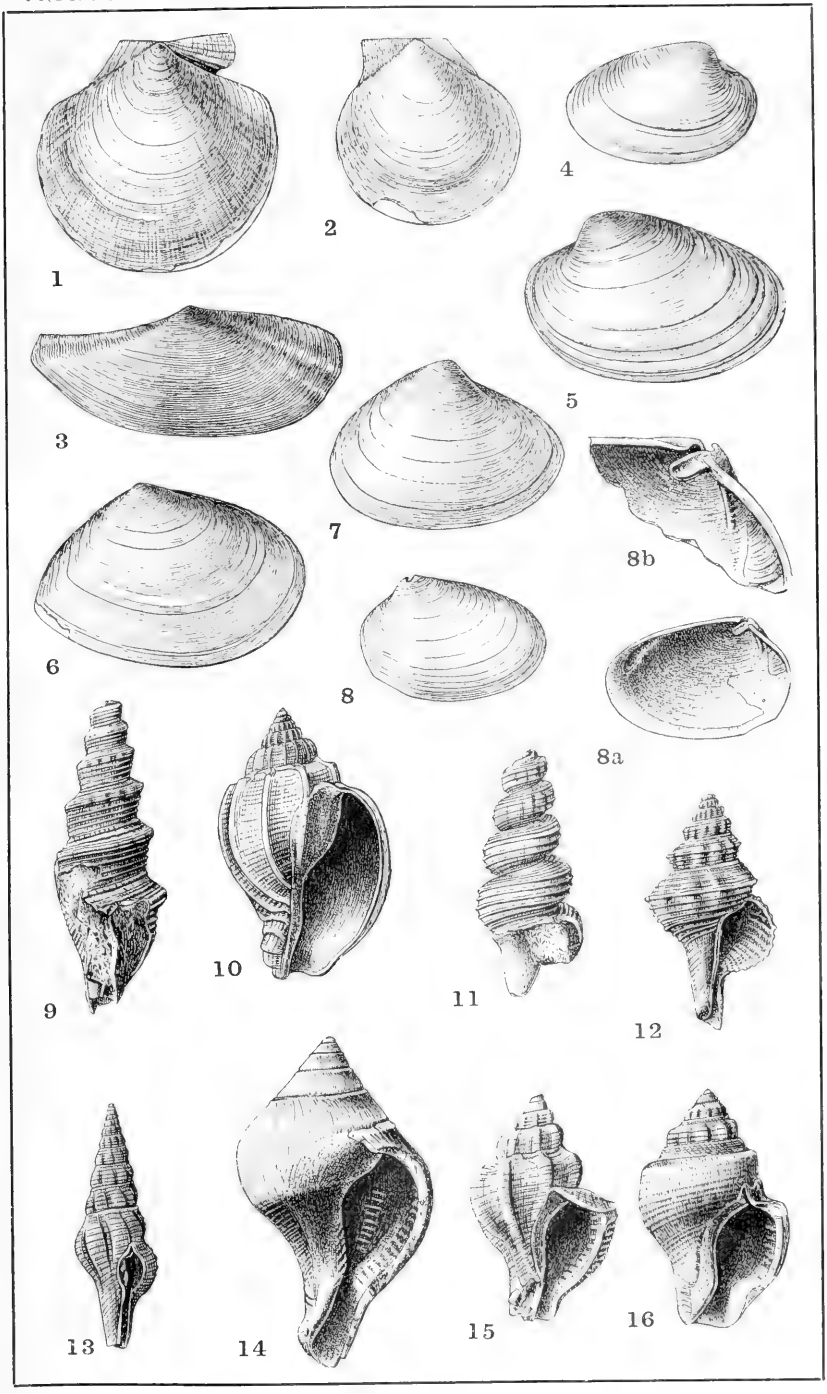
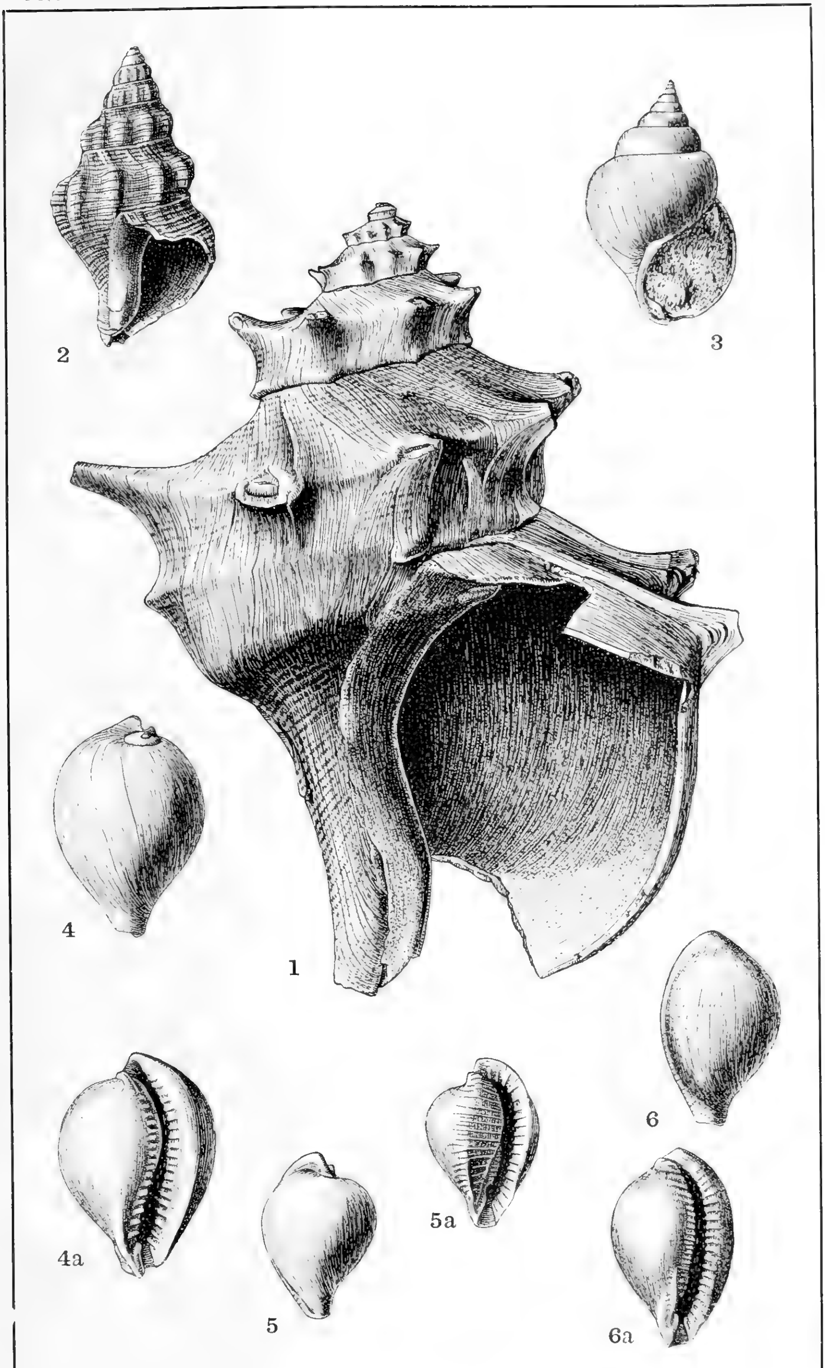


HARRIS. EOCENE MOLLUSCA OF GULF STATES.

(JACKSON SPECIES.)



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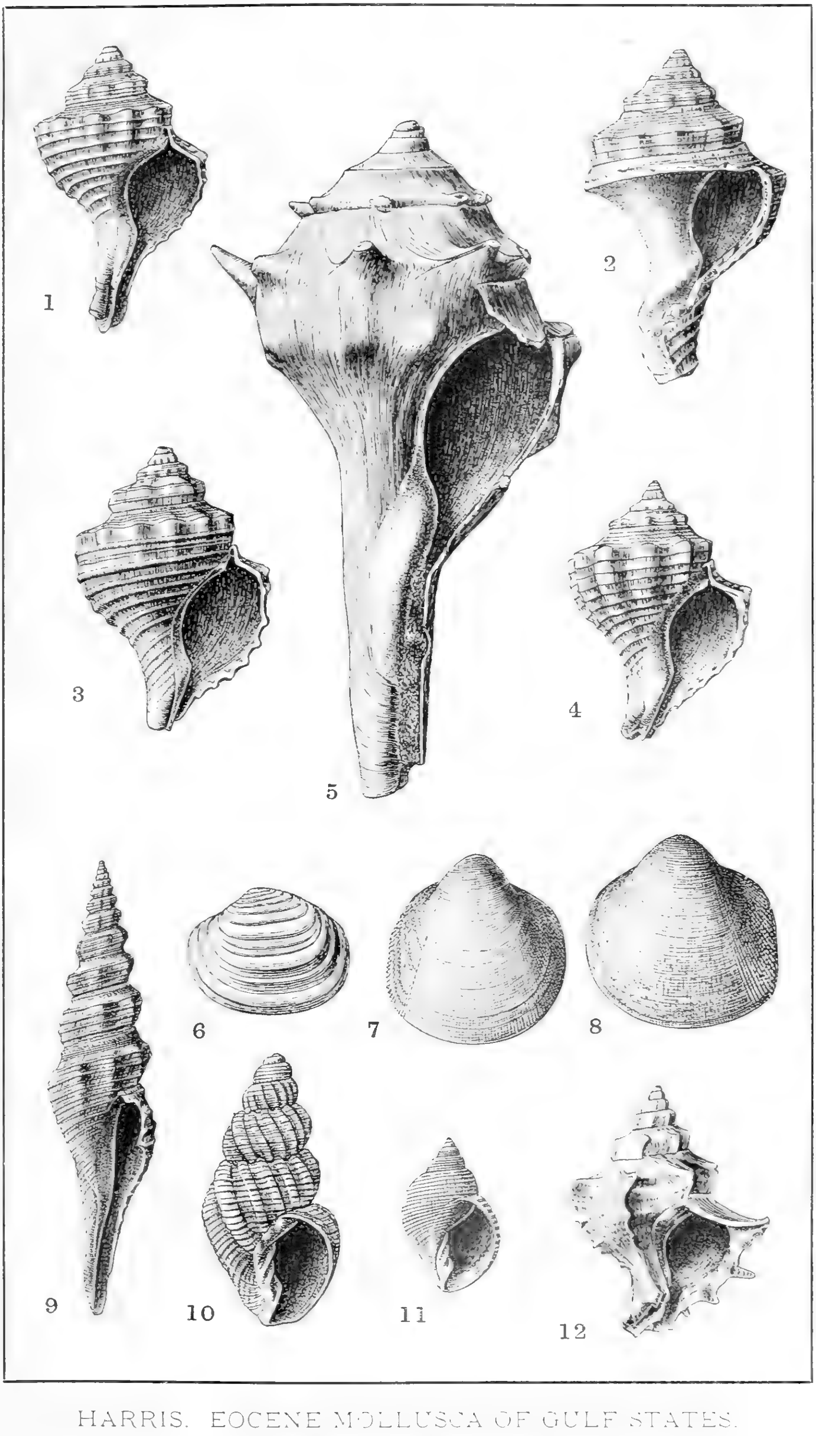
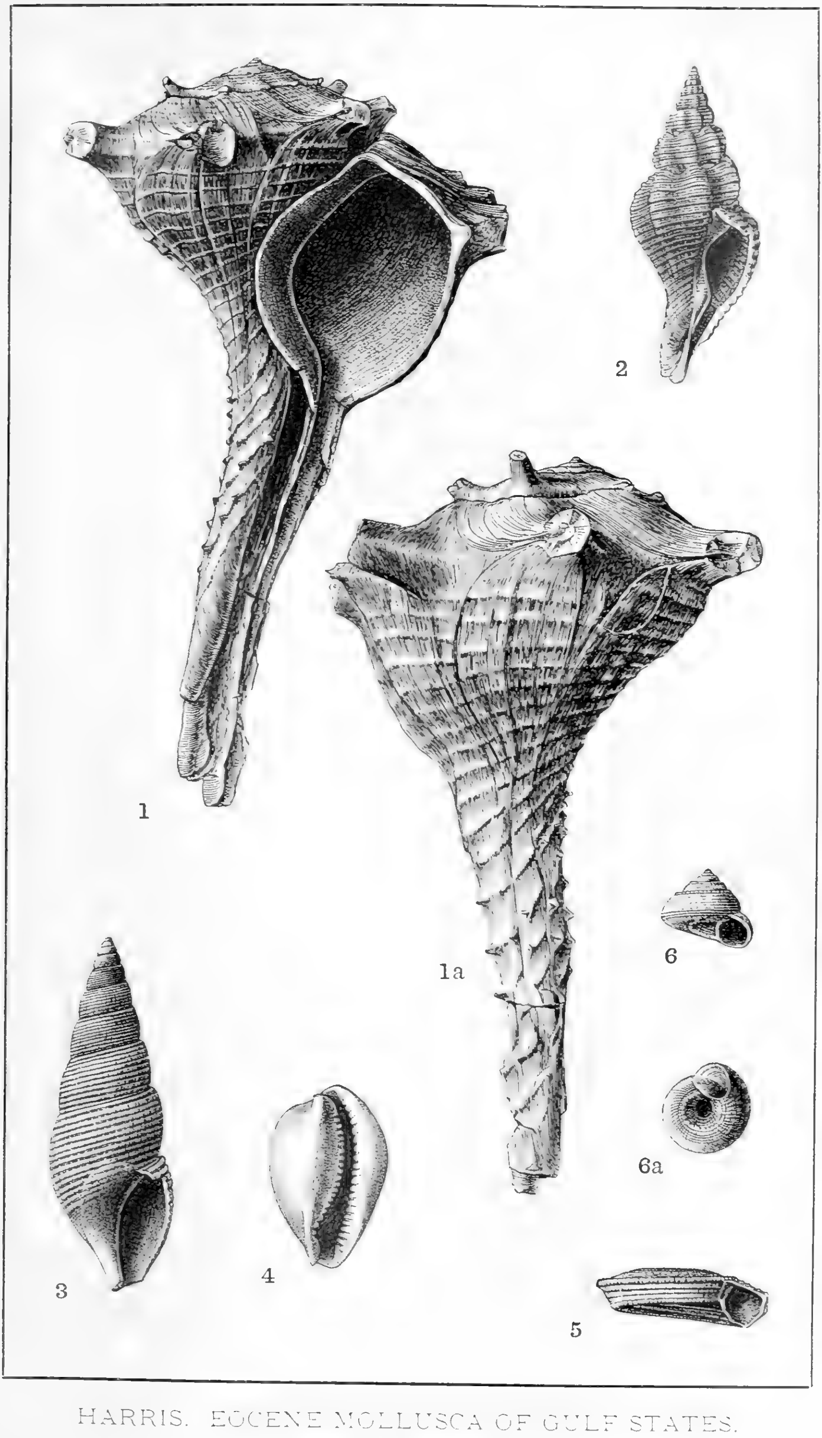


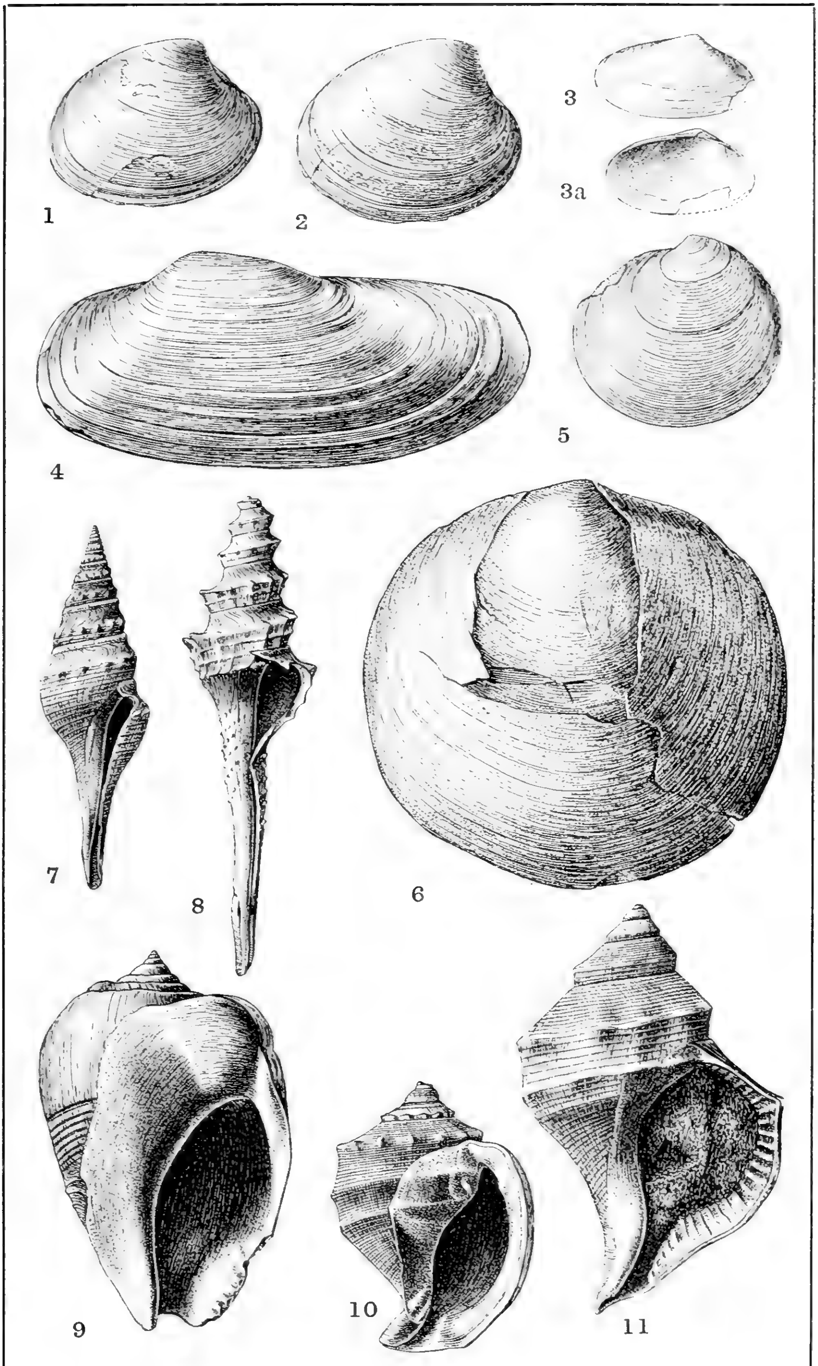
HARRIS. EOCENE MOLLUSCA OF GULF STATES.

1-5 CLAIBORNE SPECIES.

6-12 UPPER LIGNITIC SPECIES.

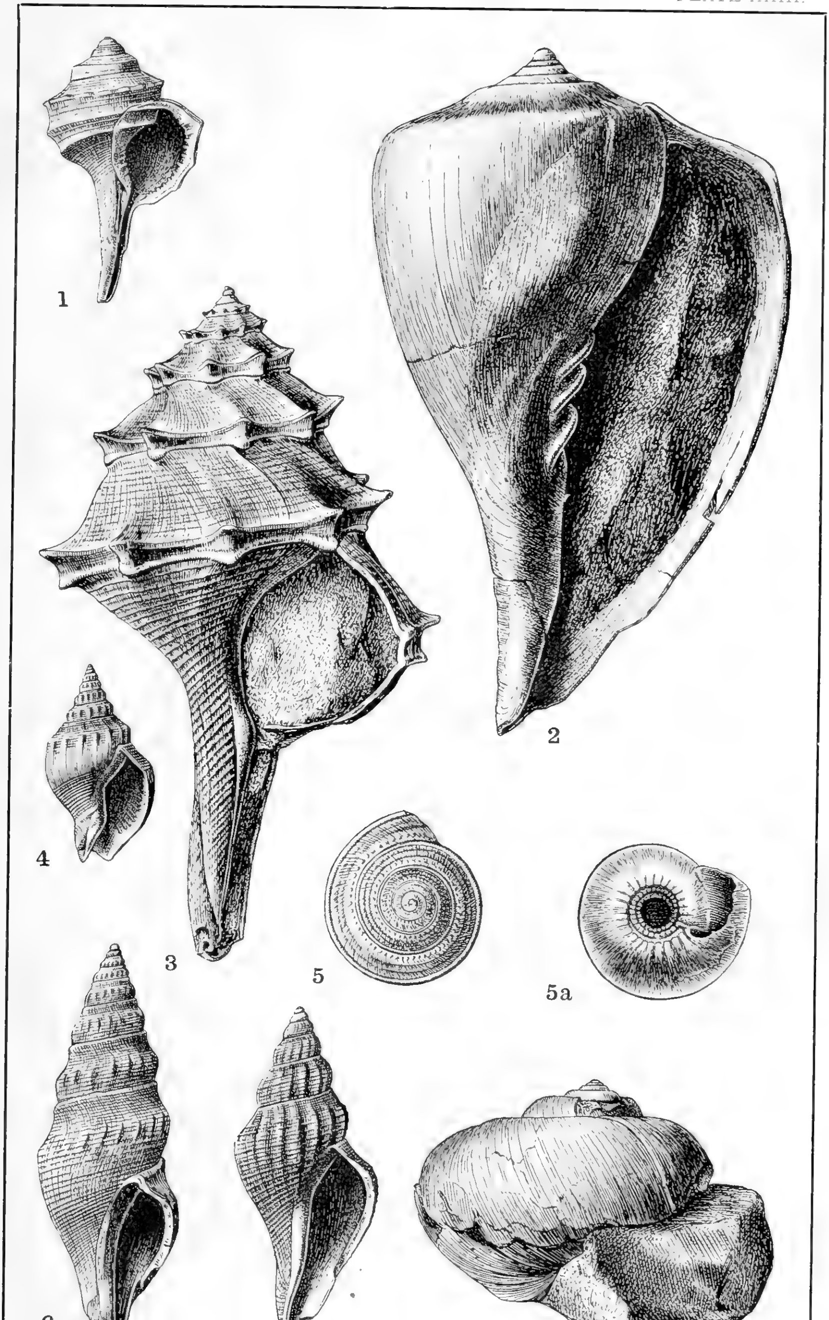


HARRIS. EOCENE MOLLUSCA OF GULF STATES.
LIGNITIC SPECIES

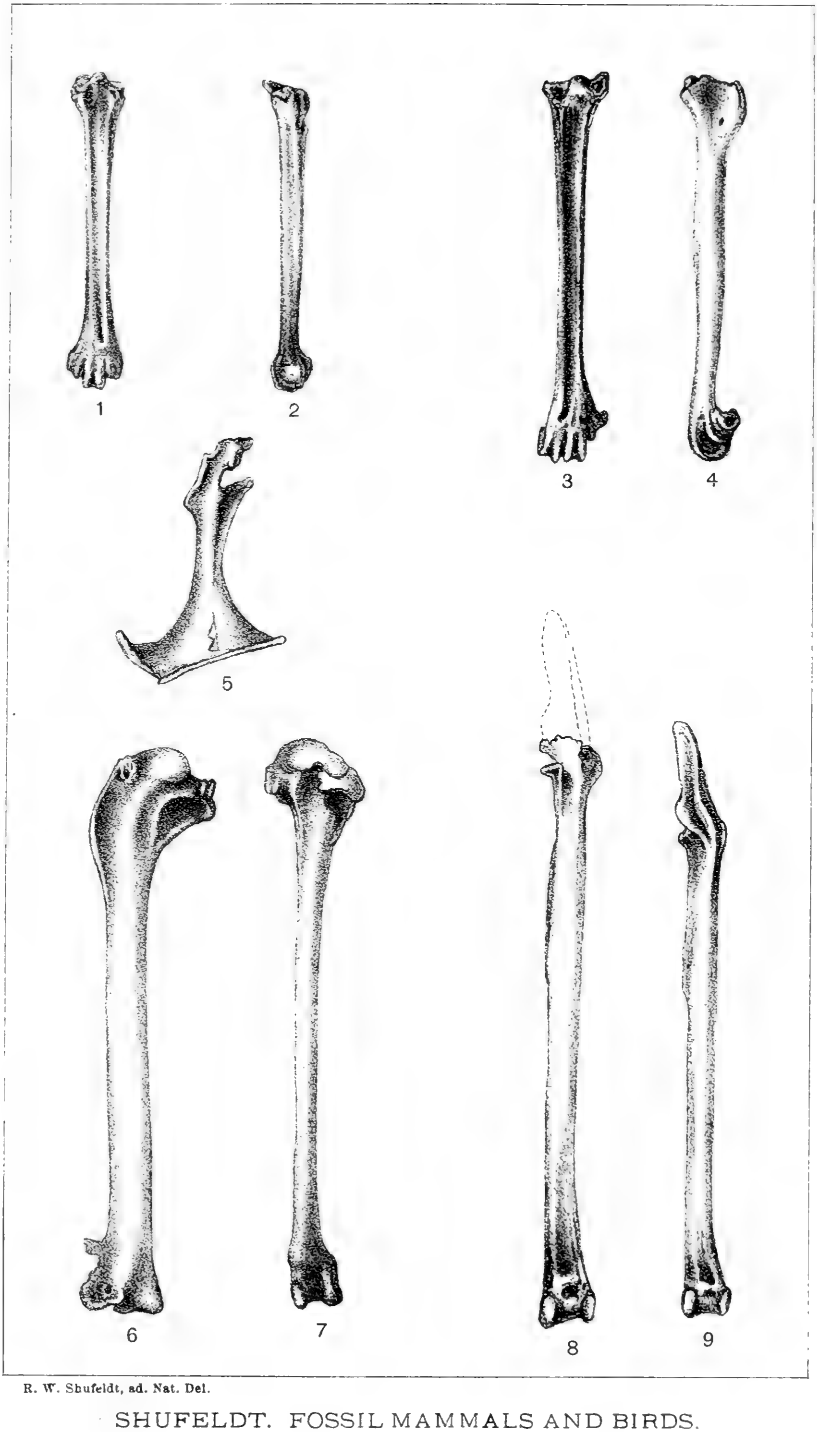


HARRIS. EOCENE MOLLUSCA OF GULF STATES.

(LOWER LIGNITIC SPECIES.)

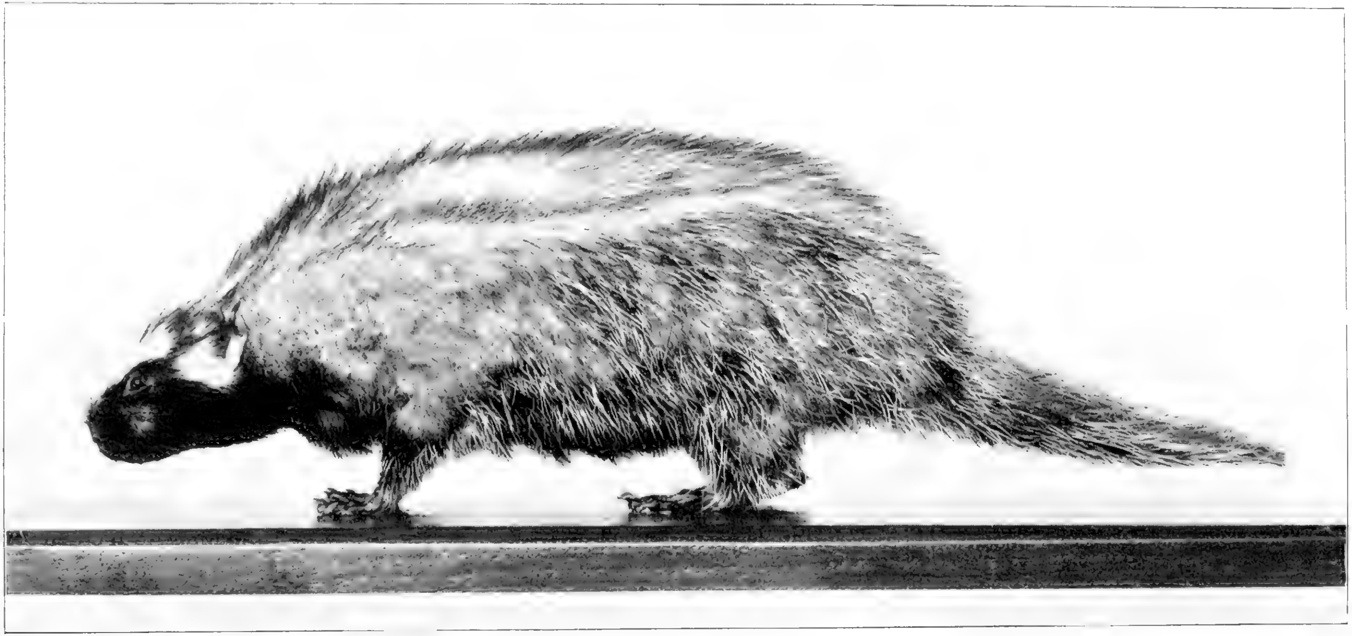


HARRIS. EOCENE MOLLUSCA OF GULF STATES.
(LOWER LIGNITIC AND MIDWAY SPECIES.)



R. W. Shufeldt, ad. Nat. Del.

SHUFELDT. FOSSIL MAMMALS AND BIRDS.



LOPHIOMYS SMITHI RHOADS.

PILSBRY DEL.

PILSBRY. NEW SOUTH AMERICAN MOLLUSKS.

PILSBRY DEL.

PILSBRY. NEW SOUTH AMERICAN MOLLUSKS.