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OF

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1890.

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EDWARD J. NOLAN,
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PROCEEDINGS

OF THE

ACADEMY OF NATURAL SCIENCES

OF

PHILADELPHIA.

1890.

January 7, 1890.

Mr. Thomas Meehan, Vice-President, in the chair.

Twenty-two persons present.

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

On Library.—Joseph Leidy M. D., W. S. W. Ruschenberger M. D., William W. Jefferis, Charles P. Perot, J. Bernard Brinton M. D.

On Publications.—Joseph Leidy M. D., George H. Horn M. D., Thomas Meehan, Edward J. Nolan M. D., John H. Redfield.

On Instruction and Lectures.—Isaac C. Martindale, Edward Potts, George A. Rex M. D., Charles Morris and J. Bernard Brinton M. D.

Standing Committee of Council on By-Laws.—W. S. W. Ruschenberger M. D., Theodore D. Rand, and Isaac C. Martindale.

JANUARY 14.

Dr. CHARLES SCHAEFFER in the chair.

Twenty-two persons present.

The death of J. Frank Knight, a member, was announced.

Pea-like Phosphorite from Polk Co., Florida.—Mr. EDW. GOLDSMITH stated that Mr. Jos. Willcox had received from Mr. E. R. Childers of Fort Meade, Fla., a specimen of rock which, it is stated, is about to be quarried for use as a fertilizer. The rock extends over a considerable area of territory that is tributary to Peace Creek, from the bottom of which stream a large amount of what is supposed to be phosphate of lime is now obtained by two companies operating there. It is essentially a phosphorite occurring in pea-like masses mixed with carbonate of lime, fragments of bones and shells, small pebbles of quartz and Limonite. Although the rock is brittle, a thin section was prepared for microscopic examination. This was accomplished by Mr. Lancaster Thomas in a way that is worth noting. The specimen was completely soaked with boiled Canada balsam prior to the grinding. The result was a transparent slide. There was observed, besides the above mentioned mixture, amorphous silica in which were imbedded acicular crystals of apatite.

The specific gravity was found to be 2·675. The rock cannot be considered rich in phosphoric acid. The latter, however, appears fairly disseminated through the whole mass. The pea-like globules were tested separately, together with fragments of bone and the dull brown-colored Limonite, phosphoric acid being found in each case. A quantitative determination of the acid has of course commercial interest but is out of the question here.

The name proposed for the rock was suggested by the pea-shaped globules. It may be considered as a variety of Phosphorite.

JANUARY 21.

The President, Dr. JOSEPH LEIDY, in the chair.

Nineteen persons present.

A paper entitled "On the Anatomy of Aerope caffra Fer.," by H. A. Pilsbry was presented for publication.

JANUARY 28.

Mr. J. H. REDFIELD in the chair.

Thirty persons present.

Papers under the following titles were presented for publication :—

"Remarks on Urosalpinx perrugatus Conr." By Frank C. Baker.

"On the Fishes described in Müller's Supplemental Volume to the Systema Naturae of Linnaeus." By David Starr Jordan.

"Geology of Artesian Wells at Atlantic City." By Lewis Woolman.

Mr. Carl Edelheim was elected a member.

Henry M. Stanley was elected a correspondent.

The following were ordered to be printed :—

ON THE DISTRIBUTION OF COLOR-MARKS IN THE PTEROPODIDÆ.

BY HARRISON ALLEN.

In a paper which I contributed to these Proceedings, 1888, p. 84, I endeavored to establish the proposition that the arrangement of the fur and the markings upon the skin in the mammalia were capable of being systematically treated. Especially I endeavored to correlate the location of color-marks with physiological or morphological factors. Thus some of the markings are due, it is thought, to effects of heat and moisture, others to the presence of important glands, or of special organs; a third group was explained on the basis of bi-lateral symmetry, etc.

The essay now presented is confined to the further elucidation of the subject, as illustrated in the fox-bats. Conformation to a general type of coloration is here easily discerned. While writers have mentioned some of the details, no evidence is presented why they may not constitute the plan upon which descriptions of species should be based. That some plan is needed is evident. In no group of mammals is it more difficult to identify species where no assistance is afforded by the examination of types or of collections which are authoritatively named. I hope that this difficulty may be lessened by mapping out the hair-bearing surfaces into regions, and by separately describing each. The study of variable species is one of the most interesting phases of modern zoology; the time has come apparently to devote greater care than has been the custom to the most variable of all the characters of the mammalia, namely, the quality, coloration, and distribution of the hair. This explanation is necessary to account for the minute description of well-known forms of bats in the ensuing pages.

The regions which will receive names in the descriptions are as follows:

The crown.

The face.

The "whisker."

The inter-ramal space, i. e.—the region between the horizontal rami of the mandible.

The post-mental space, i. e.—the space directly back of the mentum.

The occiput.

The side, the front, and the back of the neck.

The base of the prebrachium.

The side, the front and the back of the trunk.

The rump, the lower part of which forms the sacral region.

The infra-anal region or the space below the anus.

The *crown* may be said to extend back as far as the ears.

The *occiput*, to reach from the crown to the end of the curve from the crown to the neck.

The *face* (exclusively of the dorsum of the muzzle) commonly has the hair directed in varying degrees backward. The face may be naked except in clumps, or lines which will receive names according to their locations.

The "*whisker*" is the growth of hair which lies in front of the auricle. It connects the hair of the crown with that of the side or the front of the neck and the space between the rami. The hair of the face, when directed backward often slightly overlaps the "whisker."

The *space between the rami* is either of the color of the crown, face or of the front of the neck. As a rule it is a feebly developed region.

The *post-mental* space is a subdivision of the foregoing.

The *side of the neck* is an important region since the hair is here, as a rule, longer and coarser than elsewhere. The clumps usually described as "shoulder tufts," belong to the side of the neck. But the tufts are rarely differentiated. They are well seen in *Cephalotes peroni* and *Cynopterus marginatus*. In most examples the entire cervical region is occupied with hair of a special character and, as already remarked, may be continuous with the hair in front of the auricle.

The hair of the *front of the neck* in marked contrast to that of the side is almost always thinner and softer and may be almost absent. Of a shade in common with that of the side it is often of a hue which results from a mixture of this shade with that of the front of the trunk or space between the rami.

In like manner the *back of the neck* is a weaker region than the side. Usually marked with the same colors as the side it may be continuous with that of the back of the trunk or of the occiput.

The *base of the prebrachium* is not to be confounded with the lower part of the side of the neck where it forms the so-called shoulder-tuft. The hair usually forms a clump on the ventral side of the prebrachium near the shoulder. It may be an extension of the color of the side of the neck, of the side of the front of the body, or be a special development.

The *side of the trunk*, next to the side of the neck, is the most important region. It appears to be controlled by the position of the mamma, since the tract begins at the upper border of the gland. In *Cynopterus marginatus* it is confined to the region of the mamma. It extends in all forms, other than the one named, the entire length of the trunk, becomes woolly and is lost on the inguinal, femoral or crural regions. This tract appears to be the same as the region for the colors on the flanks and inner surfaces of the legs of quadrupeds generally. It is undoubtedly sexual in significance, for in addition to its relation to the mamma it lines the depression between the sides of the body and the wing-membrane and forms a sort of pouch in which the young are carried. The hair is uniformly soft and silky.

The hair of the *front of the trunk* is shorter than that of the side, and usually of varyingly contrasted shades of color.

The *back of the trunk* begins at the level of the prebrachia, usually by a sharply contrasted line with the back of the neck; but it may be continuous with that of this region as in *Cynopterus*, or be separated therefrom by a vertebral stripe, as in *Harpyia*, or by a narrowed tract, as in *Pteropus melanopogon*. When hairless (in the adult), as in *Cephalotes*, the region is still sharply limited by the lines of the prebrachia.

The *region of the sacrum* is conveniently separated from that of the back since hair may be retained here when it is absent or rudimental elsewhere, as in *Cephalotes* and *P. melanopogon*.

The "rump" includes the region last named and the loin.

The *infra-anal* region is not separated by any limit from the side of the trunk but it is sometimes useful to speak of it distinctively.

The shades on a single hair whether unicolored, or having the tip of a different color from the shaft, or the base of a different color from the shaft or tip, is always to be noted. The hair which extends from the body to the auricles, the wing-membranes and the interfemoral membrane, is uniformly unicolored. The arm may be an exception, when it is covered with the hair of the front of the trunk. The hair at the front of the crown and sides of the face is generally unicolored, as also is the "whisker." On the side of the neck the hair may be unicolored when elsewhere the hair is bi-colored.

The presence of circumpalpebral hair of contrasting color with the rest of the head, or of special patches of color about the eyes, which contribute such conspicuous features in many other quadrupeds, appear to be absent in the Cheiroptera. An apparent exception may be made in the instance of *P. capistratus;* but in this species the hair about the eyes embraces a wide region and if it receives the name circumpalpebral, this word must be in a different sense from the one previously employed in the essay on color-marks.

The white patches of hair at the base of the auricle and at the shoulder which are so note-worthy in *Epomophorus* do not appear to be generally retained. As already mentioned the clump last named is a differentiation of that of the side of the neck.

The enormous development of the wings dominates nutritive processes at the side of the body. With these changes the greater development of the hair—coarse, as in *Pteropus*, or long and soft, as in the order generally—appear to harmonize. The position of the mamma at the side of the pectoral region also assists in determining the tendencies to lateral developments if we can so conclude from the line of soft, long fur which is so commonly found beginning about the mamma and extending down to the thigh. The prebrachium is distinctly ventral in its relations (for the association of the so-called occipito-pollical muscle in some forms, as in *Molossus*, is more pectoral than napal) and the coloration of the base of the skin-expanse naturally partakes of the shades of color of the chest and abdomen.

The woolliness of the hair at and below the anus and at the sacrum is not explicable. It may be in some way associated with the generative acts.

Pteropus edwardsii.

An adult male.

Crown paler than the back of neck; it is narrowed to a point between the eyes.

Base of the auricle with a clump of dark brown (almost black) hair. Directly in front of the auricle is a broad band of hair (the "whisker") which unites the crown with the hair of the side of the neck.

Circum-palpebral patch black, faintly defined.

Cheek-patch black, distinct.

Labial hairs black, highly developed at the ricti.

Post-mental patch black, distinct.

The side of the neck with long, coarse, unicolored, reddish hair, the longest of any in the body excepting that of the side of the trunk.

The front and back of the neck like the side, but the hair is less red and shorter. The hair is blackish at the basal third or fourth.

The side of the trunk about the mamma, with long silky, black unicolored hair. This tract is continuous with that of the outer side of the leg and wing membranes where it becomes shorter and thinner.

The abdomen and the base of the prebrachium almost entirely black but with glistening yellowish tips which partially conceal the black color of the shafts. The hair is less silky than at the sides. The base of the prebrachium is of a brighter yellow than is the abdomen.

Below the anus and on the inner side of the leg the hair is woolly, black with grizzly tips.

The back is black, hairs short, appressed, becoming longer woolly and grizzly at the sacrum and on the legs.

The margin of the endopatagium with a faint line of short black hairs.

Pteropus vulgaris.

(1) An adult.

Crown and nape, and tract, in front of the auricle, dark chestnut-brown. The crown-patch advances beyond the eyes. No separate clump at the base of the auricle.

Circumpalpebral patch is of the same color as the crown and nape. The crown is unicolored; the nape is bi-colored, the basal fifth being black.

Face uniformly covered with short, brown hair without distinct cheek-patch.

Labial hairs brown, well developed.

Post mental patch, black, distinct, and continuous with the hair of the front of the neck.

Side of the neck with very long silky, black hair.

Front and back of the neck with hair of the same character but shorter; that of the front is shorter than that of the back.

The side of the trunk also with exceedingly long black, silky unicolored hair. Some of the hairs are lightly tipped with gray.

The front of the trunk with short, black, unicolored hair.

Base of prebrachium black, as in the neck.

Arm, forearm and wing-membrane brown.

Below the anus the hair is also brown; it is woolly in texture.

The *back* is brown with black at basal fourth. The hair of this tract where it extends on the wing-membrane, is silvery-yellow. The same color characterizes the hair of the extremities.

Endopatagial hairs are conspicuous on the margin of both dorsal and ventral surfaces.

(2) An Adult.

The hair as above with the exception that the color on the side of neck, side of trunk, back and front of neck, and of chest and abdomen is brown instead of black.

Pteropus rubricollis.

Three adult skins.

(1) In no region is the hair differently colored at shaft and base.

The *crown*, *nape* and *whisker* with long, erect, unicolored gray hair.

The anterior portion of the crown advanced beyond the eyes well on the nose.

The *cheek* covered with hair of the same character which is continuous with the above. The ear is covered with hair on both sides.

Circum-palpebral patch black or gray.

Labial hairs well developed, black.

Post-mental patch large, black and continuous with the hair of the front of the neck.

Side of neck, which has a distinctly ventral inclination, is covered with very long silky, hair of a tawny yellow—the tips being chestnut-brown. The patch does not extend to the shoulder nor scarcely to the back and front of neck, where the hair is more brown.

The shoulder and base of prebrachium is occupied with an equally long patch of black hair which is continuous with the *side of the trunk*. This line closely resembles that seen in *P. vulgaris* in having the hairs with ashy tips.

The chest and abdomen of the same general color as the sides of trunk but more gray.

The *hair of the wing-membranes* brownish, with gray tips.

The *back* is covered with long, black, silky hair with ashy tips The tract advances well up on the neck, and the color of the side of the neck dominates scarcely at all the color of the dorsum or ventre. The expansion of the hair on the wing-membranes at the endopatagium is of the same color as the back of the trunk, thus presenting a marked contrast with the disposition in *P. vulgaris*, or is of a dull iron-gray. Gray hair covers the humerus and the fleshy part of the forearm. The fur over the *sacrum* is not differently colored from that of the back.

The fur below the anus is long, gray, unicolored, and forms a conspicuous mass of hair between the thighs.

The *thighs* are clothed to a point nearly to the ankle with tawny-brown, or gray fur.

Posteriorly the posterior extremity is covered to the base of the metatarsus, or to the bases of claws, with hair of the same color.

(2) An adult skin.

The color essentially the same as above. The crown is of a dark iron-gray color. The color of the side of the neck distinctly dominates the back of the neck as well as the front.

P. edwardsii, *P. vulgaris*, *P. rubricollis* being all from the same localities, viz., Madagascar, the following statements respecting them may be useful:

In all the crown is distinct from the neck; the cheek hairy; the whisker is present; a disposition exists for the circumpalpebral hair to be distinct; the labial hairs are abundant and of black color; the color of the side of the neck not markedly dominating that of the back or the front; the side of the trunk distinctly differentiated.

P. rubricollis is different from the other species, inasmuch as the hairs are not dark at the base and (with the exception of the tips) are of the same color their entire length.

Pteropus edulis.

Seven specimens examined.

(1) An adult skin (No. 2745).

Crown black with dark red tips. The patch extends well between the eyes.

Base of *auricle* naked.

"*Whisker*" narrow,—confined to a rather small tract, which meets the backward directed black hair of the face to form a "cowlick."

Cheek patch is absent.

Labial hairs inconspicuous, scarcely differentiated from those of the face.

Circumpalpebral patch absent.

Side of neck with long, stiff, unicolored, reddish hair distinctly dominating the back of the neck to form a mantle, but yielding to the ventral colors on front of the neck.

Post-mental tuft of black hair conspicuous. Black hair extends on the face and the neck as far back as the line of the ears.

The base of the prebrachium and the chest thence to the middle of the ventre of a peculiar dusky shade of color which appears to be intermediate between the color of the side of the neck and that of the chest and abdomen.

The side of trunk with long soft black hair with ashy tips; it is more woolly than on the chest and abdomen.

The back is occupied by a narrow tract of appressed, black hair with grizzled tips.

Sacrum iron-gray,—same color of fur extends on the posterior extremities to the upper third of the legs. The texture is distinctly woolly.

The chest and abdomen covered with short slightly woolly hair of a dark smoky black color with ashy tips.

The hair below the anus does not differ from that of the abdomen. A few hairs are seen on the dorsal surface of the endopatagium.

(2) Adult skin. (No. 6538.)

As in preceding. The crown is more red, the black hair of the neck below the mandible forming a long distinct "cowlick" in the middle, and extending back on the line of the ears. Line of side of neck with basal plumbeous color.

No intermediate color between the mantle and the color of the chest and abdomen.

The bases of the hairs dark plumbeous on the crown and back of mantle.

(3) Adult skin. A male (No. 6541).

Red color extending entirely over the crown, below the eye and by a broad "whisker" to the surface between rami of the mandible. The black color of the face is confined, indeed, to the muzzle. The nape of the neck and the mantle is of a much lighter shade of red than the side of the neck and the crown. The shafts of the hair everywhere unicolored.

(4) Young adult skin. A male (No. 3668).

The black shades prevail. The crown, sides of face, front of neck, hair on humerus, space between the mandibular rami, being this color. The black hair of the abdomen tipped with brown instead of gray.

Pteropus maklotii.

An adult skin.

Crown of head tawny, the basal half being black.

"*Whisker*" black, as is also the neck between the horizontal rami of the lower jaw.

Face black sparsely covered with hair.

Labial fringe none.

Side of neck distinctly limited from the back and front. Hair longer and coarser than elsewhere. The basal half tawny, the apical half black with glistening ashy tips.

Back of neck uniform dark brown.

Front of neck black with glistening ashy tips.

Side of trunk with long silky black fur with ashy tips.

Front of chest and abdomen same in color but much shorter and stouter.

Back covered with uniform dark brown, appressed hair.

Over sacrum same, but more woolly and with ashy tips.

Base of prebrachium not distinctly colored from the humerus, both being dark brown.

Pteropus medius.

Nineteen skins.

(1) *Crown* dark brown, basal third much darker. Hair almost appressed.

"*Whisker*" well defined but not forming a "cowlick" with the black hair of the face.

Labial fringe absent.

Hair between the horizontal rami of the lower jaw thick and soft, and of a black or deep brown color.

Side of the neck with long, thick fur of a tawny or yellow tinge. Basal half black.

Back of neck the same. The lower margin of the mantle is of a lighter hue than the rest.

Base of prebrachium anteriorly (ventrally) clothed with short hair which is of the same color as the humerus, namely, very dark brown or black.

Side of trunk with very long silky black hair. Base of the same hue as the tips.

Front of chest and abdomen dull chestnut-brown. Basal half half black.

Region below anus woolly, dark brown.

Back with short appressed hair, dark brown to black with gray tips.

Sacrum and *legs* woolly with same color as the back.

(2) Same as No. 1.

Crown more blackish ; base of prebrachium same color as mantle.

(3) Same as No. 1.

Crown and mantle everywhere tawny, no yellow tints on body.

Chest and abdomen and base of prebrachium tawny throughout.

(4) Same as No. 1. (smaller, probably immature).

Crown rich chestnut.

Back of neck (mantle) light-yellow verging to a paler hue.

Base of prebrachium the same as back of neck.

Side of neck, front of neck and shoulder at base of humerus light chestnut.

Front of *chest* and *side of trunk* much the same but intermixed with black points.

Back with many dark chestnut points to the prevalent black hair.

(5) Same as No. 4.

Front of *chest* and *abdomen* nearly black.

In *P. medius* it is clearly seen that the basal dark shades are more persistent than the tips. The region of the crown becomes variable as the chestnut and brown tips disappear and permit the basal dark shades to show and give various effects to the general color of the region. The back seems to be composed of the basal black—the entire length of the hairs being about equal to the dark portions of the hair of the side of the neck and of the mantle.

In group No. 4. the prevalence of the lighter chestnut or yellow shades are substitutions for the tip-colors only for the darker brown or black of the other groups—with the exception of the base of the prebrachium, where the hair is entirely yellow, as in group 3 it is entirely tawny.

Pteropus poliocephalus.

Six skins of adults.

Crown and face and region between the horizontal rami of mandible dark gray. Hair in front of the ear thicker than elsewhere and verging to black. No basal contrast. The hair is thick and long except on the face.

Labial fringe absent.

Side of neck with very long and soft chestnut-colored hair. The base is black.

The front and back of the neck is of the same general character. The contrast between the parts and the side of the neck less noticeable than in other species examined.

Base of prebrachium black and distinctly differentiated from the fur of the surrounding regions.

The side of the trunk slightly more fulvous than the rest of the chest and abdomen where the hair is of a uniform gray tint as the head. The arm thickly covered with fur of the same character.

With the exception of becoming more woolly the hair of the region of anus, that below the anus and on the legs is of the same color.

The back covered with appressed hair, but unusually long and soft.

That over the lower sacrum and legs precisely the same as that of the body.

There is a faint hem of hair on both surfaces of the free margin of the endopatagium.

Remarks: The confluence of the crown, whisker, face, and region below the lower-jaw—in one color district; the merging of the side of the neck with the front and back; the imperfect differentiation of the color of the side of the trunk from that of the chest and abdomen; the exact resemblance between the front and back of the body and legs, readily distinguishes this species from any examined. With the reduction of the color-regions to three, namely, the head, neck, and body, the retention of the black tuft of hair at the base of the prebrachium is remarkable.

Pteropus melanopogon.

Twenty-four specimens of the skin of this variable form were examined, four of these were identified as male and nine as female. The remainder were undetermined, nine of this remainder were immature.

The specimens will be examined under these heads:—

(1) Two individuals, male. *Crown* to a little beyond the eyes unicolored black; the rest of crown chestnut at tips—the shaft and base being black.

Nape of the neck unicolored red-yellow.

" *Whisker* " unicolored, same color as nape.

Face with tendencies to growth of reddish black hairs with black base on the cheek, lower eyelid and malar bones and along the horizontal ramus of the lower jaw. Between these localities the skin is nearly naked.

The *space between the horizontal rami* covered with short hair of the color as the above.

The side of neck with long yellow, red unicolored hair, but slightly differing from that of the back. The hair only with black base as it joins the hair of the back.

The front of the neck sharply separated from the side in color and texture. It is less compact, unicolored dark reddish-brown much softer.

There is no differentiation at *base of prebrachium.*

Chest and abdomen uniform dark brown, unicolored.

The side of the trunk softer but scarcely longer, unicolored, almost cinereous.

The infra-anal region more woolly.

Back dark brown hairs closely appressed.

The sacrum and parts beyond distinctly woolly.

(2) Two specimens. Apparently old individuals.

No black on *crown.* Fur everywhere tawny verging in places to light chestnut red, excepting the back of the body which is sulphur yellow.

(3) One female. *Crown* covered with brown hair having glistening yellow tips.

"*Whisker*" long, yellow, unicolored.

Clumps on the face (beneath eyes and on cheek) dark brown unicolored.

Side of lower jaw, including masseter muscle, dark brown unicolored.

The thinly distributed long tawny hair of the *front of neck* invades the space between horizontal rami of the lower jaw—the *post mental space* alone being covered with a clump of brown unicolored hair as on lower jaw.

Side of neck with slightly longer hair than the back, but of the same tawny yellow, no well defined line separating the two regions.

The *base of prebrachium* on ventral surface, dark brown, the humerus tawny yellow, axilla and side of the trunk dark brown. Therefore three colors are seen at side of body from the upper margin of ventral aspect of the prebrachium to the axilla. The resemblance to the same parts in *P. medius* is close.

Side of trunk long, silky, dark brown, unicolored.

Chest and abdomen light brown, unicolored.

Infra-anal region scarcely woolly, same color as above, a conspicuous cowlick at the median line at the interfemoral membrane.

Back composed of a narrow tract of appressed, tawny, yellow hair with brown marginal lines which extend to knees.

Prebrachium entirely naked on dorsal surface.

One specimen only retained a few hairs on dorsal surface of the ulna.

(4) One female. Uniform dark tawny brown everywhere except along the *back of the body* which is sulphur-yellow.

The *side* of sorrel color and extending thence to the knees of the same brown shade as in group No. 1.

No "cowlick" on front of the interfemoral membrane.

(5) Two individuals, sexes not determined.

Crown dark unicolored brown.

Face, with the exception of a naked space between the eye and the cheek, covered with the same brown hair.

"*Whisker*" well defined but partially concealed by a prominent cowlick which is formed by the whisker and the backward directed hair of the side of the face.

Inter-ramal space, or the space between the horizontal rami of the mandible the same as the face and the crown.

The fur of the *front of neck* dark brown and sharply separated from that of the side of the neck as in group 1 of the males; yet the base of the prebrachium is arranged as in group 1 of the females.

The *fur of the back* of body dark brown with nearly black lateral lines.

(6) Nine immature examples.

(*a*) Seven of these were two-thirds grown, (*b*) one was about half grown, and (*c*) one with head and body measuring but six inches.

Group (*a*). This exhibited the general arrangement of colors and of fur as in the adults. The fur everywhere was silky. The hair of the back in all examples save one was of a rich olive-brown. The exception showed the sulphur-yellow of the adult male.

In example (*b*) the fur was everywhere dark brown excepting at the occiput where it was a shade lighter.

In example (*c*) the hair was of uniform light brown. The hair excepting that of the side of neck was scarcely differentiated either in color or length.

In all the nine individuals the skin over the dorsal aspect of ulna was covered with a distinct narrow tract of hair. In the adults with but a single exception this line was absent.

The crown tends to be very dark brown and unites with the side of the face and the inter-ramal space by a tract—the "whisker"—which extends between the ear and the eye. The color of the crown is usually abruptly contrasted with that of the occiput. The space between the eyes may be retained as a narrow patch of dark brown which is nowhere else seen upon the crown. The occiput is almost uniformly of a bright color. The back of the neck is chestnut and forms occasionally only a collar. The sides of the trunk are apt to be differently shaded from the front, *i. e.*, they are either lighter or darker than the front. The region of the pelvis both front and back is almost uniformly woolly and darker than the adjacent fur on the loin and the abdomen.

In twenty examples the crown of the head, side of face and under part of the head at the mandible tend to be differentiated from the rest of the body. The whisker is marked excepting in the very young. The side of the neck is less distinctly developed, yet the tendency for it to be so is seen in young individuals but six inches in length. The front of the neck is often sharply contrasted in color with that of the side—a peculiarity not seen in any other species examined. The nape of the neck is apt to be of a lighter color than any other portion of the body. The differentiation at the base of the prebrachium is of a variable tendency. The hair of the side of the body is relatively less long than in other species. The sulphur-yellow color of the back of the body is more marked in the female than in the male as is the disposition for the hair of the infra-anal region to be furnished with a "cowlick". The side of the tract on the back tends to be margined with hairs of a different hue from the one which is prevalent, as in *P. vulgaris.* The presence of a small tract of hair on the dorsal surface of the ulna in one adult only while it is detected in all the nine immature forms is a fact of interest.

The naked patches on the face answer nearly to the lines of dark hair on the face in *P. capistratus.* The anterior part of the dark crown in some varieties is precisely of the nature of a median dorsal stripe and appears to be identical with the stripe similarly situated in the species last named.

Pteropus capistratus.

Of this species fifteen specimens were examined, five of these having a length of forearm of 100 mm. to 105 mm; seven of 65 mm. to 80 mm. and three of 50 mm. The three last named were certainly immature.

(1) *Crown* with median black line, the remainder being white. The black line distinctly divided anteriorly on dorsum of muzzle. The eye surrounded with white hair which is directed backward and merges into that of the crown.

An oblique black line extends across the *face* from near the inner canthus to the angle of mandible. Directly in front of the whisker a vertical black line extends. It broadens slightly and merges with the black of the front of the neck and space between the horizontal rami of the lower jaw. In the space last named the hairs are arranged in the form of two lines with a white space between.

Side of neck white not longer than back. The occiput yellow-white.

Base of hair of *occiput, side, front and back of the neck* black. The white hair of the crown and the side of face including the whisker unicolored.

No differentiation at the *base of prebrachium.*

The color of the *chest* and *abdomen* dark brown with ashy or pale yellow-white tips. Side of body or color of arm scarcely differentiated. The space about nipple nearly naked (sexes not distinguished).

Back much the same, but hair slightly appressed. Margin lighter as in *P. vulgaris.* Sacrum and legs to ankle markedly woolly.

Free margin of endopatagium hairy; white hair on dorsum, arm and forearm.

(2) Same as above with white tips supplanting the yellow-white of the nape of the neck and the occiput.

(3) Same as above, everywhere darker, the base of the hair becoming conspicuous owing to the partial absence of the apical white. Black lines on the face absent except the median dorsal of the crown. The whisker light, uniform gray. The hair about eye and on crown is also gray but darker than the foregoing and is furnished with a dark brown base. The dark brown of the space between the horizontal rami of the mandible confined to the postmental space.

(4) The very immature individuals have entirely white hair on back of neck.

As already noted the lines on the face are essentially the same as the naked spaces in *P. melanopogon*. The white color approaches the borders of the eye-lids—a narrow line of integument alone intervening. No collar of black hair at this place discerned.

The wing membranes are marked by numerous irregular lines as in *Harpyia*.

Cephalotes peronii.

Five examples of this species were examined.

In two of the number, (*a* & *b*) the forearm measured 111 mm. in length; in one (*c*) the forearm measured 75 mm.; in one (*d*) (certainly immature) the forearm measured 80 mm.; and in another (*e*, also immature) it measured 65 mm.

(*a*) The *crown* and *occiput* black.

Face sparsely covered with short black hair which for the most part is directed backward and reaches almost to the ear, so that the "whisker" tract is obscurely defined if it be present at all.

The *side of neck* provided with sparsely distributed hair. The part near the shoulder with an obscure rosette-like arrangement of unicolored olive-brown hair. The front of the neck is covered with short hair of the same color which appears to be on each side an extension of the rosette upward and to the front of the neck.

The *back of neck* is of the same color with that of the occiput and crown but of a lighter shade.

The hair is distinctly longer than on the side and is easily distinguished therefrom by its darker hue.

A row of long, very distinct bristles is present on both the upper and lower lips. The bristles of the muzzle and above the eye are also exceptionally conspicuous.

The side of the trunk is distinctly separately marked from the front. The hair is of a unicolored mouse gray color, long and silky. It is continuous without interruption to the infra-anal and femoral regions.

The hair of the *front of the trunk* is shorter. The color is brown to tawny.

The endopatagium and mesopatagium is nearly one-half covered with soft hairs. The back is naked excepting over the sacrum where a few black hairs are found. Hair extends along the dorsal aspect of forearm.

(2) (*b, c & d.*) The same as above excepting that the hair over the sacrum is present in a well-defined clump and extends upward one-third the length of the back.

(3) (*e.*) Fur soft, short, appressed. Front of neck, nearly naked; the front of trunk quite so. The sorrel clump is well developed. A faint but easily discernible longitudinal stripe extends the entire length of the back. The dorsal aspect of the humerus is covered with short hair. The hair over the forearm is more marked than in the larger and more mature specimens.

Harpyia major.

Nine examples adult; sex unknown.

Crown to back of eyes unicolored, erect white-gray compact hair.

Crown to occiput the same with base plumbeous.

Side of face without differentiation unicolored tawny, hair fuller and longer in front of the ear.

Side of neck with long, relatively coarse hair—gray nearly entire length, but having rusty brown tips. Front of neck almost naked.

Back of neck with soft, shorter hair, the base is very dark, with gray tips.

Side of trunk scarcely at all different from the front.

Back of trunk—gray in color, long, erect, with basal two-thirds black. The black vertebral stripe does not extend beyond level of prebrachium. Endopatagium with hem of hair on dorsal surface. Interfemoral membrane naked beneath, sparsely covered in great part on dorsal surface with short, inconspicuous hair of the same color as that of the back.

Cynopterus marginatus.

Three specimens were examined, all adults—two males and one female.

In one of the males the *crown* and *face* were mouse-gray. No evidence of a "whisker" was present. The hair of the space between the horizontal rami of the mandible was of different texture from that of the face. The hair was longer and thinly covered the skin.

The *side of the neck* without radiating hairs. The color of this region not differing from that of the front of the trunk which was slate-gray. The region of the mamma slightly rufus.

The *side of the trunk* below the mamma with longer hair than that of the front but otherwise is not differentiated. That below the anus is continuous with the line last named but is of a more rusty tinge.

The *hair of the back* is longer than that of the front. There is no mantle. The hair is slightly woolly over *sacrum* and on the thighs.

The fur is everywhere unicolored.

The second male like the foregoing, but the sides of the neck with long coarse radiating rusty red hair. This color dominates the front of the neck. The same colored but softer hair marks the position of the mamma.

The *infra-anal region* was gray.

The single example of a female was the same as the above, excepting that the rusty hue of the mamma dominates the color of the side of the trunk and the rusty hue of the side of the neck extends less evidently on the front.

The differentiation of the region of the mamma is noteworthy in this species. The hair on the side of the neck, according to Dobson, is more rusty in the males during the rutting season than at other times. The region also may be of secondary sexual significance. It will be noted that the color in the single female scarcely differs from that of the male. To a less degree than in any form examined were the regions of the head and face distinguished.

The distribution of the hair in families other than the Pteropodidæ is not subject to the same sharp contrasts of color, nor to the same variety within specific limits. The subject, however, is worthy of extended study. As a rule the disposition to the sides of the neck and body being more heavily furred than elsewhere is evident.

In *Chalinolobus* (as remarked by Dobson[1]) the fur of the head and shoulders is darker than the rest of the body. *Atalapha cinerea* exhibits the same disposition for the hair in front of the ear and of the inter-ramal space to be darker than the adjacent regions as is noted in some species of *Pteropus*. In the young of *Atalapha noveboracensis* while the head and back including the corresponding aspect of the interfemoral membrane is uniformly clothed, the under surfaces of the head, neck, trunk and interfemoral membrane are naked. In *Artibeus* and *Carollia* an attempt at special dispositions of hair about the eye is clearly discernible. As is well known a white dorsal stripe on the head and back of *Artibeus* and on the

[1] Catalogue of Cheiroptera in the British Museum.

back in *Noctilio*, are met with. In *Chilonycteris davyi* the back of the trunk is naked as in *Cephalotes* and *Notopteris*.

In *Vesperugo lasiopterus* the disposition for hair to grow along the lines of the raised folds of the wing membranes is evident. The basal clump of hair which is so commonly present in Vespertilionidæ appears to correspond to those caudal vertebræ which are in axial line with the trunk.

In the Pteropodidæ the arrangement of the verrucæ is not of the importance assumed in other families. Thus in the last named, the rictal wart may separate the facial from the inter-ramal regions. The same structure apparently determines the direction of the auricular expanse forward. The mental warts in like manner forecast the positions of mental leaflets in *Noctilio, Chilonycteris* and *Mormops*. The region of the warts at the side of the muzzle becomes the site of remarkable outgrowths in *Synotus* and *Corynorhinus*. In *Molossus rufus* a group of hair-bearing verrucæ limits the area of distribution of the hair on the dorsum of the interfemoral membrane. Special patches of hair are met with on the same surface in the female of *Miniopteris schreibersii*.*

For the opportunity of examining the material upon which the study of the Pteropodidæ is based I am indebted, in great part, to the courtesy of Mr. F. A. Ward of Ward's Natural History Establishment, Rochester, N. Y.

* Proc. Acad. Nat. Sci., 1889, p. 322.

ON NEW FORMS OF VERTIGO.

BY DR. V. STERKI.

It was to be expected that a more exhaustive research for small *Pupidæ*, and a closer examination of materials already in the different collections, by one observer, would bring to light quite a number not only of new species but of new varieties and local forms. There are now six, or possibly seven new *Vertigo*, a part of them having been in my collection for more than three or four years, waiting for confirmation. Two represented by only two examples each—one of them from N. E. Ohio, the other from Illinois—are omitted here, although I am satisfied they are good species.

The four to be published here are established beyond a doubt, owing to the kindness of quite a number of conchologists, who furnished me specimens and sent me their whole collections of Pupidæ for examination. In place of minute systematic descriptions, which will follow elsewhere, I prefer here pointing out their main characters and comparing them with species already known.

Vertigo callosa, sp. nov.

There are in collections two different species under the name of *V. gouldii* Binn. Their size and coloration is nearly the same, at least in most variations, as are also the apertural lamellæ as to number and position. Yet they are decidedly and constantly distinct, especially by the formation of the outer wall at the aperture. Judging from the descriptions and more especially from the figures, the true *V. gouldii* is characterized as follows: the last whorl is somewhat predominating, thus rendering the whole shell more ovate or conic ovate; the palatal wall near the aperture is decidedly flattened, or impressed, the impression comprising also the crest and being especially well marked at the "auricle" (as I name the more or less projecting part about the middle of the outer margin, to have a concise expression), forming a roundish groove outside and a decidedly projecting angle inside, thus producing the "two curves meeting in the center of the peristome." A feature, not striking but only seen by careful examination, is the position of the short tooth-like lamella at the base, somewhat nearer the margin than the end of the columella, the base perceptibly widened at that place; the said lamella is probably an equivalent of the inferior columellar lamella, which in most of Vertigos stands very low, in many exactly at the base.

The other species, *V. callosa*, has the last whorl relatively less wide, so that the whole shell is of a more oblong shape. In the palatal wall, only the part behind the crest is somewhat flattened, while the latter itself forms one unbroken curve from the base up to the suture, and at the moderately projecting auricle there is only a slight flattening. The inferior columellar lamella is at the end of the columella, sometimes wanting or a mere trace. Well worthy of notice is a peculiar formation of the surface, the epiconch showing microscopic wrinkles or foliations in the direction of the lines of growth producing a peculiar silky gloss, especially on quite fresh examples, and more in some forms than in others.

The first two examples of this species I obtained in 1885 from Mr. Henry Moores, of Columbus, O., and in 1889 I saw a few more in his collection. In 1887 Mr. E. W. Roper sent me some others from Mass. Last year in different collections I saw quite a number of specimens from different places in New York near the metropolis, under various names: *V. gouldii, milium, ovata* and also mixed with *bollesiana*. Of the Ohio examples the color is somewhat lighter, the callus and the lamellæ are strong and white, while in the eastern examples they are somewhat thinner and more of the color of the shell. The name *callosa* was thus mainly derived from the Ohio form (which, however, may be regarded as a variety).

It is with some hesitation, however, that I now bring it under this head: it is the equivalent of the European *V. pygmaea*, Drap., of which I have examples for comparison from different countries of the old continent[1]. The two may even be identical; at least it would be absolutely impossible to distinguish New York examples from most Europeans. Both forms agree also in certain variations of the apertural lamellæ; the inferior columellar lamella may be absent in either, or there may be present a small suprapalatal fold thus rendering the number variable from 4–6, the typical, however, being 5. An examination of the soft parts will probably decide the question; so far I have not had an opportunity to make it.

On our continent, the range of distribution of the two species—*V. gouldii* and *callosa*—seems to be somewhat different, the former having been found in New York, Ohio, Illinois and Colorado, the latter from Massachusetts to Ohio.

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[1] Which I have partly collected myself there during a number of years.

Vertigo binneyana, sp. nov.

Last year, Mr. W. G. Binney kindly presented me with two examples of a *Vertigo* collected at Helena, Montana, by Mr. H. Hemphill, which seemed to be of a new species; but yet I did not like to publish a description founded upon only these two specimens. Lately among a number of small *Pupidæ* from different parts of British America sent by Mr. Geo. W. Taylor of Ottawa, there were a few examples of this same species from Winnipeg, Manitoba, dead and weathered, but good enough to be identified.

They are of the size and general appearance of *V. callosa*, very narrowly perforate, cylindrical oblong, light chestnut-colored; whorls 5, moderately rounded, nearly smooth; aperture relatively small, peristome little expanded: outer wall with a well formed crest interrupted by a rather long revolving groove; corresponding to the crest there is a callus of lighter color; lamellæ 6; on the apertural wall a small supra-apertural and a well developed apertural; collumellar appearing rather massive; at the base one, rather small but well formed, appearing tooth-like; palatals 2, long, especially the inferior. L. 2·0 D. 1·0 mill.

Probably there are other examples of this species in collections and more will be found in the northwest. It is named in honor of Mr. W. G. Binney to whom I owe the two beautiful specimens in my collection.

Vertigo oscariana, sp. nov.

This is the most peculiar of our species. It is of the size of *milium* but oblong with either end nearly equally pointed, the last whorl being considerably narrowed and flattened towards the subtriangular, small aperture; shell thin, delicate, of pale horn color, as is the palatal wall and margin; the latter simple and straight, with a very slight, thin callus inside; lamellæ 3, whitish, rather small: one apertural, one columellar (longitudinal) and the inferior palatal; sometimes there is also a very small superior palatal. Length 1·5, diam. 0·8 m. m.

This remarkable *Vertigo* has been detected in Eastern Florida, on the coast at Mosquito Is., etc., by Mr. Oscar B. Webster and his father, Mr. Geo. W. Webster, of Lake Helen, Florida. These gentlemen took much pains to ascertain the range of distribution of this form and some others, and it is consequently only just to name the species in honor of Mr. Webster. The most striking character of it, besides the narrowed last whorl, is the thin and straight palatal wall and margin, so that, indeed, the shell appears to be immature. But when seen under a glass of sufficient power, the margin is completed and, as already mentioned, there is a thin callus at a little distance from the margin. Moreover, Mr. Webster wrote me that of more than 150 examples he had seen, all were alike.

A few days ago, in a lot of *P. corticaria* Say, from Ithaca, N. Y., sent from Texas, there was one example of this species, the shell dead but in fair condition, a little larger and less fragile than the Florida examples, and with a well marked callus corresponding to a slight but distinct crest. The specimen may have been collected in New York, and from its appearance at least I would ascribe to it an origin north of Florida.[1]

By the kindness of Mr Webster I was enabled to see a living example. The foot and the lower parts of the head are nearly colorless; head, eye-tentacles and neck light gray. Jaw very tender, thin, pale yellow, consisting of about 14 longitudinal plates, shorter and wider in the middle, longer and narrower toward either end; it is much like that of *V. tridentata*, Wolf. Odontophore about 0·36 mm. long, 0·1 wide, about 110 square rows in each $\frac{m}{3}+\frac{9}{3}+\frac{4}{x}$ teeth; central very small; laterals gradually passing into marginals; the latter serrate. Different from that of *V. tridentata*.

Vertigo rugosula, sp. nov.

Related to *V. ovata* and *gouldii*; in shape more elongated than the latter, more cylindrical and somewhat larger. Apertural parts and lamellæ much like those of *ovata*, but the columella is decidedly longer and straighter, and the inferior columellar lamella is distinctly placed on it. L. 1·8–2·0 D. 1·1 mm. Of a peculiar formation is the surface: of the 5 well rounded whorls, about one and a half of the upper are nearly smooth; the following with exception of the last are distinctively and regularly striated, the last very finely but distinctly rugose in the sense of the lines of growth, near the aperture again striated. Color, dark chestnut.

This is a beautiful species, of which I saw the first example in the collection of Mr. Bryant Walker, who had found it, in April last, at Pass Christian, Mississippi. Last September, Mr. W. G. Mazyck collected a number of them on Sullivan's Island, S. C. In either place they were in company of *Pupa rupicola* Say. Quite lately I have seen one example from Lee Co., Texas, sent by Mr. J. A. Sing-

[1] Since the above was written, I found a few examples in drift from Guadalupe River, Texas, collected by Mr. J. A. Singley, sent by Mr. Wm. A Marsh.

ley; it was a dead shell, and not fully mature, but recognizable. The species consequently seems to be widely distributed along the South-Atlantic and Gulf Coasts.[1]

In eastern Florida, Volusia Co., etc., a form has been found to be quite common which I refer to this species, but as a distinct variety which may be called *ovulum.* It is somewhat smaller, ovate, the striation and rugosity of the surface are less marked, and the inferior apertural lamella is wanting; in turn it has in most examples a lamella at the base (between inferior columellar and inferior palatal) and the callus in the palatal wall is rather strong. The coloration of part of them is somewhat lighter. It cannot be confounded with *V. ovata* Say, its relations to the type of *rugosula* being evident, and in addition, *ovata* has been found with it. Nor can it be referred to *ventricosa*: it is larger and stronger, of much darker color, its surface is not so smooth and polished, it has 3 or even 4 lamellæ more, and the columella is longer.

[1] Two specimens were sent in by Mr. H. Hemphill, who collected them at Fish Camp, Fresno Co., Cal.

FEBRUARY 4.

Mr. WILLIAM W. JEFFERIS in the chair.

Twenty persons present.

A paper entitled "The Genesis and Horizons of the Serpentines of South Eastern Pennsylvania," by Theodore D. Rand, was presented for publication.

FEBRUARY 11.

Dr. CHARLES SCHAEFFER in the chair.

Seventeen persons present.

Papers under the following titles were presented for publication:—

"Note on a Southern Pupa." By H. A. Pilsbry.

"A Review of the Cernaycian Mammalia." By Henry Fairchild Osborn.

"On Arenicola cristata and its Allies." By J. E. Ives.

FEBRUARY 18.

Mr. HAROLD WINGATE in the chair.

Nineteen persons present.

A Remarkable Variation of Stemonitis Bauerlinii, Mass.—DR. GEORGE A. REX presented a series of specimens illustrating a strongly marked variation of *Stemonitis Bauerlinii* Mass., and the successive phases of its reversion to the typical form.

Four years previously, he had found on the surface of a decaying log in Fairmount Park, Phila., a patch of sporangia of a *Stemonitis* which, by a superficial inspection appeared to be *Stemonitis Morgani* Pk. Subsequent examination with the microscope, however, showed certain peculiarities of structure, not found in any known species of *Stemonitis.* These variant characters were so marked that they would have justified, had they proved constant, the creation of a new species and also, perhaps, a new generic type.

All of the sporangia of the entire growth which covered a superficial area of five or six square inches, were alike in structure and perfectly mature, so that their unusual form was not due to irregular individual development or immaturity. The sporangia differed in form from typical *Stemonitis,* in being irregularly three-sided, or triangular in section in the upper two-thirds of their length, instead of being cylindrical as usual.

This irregular shape was due to the anomalous position of the columella which was lateral and not central, running from the base of the sporangium nearly to the end, in a spiral of about two and one-half turns, appressed and closely attached to the inner face of the sporangium wall.

The internal capillitium, usually composed of radial threads running from the central columella to the peripheral network was wanting; but in place of it, a few delicate threads bound the columella, at short intervals to the periphery, and then ramified for a little distance upon the latter.

The sporangium wall or periphery was most remarkable, being, in effect, a rigid sheath of plasmodic matter, perforated by circular and oval openings, instead of the peripheral network of threads parallel to the axis of the sporangium, which is characteristic of typical *Stemonitis.* At intervals, on the surface of this plasmodic sheath, knots were developed from which short threads branched in all directions, sometimes connecting with those binding the columella but generally blending with the substance of the sheath.

As the season was advanced no other specimens were found in that year, but in the following year, three crops of *Stemonitis* were successively developed at intervals of about one month on the same area of log surface which had been carefully marked and noted. By a warrantable inference these growths were developed from the spores, or part of the same plasmodium as the specimens of the previous year. Each crop bore the main variant characters of the original specimens, but approached successively nearer the true *Stemonitis* type.

The last found growth differed but slightly from *Stemonitis Bauerlinii* Mass., yet, as it presented all its diagnostic characters, the whole series could logically be referred to that species.

These and all similar variations in the sporangia of the myxomycetes, are caused by the irregular or unusual differentiation of the formative plasmodium during development. In the present case, the sporangium wall gained an increased amount of plasmodic matter at the expense of the central capillitium.

Whether this change was abrupt, or the result of several generations leading to it, could not be known, but the observations which were made, though lacking some of the essentials of scientific exactness, seemed to show a very interesting example of the reversion of an extremely variant form to its original type.

The speaker believed that this abnormal form would again be developed and found, and he desired, therefore, to place it on record as *Stemonitis Bauerlinii* Mass. f. *fenestrata.* He acknowledged his indebtedness to the courtesy of Mr. George Massee, the author of the species, for an authentic specimen of *Stemonitis Bauerlinii.*

FEBRUARY 25.

Mr. JOHN H. REDFIELD in the chair.

Fourteen persons present.

The death of Dr. Charles C. Parry, a Correspondent, was announced.

The following was received :—

REPORT OF THE COMMITTEE ON THE HAYDEN MEMORIAL GEOLOGICAL AWARD.

The committee appointed by the Academy of Natural Sciences to recommend the award of the Hayden memorial medal for the most important contribution to the science of geology, has the honor to report to the Academy that is has selected Prof. James Hall, the State Geologist of New York, for the distinction of receiving the first award of this medal. In making the selection the committee feels confident that it will have the endorsement of every geologist both here and abroad, but it deems it due to the eminent character of the recipient, and of the work which he has done for fifty-eight years and is still doing for science, that these services should be here formally acknowledged.

Prof. Hall was born at Hingham, Mass., on Sept 12th, 1811, and is therefore now in his 79th year. He commenced his scientific life in 1832 when, after graduation at the Van Rensselaer Polytechnic school he immediately assumed the duties of a Professor there. His dedication to the special branch of research to which he has made so many and important contributions, began in 1836 when he was appointed Professor of geology at that institution, and the same year one of the Assistant Geologists on the then just instituted geological survey of New York. In 1837 he was made State Geologist in charge of the fourth division of the State. His final report of this district was made in 1843, and thence with the title of State Geologist he was placed in charge of the paleontological work. From this date till 1879 five volumes of the paleontology of the terrains from the Potsdam sandstone to the base of the coal measures have been issued. He has prepared a complete revision of the paleozoic brachiopoda of North America which is now in press and which has necessarily required researches as far west as the Rocky Mountains.

He was also State Geologist of Iowa in 1855. In 1857 he was elected State Geologist of Wisconsin. He has besides prepared monographs of the Graptolites of the Quebec group (1865); two volumes of the geology and paleontology of Iowa (1858–9); the chapters on geography, geology and paleontology, of Wisconsin in 1862; Fremont's exploring expedition Appendix A. (1845); Expedition to the Great Salt Lake (1852); United States and Mexican Boundary Survey (1857); United States Geological Exploration of the Fortieth Parallel, Vol. IV. He has published volumes of reports of progress ever since 1866, when on the reorganization of the New York State Museum he was appointed director as well as State Geologist. Notable among these are Vol. VI, on the Corals and Bryozoa from the Lower and Upper Helderberg and Hamilton; Vol. VII, containing descriptions of the trilobites and other crustacea of the Oriskany, Upper Helderberg, Hamilton, Portage, Chemung and Catskill—in fact eleven volumes altogether. He received the grand cross of the order of St. Maurice and St. Lazarus from the King of Italy in 1882, and the Walker quinquennial grand prize of $1000 from the Boston Society of Natural History in 1884.

He is the only surviving founder of the American Association of Geologists which was organized in Philadelphia in 1840, and out of which grew the American Association for the Advancement of Science. He was one of the charter members of the National Academy of Science, and one of the original founders of the International Congress of Geologists, at all sessions of the latter of which he has attended having been elected Vice-President representing the United States.

He was elected a Correspondent of the Academy of Natural Sciences of Philadelphia in 1843, one of the foreign members of the Geological Society of London in 1848, and received its Wollaston medal in 1858. He was elected Correspondent of the Academy of Sciences of Paris in 1884. He was the first President elected by the Geological Society of America on its organization in 1889.

Probably no one living has influenced to a greater extent the domain of invertebrate palaeontology, and much of the exactitude of knowledge which his researches have introduced into the New York reports have made these the standard of geological nomenclature and classification throughout America.

JOSEPH LEIDY.
J. P. LESLEY.
ANGELO HEILPRIN.
PERSIFOR FRAZER.
WILLIAM B. SCOTT.

The following were elected members:—

Mahlon Walker M. D., William H. Bricker M. D., Samuel G. Dixon M. D., David Jayne Bullock, Stephen Farrelly and Baird Halberstadt.

The following were ordered to be printed:—

ON THE ANATOMY OF AEROPE CAFFRA Fer.

BY H. A. PILSBRY.

In the Proceedings of this Academy for 1889, p. 277, the writer gave an account of the anatomy of a South African land snail, *Helix knysnaënsis* of Pfeiffer, which was there placed provisionally in the genus *Aerope*, pending fuller knowledge of the organization of *A. caffra*, the only species heretofore referred to that genus. Through the continued kindness of Mr. John Ponsonby, of London, I am enabled now to describe a specimen of *A. caffra*, which was mailed living at London, but encountering some untoward accident *en route*, reached me with the shell broken and the softer tissues of the animal in such a condition that the parcel was regarded with suspicion and aversion by the Post-office official who gave it me. Upon dissecting the snail—a fine, large specimen—I found it in comparatively good condition, but somewhat softened by decomposition although I had placed it in alcohol as soon as received.

The foot is shaped like that of *A. knysnaënsis*, and measures about 42 mm. in length, 20 in greatest breadth. The sinus separating the sole from the head is quite deep. The sole is whitish; the upper surface of the foot and head is blackish. The dorsal grooves, usually prominent in *Agnatha*, are inconspicuous. There are, of course, no epipodial grooves nor caudal mucous pore.[1] The buccal mass is very large and long, measuring 35 mm. in length. The radula (pl. I, fig. A) is 40 mm. long, 4½ wide. The formula of teeth is about 16–1–16. The rhachidian tooth (pl. I, fig. C, *r*, and B) is narrow, lanceolate, its basal-plate narrow, emarginate, but not nearly so distinctly forked as in *A. knysnaënsis*. The laterals are large, set in very oblique rows, and increase rapidly in size from the inner to the fifth, which is very large. The basal-plates of the inner laterals are oblong, but those of the outer (fourth and fifth laterals) are nearly square. Outside of the fifth lateral tooth there are about a dozen

[1] Two notices of the animal of *A. caffra* have been published: a short no e by Mörch, reprinted in the foot-note of my previous paper on *Aerope* (Proc. A. N. S. Phila., 1889, p. 177); and a description of the external appearance and habits of the animal by Mr. J. S. Gibbons (in the Journal of Conchology, III, p. 95, July, 1880). The species was collected at Port Natal and Port Elizabeth by Mr. Gibbons. There are short, thick, conico-triangular labial tentacles visible in the living animal, as in *Glandina*, etc. These are wholly retracted in alcoholic specimens.

very minute, slender teeth, almost obsolete. A complete half row of teeth is figured on the plate.

The characters of the radula prove, as I had anticipated, that this species and *A. knysnaënsis* are congeneric, forming a group exhibiting characters distinct from all other agnathous genera. Compared with *knysnaënsis*, the *A. caffra* differs in the greater specialization of the radula, seen in the reduction of the lateral teeth to five on each side, instead of twelve; and in the smaller outer laterals. I do not regard the minute teeth lying outside of the fifth lateral as "marginals" or uncini, but as degenerate lateral teeth; true uncini being absent in the *Agnatha*, which in this respect hold somewhat the same relation to the *Gnathophora* that *Rhachiglossa* or *Toxoglossa* bear toward *Tænioglossa*. In the characters of radula, *Aerope caffra* represents the highest specialization of agnathous snail yet made known. The characteristics of the *Agnatha*,—oblique rows of thorn-shaped teeth, becoming smaller toward the center and the outer edges of the radula—are here exaggerated. In no hitherto known genus are the functional lateral teeth so few, or the outer ones so nearly lost.[1] In no other genus is there so abrupt a break in the size of the lateral teeth. The tendency in *Agnatha* seems to be toward a type of radula analogous to that represented in Pectinibranchs by the *Toxoglossa*.

The genitalia have considerable resemblance to those of *A. knysnaënsis*. The vas deferens is curiously convoluted just below the twisted portion of the oviduct (see fig. F). The albumen gland (*a. g.*) is very large, but perhaps more swollen in my figures than in a freshly killed animal. I did not find any spermatheca, but think that this was owing to the soft, partly decayed condition of the viscera. I did not dissect out the ovo-testis. The orifice of the genetalia is very near the right tentacle.

The blind sac opening below the mouth, supposed by Dr. Leidy to be the seat of the olfactory sense, is very long, folding upon itself, terminating in the muscular tissues of the foot about one-third the length of the latter from the posterior extremity. When extended the length of the sac is about 100 mm.

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[1] *Rhytida* may be considered more specialized in one respect:—the absence of a rhachidian tooth.

Explanation of Plate I.

Fig. A. Radula of *Aerope caffra*, natural size.
Fig. B. Enlarged view of rhachidian tooth.
Fig. C. Complete half-row of teeth.
Fig. D. Genitalia. *P.* penis; *p. r.* penis retractor muscle; *v. d.* vas deferens; *a. g.* albumen gland.
Fig. E. Albumen gland, opposite side; *e.* epididymis.
Fig. F. Lower portion of oviduct, showing the convoluted vas deferens.
Fig's G. H. I. J. K. *Pupa hordeacella* Pilsbry.

NOTE ON A SOUTHERN PUPA.

BY H. A. PILSBRY.

During the past year the writer has had occasion several times to examine and determine specimens of a certain *Pupa* from various localities in the South, the extreme points being Arizona and Florida. It seems to him highly desirable to have a name and a recognizable description and figure for a form so widely distributed, and so constantly separated by local naturalists from the already known species as the following:—

Pupa hordeacella n. sp. (Pl. I, figs. G, H, I, J, K.)

The shell is of a long-ovoid shape, smaller and more slender than *P. servilis* Gould, translucent, waxen-white, finely striate; the aperture is rounded, with a thin, expanded peristome. Within, there is on the parietal wall, an entering fold arising near the termination of the outer lip, its edge a trifle sinuous or nearly straight; the columella has a fold about in the middle. There is a tiny, deep-seated fold on the base of aperture, near the columella, an entering fold within the outer lip, equidistant from the above-described parietal and columellar folds, and a tiny denticle above it. The columellar fold is not situated so high on the pillar as in *P. servilis*. The latter half of the body-whorl is flattened on the outer-lower portion, as the figure J. shows. There is a low wave-like ridge or 'crest' also, but scarcely visible in many specimens.

Alt. 1·8, diam. 8 mm.

The figures were drawn with the aid of camera lucida. They should be compared with Gould's excellent figures of *P. servilis*, in Boston Journal of Natural History, vol. IV, plate 16, fig. 14, and those of *P. pellucida* in Strebel's Beitrag zur Kenntniss der Fauna mexikanischer Land-und Süsswasser-Conchylien, Theil iv, pl. xv, fig. 10. The latter are the more valuable in this connection as they are not only faithful drawings on a sufficiently large scale, but are the only ones drawn from Continental specimens (Vera Cruz, Mexico). The measurements given by Strebel and Pfeffer are alt. 2½, diam. of last whorl fully 1 mm.; alt. of aperture, ⅗ mm. Gould's *P. servilis* and Pfeiffer's *P. pellucida* were both described from Cuba. I see no reason for not following W. G. Binney in considering them synonymous, *pellucida* having precedence.

The shells above described were at first refered to the *P. pellucida* of Pfr., or *P. servilis* Gld.; and later the writer gave to them the mss. name of *P. hordeacella*. Whether the characters of the form prove constant enough to give it specific rank, or whether it will finally be considered a variety or race of *P. servilis* Gould, is a matter that my acquaintance with the group does not enable me to decide. In its constantly much smaller size we have a perfectly tangible character that will enable one to readily separate the two forms without the use of a magnifier.

In this connection it will be perhaps useful to point out the fact that in the specimens sent out by Gabb as his *Pupa hordeacea* there are two forms mingled. One is the present species; the other is the true *hordeacea*, a form of about double the size of this, with a more acute, stronger crest or ridge behind the outer lip, and a decidedly pinched base to the last whorl. *P hordeacea* has the teeth of the outer lip more deep-seated and smaller than *P. servilis* or *P. hordeacella*.

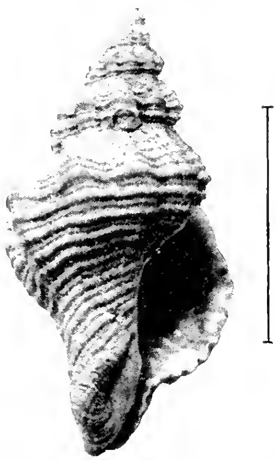
The specimens before me are from the following sources:—Arizona, collected by Dr. Horn; New Braunfels and other places in central Texas, collected by Mr. J. A. Singley and the writer; St. Augustine, Florida, collected by Mr. C. W. Johnson, of the Wagner Institute, Philadelphia.

The figures on Plate I are drawn from New Braunfels specimens, which may be regarded as typical for the species.

REMARKS ON UROSALPINX PERRUGATUS Conr.

BY FRANK C. BAKER.

This mollusk was described by Conrad in the American Journal of Science, New Series, vol. II, 1846, p. 397, as follows: "*Fusus perrugatus* Conrad. Manatee River. Fusiform, with remote longitudinal ribs, and large prominent revolving lines alternating with a fine line; whorls longitudinally rugose, upper half flat and oblique; aperture rather more than half the length of the shell, purple within; labrum striate; color of the exterior cinereous. Proportionally wider than *F. cinereus*, with fewer and larger ribs and lines."



The only references I have been able to find, which have been made to this shell since the foregoing description, are those by Dr. W. H. Dall in Bulletin No. 37 of the United States National Museum, p. 120, and in the Blake Gasteropoda Report[1] p. 214, in which he says: "There are three American species known to belong to it; (*Urosalpinx*) *N. cinereus* Say, ranging from Massachusetts to Florida; *N. tampaensis* Conrad, known only from the west coast of Florida .... lastly *N. perrugatus* Conrad."

Among a number of specimens of *cinereus* in the collection of the Academy of Natural Sciences of Philadelphia I found several trays of *perrugatus*, and as no really good description, and no figure has been published of this species, I take this opportunity of redescribing and figuring the same.

Urosalpinx perrugatus Conrad.

Shell fusiform, solid, cinereous, under the lens showing a scabrous texture; whorls six, subcarinated, longitudinally plicate, the folds eight in number on the last whorl, large, rounded; there are eighteen strong, spiral liræ, with fine intervening threads; aperture ovate, rather more than half the length of the entire shell; outer lip rounded,

[1] Bulletin Museum of Comparative Zoology of Harvard College, vol. XVIII, pt. 2.

edge scalloped by the spiral liræ; inner lip arcuate, smooth; canal longish, open, reflexed; umbilicus none, but there is a furrow in its place, bounded by a fasciole; aperture purple within; apex knob-shaped, smooth.

Alt. 32, diam. 15 mm. Aperture (including canal) alt. 6, diam. 6 mm.

It is separated from *cinereus* by its greater proportional width, its stronger ribs and spiral liræ and more scabrous texture. It is at once separated from *tampaensis* by its sculpture; that of *tampaensis* being latticed by the intersection of the longitudinal and spiral lines; there are other differences which will at once separate it from that species.

Mr. Tryon, in his excellent Manual of Conchology, seems to have overlooked this species as it is not given in either text or index.

Specimens have been collected at Cedar Keys, Florida, by Mr. H. Hemphill, and I understand from collectors that it has been found elsewhere on the west coast.

ON THE FISHES DESCRIBED IN MULLER'S SUPPLEMENTAL VOLUME TO THE SYSTEMA NATURÆ OF LINNÆUS.

BY DAVID STARR JORDAN.

The edition in German of the Systema Naturæ of Linnæus[1] published by Professor Philipp Ludwig Statius Müller at Nuremberg in 1776 has been long overlooked by naturalists, and thus far it has never been quoted by writers on fishes. My attention has been called by Mr. Leonhard Stejneger, to the fact that in the supplementary volume of this work a few fishes have been described. I give in the present paper a list of them. The copy of the work examined by me belongs to the library of the United States National Museum.

The following are the fishes mentioned :—

"Der Buntkopf. Coriphaena lineata" (p. 203).

"Der Kopf ist an diesem Fische gedrückt, nackt, abhängig, und mit bunten Querlinien schön gezeichnet. Die Kiemendeckel sind glatt. Oben und unten sind zwey von einander abstehende, scharfe, längere, und hervorstossende Zähne vorhanden. Die Rückenflosse hat ein und zwanzig Finnen, wovon vier scharf sind, die Brustflosse eilf, die Bauchflosse sechs, und am After befinden sich fünfzehn. Die Schuppen sind sehr gross, die Flossen, welche der Länge nach stehen, mit kleinen Linien bezeichnet, und der Schwanz ist abgerundet. Das Vaterland ist Carolina. Linnæus."

This is the original of the description given by Gmelin in 1788. The name *Coryphæna psittacus* of Linnæus, 1766, is still older, and the species will still stand as *Xyrichthys psittacus.*

"Der Stachelbärsch. Perca asper" (p. 204).

A description of *Stizostedion* (=*Lucioperca*) *wolgense*, quoted from "Pallas, Reisen."

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[1] Des | Ritters Carl von Linné | Königlich Schwedischen Leibarztes sc. sc. | vollständigen | Natursystems | Supplements= | und | Register=Band | über alle | sechs Theile oder Classen des Thierreichs | mit einer | ausführlichen Erklärung ausgefertiget | von | Philipp Ludwig Statius Müller | Prof. der Naturgeschichte zu Erlang. Mitglied der Röm. Kaiserl= | A kademie, wie auch der Berlinischen Gesellschaft der | Naturforscher, etc. | Nebst drey Kupfertafeln. |

Mit Churfürstl. Sächsischer Freyheit | Nürnberg. | bey Gabriel Nicolaus Raspe, 1776.

This name antedates the use of the same name, *Perca asper*, for *Aspro vulgaris* by Gmelin.

"Der kleine Seehahn. Trigla minuta" (p. 205).

This is the *Trigla minuta* of Linnæus, Mantissa, and of Gmelin. It is said to come from the East Indies and is as yet unidentified.

"Der carolinische Seehahn. Trigla Carolina" (p. 205).

"Das Exemplar des Ritters war mehr als Finger lang, mit sehr feinen Schuppen besetzt und hatte ebenfalls drey fingerförmige Fortsätze. Die erste Rückenflosse hat zehen stachlige, die zweyte dreyzehn weiche, die Brustflosse fünfzehn, die Bauchflosse sechs, die After-flosse zwölf, und die Schwanzflosse zehn Finnen. Der Kopf ist mit sternartigen Charactern gezieret. Die Seitenlinie ist einfach, und fast glatt. Der Schwanz ist ausgerandet, und die erste Rückenfinne der Länge nach mit Stacheln besetzt. Der Aufenthalt ist im Meere bey Carolina. Linnæus."

This is identical with the description quoted by Gmelin from the Mantissa of Linnæus. I have not seen the latter work and do not know whether it is prior to the work of Müller or not. Presumably it is.

"Der Nelma. Salmo Nelma" (p. 207).

This is *Salmo nelma* Pallas, *Salmo leucichthys* Güldenstadt, a Russian species of *Stenodus*.

"Der Taimen. Salmo Taimen" (p. 208).

This is the *Salmo taimen* of Pallas.

"Der Lenock. Salmo Lenok" (p. 208).

Also quoted from "Pallas, Reisen," the date of which is 1774 or 1775. This is the *Brachymystax lenok* (*coregonoides*), which according to Dr. Günther may be the male of the preceding species.

"Der Springfisch. Exocœthus exsiliens (p. 209).

"In Carolina wird ein Fisch dieses Geschlechts gefunden, dessen Bauchflosse bis an den Schwanz hinan reicht. Er ist der fliegenden Wachtel No I sehr ähnlich, aber das Exemplar, welches der Ritter bekam, war kaum länger als ein Finger. Der Körper ist nicht silberfärbig. Die Flossen sind blass, und haben ein und andere schwarze Binde. Die Rückenflosse hält zehn, die Brustflosse fünfzehn, die Bauchflosse, welche (wie an der ersten angeführten Art), mitten zwischen dem Kopfe und After anfängt, und nur ein Viertel der Länge vom Schwanze entfernet ist, mit dem Ende aber an die Schwanzflosse stösst (dergleichen nicht einmal an der ersten Art statt findet hat sechs, die Afterflosse eilf, und die Schwanzflosse, die am untern Lappen am längsten ist, hat zwanzig Finnen oder Strahlen. Linnæus."

This is an abridgment of the description given by Gmelin of *Exocœtus exsiliens*. Unless some earlier description exists, the species will stand as *Exocœtus exsiliens* Müller.

" Der Bachkarpfe. *Cyprinus rivularis*" (p. 210).

Quoted from " Pallas Reisen."

This is the *Cyprinus phoxinus* Linnæus=*Phoxinus phoxinus*.

A REVIEW OF THE CERNAYSIAN MAMMALIA.

BY HENRY FAIRFIELD OSBORN.

This remarkably interesting mammalian fauna of the lower Eocene of France has been derived exclusively from a small exposure of the *Conglomérat de Cernay* near Rheims and described in numerous papers by Dr. Victor Lemoine, Professor in the École de Médecine de Reims. The collection is in the private museum of this author and his contributions are scattered through various French periodicals between 1878 and 1888. The Cernaysian fauna, it thus happens, is not thoroughly known or appreciated abroad except by those who have had the good fortune to examine the original types. The fossils are, for the most part, in beautiful preservation and the skulls of *Arctocyon*, *Pleuraspidotherium* and other forms are finer than anything known from European strata of corresponding age. The abundance of the Insectivora is especially notable, for these beds promise to throw as much light upon the early history of this order as the Puerco rocks do upon the Ungulata and Creodonta.

In course of two visits to Rheims I have collected the following brief studies and original sketches for publication, after a careful comparison of my own observations with those published by Dr. Lemoine. I wish to express my high appreciation of the value of the paleontological discoveries of this author and my personal indebtedness for the privilege of freely examining his collection.

Articles upon the Cernaysian Mammalia, Lemoine, 1878–88.

('78a.) "Communication sur les Ossements Fossiles des Terrains Tertiaires Inférieures des Environs de Reims." Soc. d'Histoire Naturelle de Reims, May 8th, 1878.

('78b.) "Recherches s. l. Ossem. Foss. d. Terr. Tert. Infér. d. Reims; 1re partie, Étude du genre *Arctocyon*." Ann. des Sc. Naturelles, July 1878, T. VIII.

('79a.) "Comm. s. l. Ossem. Foss. des Terr. Tert. Infér. d. Env. d. Reims;" Assoc. Franc. p. l'Avancement des Sciences, August, 1879. Reprinted, Rheims, 1880.

('80a.) "Terrains Tertiaires des Environs de Reims." Assoc. Franc. p. l. Avanc. d. Sc.; Reims, 1880.

('82a.) "Sur l'Encephale de *l'Arctocyon Duellii* et du *Pleuraspidotherium Aumonieri*." Bull. d. l. Soc. Géol. de France, 3e Série, t. x, April, 1882. See also Comptes Rendus, April, 1882.

('82b.) "Sur deux *Plagiaulax* tertiaires, recuellis a. Env. d. Reims." Comptes Rendus, Nov. 20th, 1882.

[1] The list of papers relating to the Reptilian and Avian fauna of Cernay is equally extensive.

('83a.) "Étude s. l. *Neoplagiaulax* d. l. Faune Eocène infér. d. Env. d. Reim." Bull. d. l Soc. Géol. d. France, 3 Sér., T. XI, 1883.
('83b.) "Sur l'*Adapisorex*, nouv. gen. d. mamm. d. l. faune Cernays. d. Env. d. Reims." Comptes Rendus, Dec., 1883.
('84a.) "Caractères gén. d. *Pleuraspidotherium*, etc." Comptes Rendus, Dec., 1884.
('85a.) Étude s. quel. mamm. d. petite taille d. l. faun. Cern. d. Env. d. Reims." Bull. d. l. Soc. Géol. d. France, 3 Sér., T. XIII, Jan., 1885.
('87a.) "Sur le genre *Plesiadapis*, etc." Comptes Rendus, Jan., 1887.
('87b.) "Sur l'Ensemble d. recherches paléon. faites dans l' Terr. Tert. inf. d. Env. d. Reims." Comptes Rendus, Feb., 1887.
('88a.) "Sur quel. mamm. Carnassiers recuel. dans l' Eoc. inf. d. Env. d. Reims." Comptes Rendus, Feb., 1888.

PERIOD OF THE CERNAYSIAN.

Dr. Lemoine considers the Cernaysian parallel with the American Puerco and below the Wasatch level, as the fauna is evidently primitive and local beds are found above this horizon which contain *Hyracotherium* and other characteristic Wasatch genera. But *Coryphodon* is found in the *Conglomérat de Meudon*, which is generally considered by French geologists as contemporaneous with the Cernaysian. Upon the whole, the prevailing stages of development observed in the teeth of the different series are somewhat more modern than the Puerco types and offset the contemporary character given by *Arctocyon* and *Neoplagiaulax*.[1] The Cernaysian may, therefore, with some certainty be considered intermediate in time between the Puerco and Wasatch, and probably not far from parallel with the lower Egerkingen fauna recently described by Rütimeyer. I have arranged the following table, after consulting Professor Gaudry and the geological papers of Lemoine ('80a), de Lapparent (4, p. 1130) and Geikie (5, p. 844).

Divisions of the Suessonian or Lower Eocene of France, Paris Basin.

N. AMERICA.	GT. BRITAIN.	FRANCE.	
		C.	
	London Clay . . .	Sables de Cuise	*Miolaphus.* *Hyracotherium.*
	Oldhaven Beds	B.	*Palaeonictis.*
Wasatch		Argiles a lignites	*Coryphodon.*
	Woolwich Beds	Conglomérat de Cernay, (de Meudon) . .	*Pleuraspidotherium.*
	(Plastic Clay.)	A.	
		Calcaires de Rilly la Montagne	*Protoadapis.*
Puerco	Thanet Sands . .	Sables de Bracheux; de la Fère	*Arctocyon primaevus.*
		Marnes de Meudon	

[1] Corresponding to *Mioclaenus* and *Ptilodus* respectively.

One marked feature of this fauna is that, while related to others of the lower Eocene, only one of the genera and none of the species have been found elsewhere. The order best represented is the Insectivora with at least four genera, then the Creodonta with three genera, the Mesodonta or Lemuroidea, and the Multituberculata. The last is a distinctively Mesozoic order and embraces in this horizon the single genus *Neoplagiaulax*, the survivor of an ancient and widely spread family. Leaving this exceptional type out of consideration, the following are the general characteristics of the Cernaysian mammals: 1. The teeth are tritubercular[1] and in only one genus (*Pleuraspidotherium*) is the *hypocone* of the superior molars fully developed; the intermediate tubercles (*para-* and *meta conules*) so characteristic of the Wasatch mammals, are not generally well developed. In the inferior molars, the primitive triangle is, in most species, broken by the loss of the *paraconid*. 2. The brain is small ('82a p. 333, *Arctocyon*, *Pleuraspidotherium*), with large olfactory lobes, narrow hemispheres leaving the optic lobes exposed and short transversely extended cerebellum. 3. The skull (excepting in the Lemuroidea) has a deep sagittal crest and broad, low occiput, with slender widely-arching zygomata, and the anterior nares small and terminal in position. 4. The feet are plantigrade (again possibly excepting the lemurs). One feature of great interest to which Dr. Lemoine called the writer's attention is the invariable presence of the astragalar foramen (see fig. 5, *af.*); this is observed also in all Puerco astragali. The femur has a third trochanter and the humerus usually has the entepicondylar foramen.

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[1] The following is a table of the nomenclature which I have proposed for the tooth cusps equivalent to that employed by Gaudry in the "*Enchainements du Monde Animal*" p. 55. (See 1, p. 1072.) These terms express the homologies which exist between the upper and lower molar cusps, of all the known mammalia excepting those with multituberculate molars.

Abbr.	*Molaires supérieures.*		Abbr.
I,	denticule interne du premier lobe	protocone,	pr.
E,	" externe " " "	paracone,	pa.
e,	" " " second "	metacone,	me.
M,	" médian " premier "	protoconule,	pl.
m,	" " " second "	metaconule,	ml.
i,	" interne " " "	hypocone,	
	Molaires inférieures.		
E,	denticule externe du premier lobe	protoconid,	pr^d
	(denticule interne antérieure)	paraconid,	pa^d
I,	" " du premier "	metaconid,	me^d
e,	" externe du second "	hypoconid,	hy^d
i.	" interne " " "	entoconid,	en^d

With these primitive features in common, the orders are nevertheless sharply distinguished from each other, and the writer's principal grounds for considering this horizon as more recent than the Puerco, are the numerous instances of a high degree of reduction and specialization. The lemuroids are very abundant, with the long slender tail and rotating forearm of the climbers. *Plesiadapis* is an exact counterpart in molar development of the remarkably reduced *Anaptomorphus* of the Wasatch, while the older *Protoadapis* has the fuller dentition of the Puerco *Indrodon*. *Adapisorex* is not a related form as its name would indicate but should be classed with the tiny *Adapisoriculus* among the Insectivora. *Pleuraspidotherium* and *Orthaspidotherium* were also probably insectivores and as they are both represented by well preserved skulls and portions of the skeleton they constitute by far the best known of the early members of this important order. All the above animals belong to the smaller and least primitive members of this fauna. The more ancient facies is given by the small and large Creodonts. *Hyænodictis* is a small animal with molars similar to those of the Puerco *Triisodon*. *Tricuspiodon* has an inferior tuberculo-sectorial of the most primitive type. *Arctocyon* is the largest animal, with molars of the Puerco *Mioclænus* pattern. The minute *Neoplagiaulax* is in a slightly later stage of development than the Puerco *Ptilodus* of Cope. No Condylarthra have as yet been discovered in the Cernaysian ; the absence of ungulates is thus in marked contrast with their abundance in the Puerco and Egerkingen strata.

THE RHEIMS FAUNA.

Calcaires de Rilly	*Conglomérat de Cernay*	*Argiles á lignites.*
	(Lemuroidea.)	
Protoadapis	Protoadapis Copei.	
" crassicuspidens	Plesiadapis tricuspidens	Plesiadapis Daubréei.
" recticuspidens.	" Remensis	"
" curvicuspidens.	" Gervaisii	" Chevillioni.
	(Insectivora.)	(Ungulata.)
	Adapisorex Gaudryi	Pachynolophus.
	" Chevillioni	Protodichobune.
	Adapisoriculus minimus	Lophiodochoerus.
	Pleuraspidotherium Aumonieri	Lophiodon.
	Pleuraspidotherium Delessei.	
	Orthaspidotherium,	
	(Creodonta.)	
	Arctocyon Gervaisii.	
	" Dueilii.	

Hyænodictis Gaudryi	Hyænodictis Filholi.
Tricuspiodon.	
Procyonictis	Proviverra.
(Multituberculata.)	
Neoplagiaulax eocaenus.	
" Marshii.	
" Copei.	

MESODONTA.

Schlosser (2, p. 38) has shown that the American lower Eocene monkeys are probably not lemurs, as Marsh and Cope have supposed, because the true lemurs, with one or two exceptions, have incisiform lower canines and caniniform anterior premolars; in other words in most genera, the first premolar has the function and form of a canine. This important distinction renders it probable that *Protoadapis* and *Plesiadapis* belong among the Mesodonta (Pseudolemuroidea. Schlosser). The latter genus has a highly reduced and modified dentition, with no resemblance to that of *Adapis*. The former has a large canine and much reduced first premolar and resembles some of the American forms.

PROTOADAPIS. Lemoine.

P. (Plesiadapis) *recticuspidens*, Lem. '78, p. 14. *P.* (Ples.) *crassicuspidens*, Lem. '78, p. 13. *P. curvicuspidens*, Lem. '78, p. 12. *P. Copei*, Lem. '79a, p. 7.

Gen. char.: Dentition $i_{\overline{2}}\ c_{\overline{1}}\ p_{\overline{3(4)}}\ m_{\overline{3}}$. Inferior molars quinquetubercular. The first lower premolar occasionally present. The incisors small. The canines large.

This is an older and more primitive form than *Plesiadapis* as shown by its fuller dentition and the retention of the paraconid which completes the primitive triangle of the lower molars. These teeth recall the structure seen in *Microsyops* among the American Mesodonta. Although belonging to an older horizon we have no positive grounds for supposing that this genus is an ancestor of *Plesiadapis*, or that either of these forms are genetically related to *Adapis*. In fact the tendency to a rapid reduction of the premolars and specilization of the incisors point away from *Adapis* in both cases.

PLESIADAPIS, Gervais.

P. tricuspidens, Gervais (3 p.). *P. Remensis*, Lem. '87a. *P. Gervaisii*, Lem. '87a. *P. Daubréei.* Lem. '87a.

Gen. char.: Dentition $i\frac{2}{1}\ c\frac{1}{0}\ p\frac{2}{2}\ m\frac{3}{3}$. Median superior incisor and one lower incisor enlarged, remaining incisors and canines small or wanting. Upper molars trituberculur. Lower molars quadritubercular. Last lower molar with a third lobe.

Lower jaw. The large incisor of the type species is tricuspid but there is every shade of variation among the specimens to the unicuspid incisor found in *P. Daubréei.* Behind this tooth is a diastema. The premolars consist of a lofty cusp followed by a heel. The molars, except the last, are distinctly quadritubercular with an occasional trace of the paraconid. Upper jaw. The enlarged incisor is followed by a small lateral incisor and canine. The last premolar has a slightly reduplicate external cusp. In the molars the transverse diameter exceeds the antero-posterior, and as in *Anaptomorphus* the series is decidedly arched, the conules or intermediate tubercles are faintly developed while the hypocone is still a cingule.

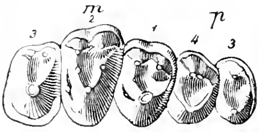

Fig. 1.
PLESIADAPIS(?) REMENSIS.
Superior molar series, about $\frac{3}{2}$ natural size.

The skull is short and relatively broad, with a deep, rounded occipital crest. The chin is rounded; the posterior portion of the jaw is large and deep with a prominent coronoid process. The skeleton is decidedly lemuroid with a freely rotating radius, a third trochanter upon the femur, the tibia arched, the phalanges long and strong, the ungual phalanges flattened and oval at the tip.

INSECTIVORA.

Dr. Schlosser (2 p. 47) has pointed out that *Adapisorex* and *Adapisoriculus* are Insectivora both in their skeletal and dental characters, and has also referred them to a new family, the *Adapisoricidæ.* The humerus is perforated. The femur has a free head and elevated great trochanter.

ADAPISOREX, Lemoine.

A. Gaudryi, Lem. '83b, type species. *A. Chevillionei*, *A. Remensis*, *A. minimus*, Lem., '83b. See also '85, Plate X.

Gen. char.: Dentition i_{2}^{-} c_{1}^{-} p_{4}^{-} m_{3}^{-}. Lower molars quadritubercular. Third molar small and without posterior lobe. Lower incisors and canines procumbent.

The characters of the lower jaw of this small insectivore indicate clearly its wide separation from the above lemuroids. The jaw is long and slender, sloping to the chin with a weak and pointed coronoid and angle. The enamel upon the first incisor is banded; the second incisor is short while the canine is reduced. The premolars increase in size, pm_4 being very prominent. The lower molars diminish rapidly from m_1 to m_3, the latter being very small and lacking the third lobe which is so characteristic of the Mesodonta; the pattern is mainly quadritubercular, the paraconid, if present, being very small.

ADAPISORICULUS, Lemoine.

The type of this genus (see '85, p. 212, Pl. XI) is much smaller than *Adapisorex* and well distinguished by the very lofty protoconid and metaconid of the lower molars. It has otherwise the same characters upon a small scale. The family relationship with *Adapisorex* is doubtful.

Decticadapis is another genus of small mammals founded upon two upper and one lower incisor teeth but not as yet well characterized.

Pleuraspidotherium and *Orthaspidotherium* have been considered in the Ungulate series by Lemoine but Schlosser is correct in placing them in the Insectivora, although I cannot agree with him in placing them near *Erinaceus*. While the molar patterns resemble somewhat those of *Erinaceus*, the complexity of the crowns of the posterior premolars removes the idea of relationship which is suggested by this resemblance. In *Centetes*, *Gymnura* and *Ericulus* we observe a similar assumption of the molar pattern by the premolars. In general, the reduction of the dental series between the median incisor and last premolar affords conclusive evidence as to the relationship of these forms to the Insectivora.

ORTHASPIDOTHERIUM, Lemoine.

Proposed '85a, p. 205.

Gen. char.: Dentition $i\frac{3}{3}$ $c\frac{1}{1}$ $p\frac{4}{4}$ $m\frac{3}{3}$. Upper molars as in *Pleuraspidotherium*. Third and fourth upper premolars with single external cusps. Inferior molars with less distinct crests, and m_3 with a third lobe. Fourth lower premolar simple with a posterior heel.

This genus is evidently related as a more generalized form to the following but is distinguished by its smaller size, simpler premolars, fuller dental series and relative absence of diastemata.

PLEURASPIDOTHERIUM, Lemoine.

P. Aumonieri, Lem. '78a, p. 15, type species. *P. Delessei*, Lem. '80a, p. 10.

Gen. char.: Dentition $i\frac{3}{3}$ $c\frac{1}{1}$ $p\frac{?3}{?3}$ $m\frac{3}{3}$. Upper molars mainly quadritubercular, with small intermediate cusps.

Lower molars quadritubercular with distinct transverse crests; third lower molar without third lobe. Third and fourth upper premolars with single internal and paired external cusps. Fourth lower premolar quadritubercular.

Upper jaw. The incisors decrease in size laterally, forming a series with the small canine, behind which is the rudimentary first premolar followed by a diastema. The third premolar is tritubercular; the fourth has in addition the trace of the protoconule and is thus evidently assuming the molar pattern. The outer faces of the para- and meta-cones are flattened with a median cingulum cusp, presenting a resemblance to the same aspect of the molars of *Pachynolophus;* only the second and third molars have developed the hypocone, and the crowns are still subtriangular. Lower jaw. The lower median incisor is small; the second incisor is large and nearly horizontal. The anterior triangle is still marked by the persistence of the paraconid.

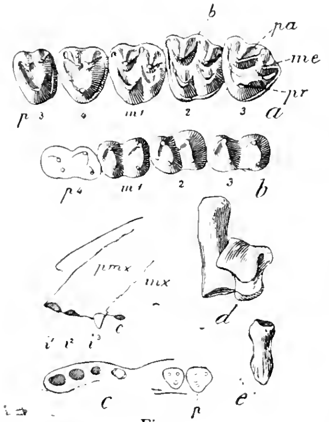

Fig. 2.

PLEURASPIDOTHERIUM (?) AUMONIERI. *a*, Superior molar series, omitting anterior premolar, x$\frac{1}{1}$. *b*, Inferior molars, omitting two anterior premolars, x$\frac{1}{1}$. *c*. Lateral and inferior views of the premaxillary region (reduced). *d*, Anterior view of the astragalus and calcaneum (reduced). *e*, Distal phalanx, association somewhat uncertain.

The skull has a strong arched sagittal crest with a broad low occiput and spreading sagittal crests. The mastoid is exposed. Dr. Lemoine describes two small bones between the frontals and nasals, also an inter-parietal. The anterior nares are small and terminal in position and the posterior nares are placed posteriorly. The proportions of the cranial and facial regions suggest those in *Didelphys.* Skeleton. The limbs are rather short. There are two sacral vertebræ (see '84b). The femur has a third trochanter and pit. The fibula is complete and the tibia articulates with the calcaneum ('84b). The astragalus has a flat trochlea and the usual foramen; the neck is long; it articulates distally with the navicular only. The calcaneum has the usual concave cuboidal facet.

The humerus has no condylar foramen. The structure of the radius indicates no power of rotation; the ulna has a well-developed olecranon process. Dr. Lemoine states that the metacarpals are shorter than the metatarsals. The phalanges spread very slightly and are cleft distally. The brain shows (see '82a) elongate olfactory lobes and hemispheres with extremely narrow frontal lobes. The cerebellum is short and extended transversely.

CREODONTA.

The following genera belong to three families. *Arctocyon* to the *Arctocyonidae*. *Hyaenodictis*, probably to the *Mesonychidae*. *Triensipiodon* cannot at present be classed. Its nearest affinities are with *Stypolophus* or *Didymictis*.

ARCTOCYON, De Blainville.

A. primaevus, De Blainville. *A. Gervaisii*, Lem. '78a, p. 7. *A. Dueilii* Lem. '78a, p. 8.

Gen. char.: Dentition i $\frac{3}{3}$ c $\frac{1}{1}$ p $\frac{-}{4-3}$ m $\frac{3}{3}$. The superior molars tritubercular with a well developed hypocone. The inferior molars quadritubercular with the paraconid usually absent. The premolars simple.

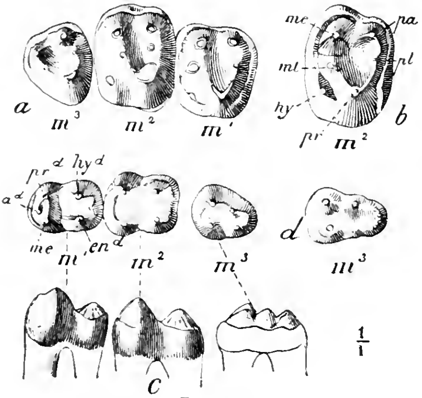

Fig. 4.

ARCTOCYON. *a*, Superior molars referred to *A. Dueilii*. *b*, *A. Gervaisii*, an unworn second superior molar. *c*, *A. Gervaisii*, inferior molar series viewed from the crown and external side, $\frac{1}{1}$. *d*. *A. Gervaisii*, last inferior molar. Abbrev.: *pr*, protocone: *pa*, paracone; *me*, metacone; *hy*, hypocone; *ml*, metaconule; *pl*, paraconule.

The general characters of this genus are too well known to require detailed enumeration here. The type species, *A. primaevus*, of de la Fère, is the oldest, largest and probably the most primitive; it has four premolars, the first premolar is one rooted. The *A. Dueilii* (type of *Heterohorus* Cope[1]), of the Cernaysian, also has four premolars; the first premolar is two rooted; the series is compact ('78, Pl. III, fig. 1) and the lower jaw is relatively short, deep and massive ('78a, p. 26). Dr. Lemoine estimates the posterior molar at c80 (antero-posterior diameter). The *A. Gervaisii* (type of *Hyodectes*, Cope[1]) is distinguished by three premolars, the elongate and rela-

[1] "Tertiary Vertebrata," p. 259.

tively shallow lower jaw; the series is less compact; the posterior molar varies in antero-posterior diameter (see *c* and *d*, fig. 5).

The actual structure of the superior and inferior molars, as shown in the accompanying figures, is of great interest as the much worn molars of the type species have always been described as quadritubercular, and the published drawings of the Cernaysian specimens have given the impression that the crowns are covered with accessory cuspules. The effect of wear upon the crown is seen in a comparison of the second upper molars shown in *a* and *b*. The latter is a perfect example of the primitive tritubercular bunodont molar with

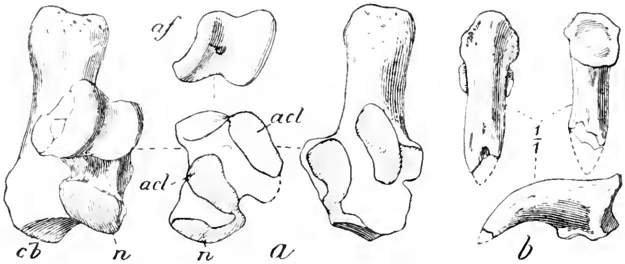

Fig. 5.
ARCTOCYON. *a*, Astragalus and calcaneum. Abbrev.: *cb*, calcaneo-cuboidal facet; *n*, astragalo-navicular facet; *af*, astragalar foramen; *acl*, *acl*, superior and inferior astragalo-calcaneal facets.
b, Terminal phalanx, superior, inferior and lateral views.

the three secondary cusps, the proto- and meta-conules and hypocone in their initial stages of development. This type is seen in *Mioclaenus* and *Miolaphus* (*Platychoerops*), but is repeated in so many different phyla that, considered independently, it forms an insecure basis for taxonomic deductions. The lower molars are mainly quadritubercular; the anterior half of the crown, or primitive triangle, is, however, prominent and in the first molar the paraconid is quite distinct.

HYAENODICTIS, Lemoine.

Proposed, '79, p. 5. *H. Gaudryi*, Lem. '85a, p. 204.

G e n. c h a r.: L o w e r m o l a r s t r e n c h a n t w i t h t w o e l e v a t e d c u s p s (protoconid and metaconid), a n d a p r o m i n e n t h e e l s u p p o r t i n g a p o s t e r i o r p a i r o f b a s a l c u s p s (hypoconid and entoconid). F o u r t h p r e m o l a r t r e n c h a n t w i t h o n e m a i n c u s p a n d t w o p r o m i n e n t b a s a l c u s p s a n t e r i o r a n d p o s t e r i o r.

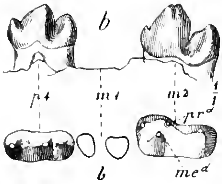

Fig. 3e.
b, Hyaenodictis, internal and superior views of the fourth premolar and second molar, x 1/1.

The molars of this genus differ from those of *Dissacus*, Cope, in the double posterior basal cusps and from those of *Triisodon*, Cope, in the less distinct separation of the internal cusps (? metaconid). They apparently agree with both the above types in the loss or reduction of the antero-internal cusp (paraconid) of the primitive triangle. There is a small cusp upon the anterior slope of the crown but this can hardly represent an element of the primitive triangle.

TRICUSPIODON, Lemoine.

Proposed '85, p. 204–5. See also '88a, p. 2.

This genus is apparently well established upon the type of a single lower molar, bearing a lofty primitive triangle with the three cusps complete. This portion resembles the tuberculo-sectorials of *Palaeonictis*, *Stypolophus*, *Didymictis*, or on a large scale the recent *Centetes* but the crown as a whole is well distinguished by the rudimentary character of the heel. This consists of a low simple cusp instead of the broad talon seen in the above genera. Dr. Lemoine has rightly recognized this tooth as closely related in form to the molars of the Jurassic *Peramus* and *Spalacotherium*.

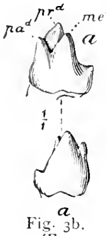

Fig. 3b.
a. Tricuspiodon, probably a first inferior molar, x 1/1.

Procyonictis (see '85a, p. 215) is founded upon a single tooth much less characteristic than the above. It is composed of a lofty main cone with anterior and posterior basal cusps. It is possibly a premolar of one of the above genera.

MULTITUBERCULATA.

NEOPLAGIAULAX, Lemoine.

N. (Plagiaulax) *eocaenus*, Lem. '80, p. 12; *N. Marshii*, '80, p. 12 (reprint). Genus established, '82b. *N. Copei*, '85, p. 213.

This well-established genus is distinguished from *Plagiaulax* and *Ptilodus* by the presence of but one premolar. Dr. Lemoine's collection embraces a number of isolated teeth, among them the upper molars. These (*c*) are composed of three rows of minute cones separated by well-worn longitudinal valleys. Each of these cones is subcrescentoid as in the upper molars of *Tritylodon*. The large upper premolar (*a*) has an indented border and is similar to that found in the maxilla of *Ctenacodon* (Marsh) with much more numerous serrations. It is difficult to form any positive opinion as to the position of the third tooth figured (*b*). It is approximately the same size as the above premolar, with one elevated row of seven marginal tubercles and one depressed row of five tubercles.

Fig. 6.

NEOPLAGIAULAX. *a*, Probably a superior premolar, referred to *N. Marshii*. *b*, *N. eocaenus*, Probably a superior premolar. *c*, A superior true molar, the posterior portion of the crown partly fractured. All figures enlarged approximately, $\frac{3}{1}$.

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MARCH 4.

The President, Dr. JOSEPH LEIDY, in the chair.

Seventeen persons present.

The death of Jacob Ennis, a member, was announced.

Hypoderas in the Little Blue Heron:—PROF. LEIDY stated that Dr. B. H. Warren had submitted to his examination some pieces of the flesh with areolar tissue and fat, from two individuals of the Little Blue Heron, *Florida cærulea*, through which were scattered a number of little egg-like bodies. These on examination proved to be a Mite of the genus *Hypoderas*, of Nitsch, of which a dozen species, found as subcutaneous parasites, in different birds, have been described by Giebel (Zeitschrift gesam. Naturwis. 1861, 438). The bodies in the Little Blue Heron were enclosed in connective tissue on the surface of the portions of muscles and elsewhere. They are white, elliptical, from 1·25 to 1·5 mm. long by 0·375 mm. broad, and are provided with four pairs of short, brown, bristly limbs. In other specimens, submitted by Dr. Warren, consisting of the carcass and portions of the flesh of four individuals of the Blue-bird, *Sialia sialis*, similar egg-like bodies were found. They appeared to be embedded in the flesh among the muscular fibers. In the carcass they were scattered, especially on the back of the trunk, the neck and the outside of the upper part of the thighs. They are white, elongated elliptical bodies from 1 to 2 mm. long, but without any external appendages. No distinct internal structure was observed. Though resembling to the naked eye the *Hypoderas* Mites, they are probably of a different nature, and perhaps may be psorosperms.

Notice of an Ichneumon Fly.—DR. LEIDY exhibited a specimen submitted to him by Dr. J. T. Rothrock, who received it from Mr. John A. Webb, of Osprey, Florida. It is a caterpillar, attached to a twig of Red Mangrove, enveloped in a mass of small white cocoons of an ichneumon fly. The mass, nearly two inches long and nearly an inch thick, contains 275 cocoons, from which were hatched as many ichneumon flies.

MARCH 11.

Mr. THOMAS MEEHAN, Vice-President, in the chair.

Sixty-three persons present.

The death of William Bucknell, a member, was announced.

On a new Bulimulus:—MR. H. A. PILSBRY exhibited specimens of a new *Bulimulus* from Texas, with examples of the already known species *B. Schiedeanus* and *B. dealbatus*. He stated that the new form while belonging to the same group, is slenderer than *B. Schiedeanus*, and is *strongly longitudinally striate*, differing in this character from all other known United States *Bulimuli*. This character will also separate it from Mexican forms of the genus. The speaker proposed to call it *Bulimulus Ragsdalei*.

MARCH 18.

Mr. HAROLD WINGATE in the chair.

Fifteen persons present.

A paper entitled "Contributions to a further knowledge of the North American Hesperidæ." By Eugene M. Aaron, was presented for publication.

MARCH 25.

The President, Dr. JOSEPH LEIDY, in the chair.

Sixteen persons present.

A paper entitled "Synopsis of the American Carbonic Calyptræidæ." By Charles R. Keyes, was presented for publication.

Fossil Vertebrates from Florida.—PROF. LEIDY stated that he had recently received from Archer, Florida, seven boxes of fossil bones and teeth, collected by Mr. J. B. Hatcher, under the direction of Prof. Marsh, by whom they had been submitted to him for examination on account of the United States Geological Survey. The collection was from the same locality from which others had been formerly sent to him through the Survey. It contains many specimens of interest but none adding to the species already announced. For the most part they consist of remains of *Mastodon floridanus*, *Rhinoceros proterus* and *Auchenia major*. Of the first there are a number of well preserved molar teeth and among them specimens confirming the observation of H. von Meyer, that in this genus two premolars succeeded the series of deciduous molars.

According to Mr. Wm. H. Dall, who visited the bone beds, the fossils are found in a tenacious clay, without pebbles, occupying depressions of the oligocene limestone of the country.

The fossils consist of isolated bones, fragments of others, and teeth, mostly of the larger and firmer kind, well preserved and neither water-rolled nor weather-worn. Portions of skulls and the hollows of Mastodon molars are usually filled with comminuted bones mingled with clay. A specimen of the skull of a Rhinoceros, with all the molar teeth of both sides retained in position, carefully removed together, in a mass of clay by Mr. Hatcher, was crushed into a multitude of fragments, which fell apart on the drying of the specimen. It would appear that the more delicate fossils were crushed while embedded in the clay; by what means was not obvious.

Thomas H. Dudley was elected a member.

The following were ordered to be printed:—

ON THE MODIFICATIONS OF THE APEX IN MUREX.

BY FRANK C. BAKER.

The embryonic apex in this group consists of from one to one and a quarter (in one instance of two and a half), polished, unvarixed whorls, which are either rounded or carinated, and are generally provided with a distinct varix at the ending of the embryonic whorl. The tip of the apex is in many of the species a little depressed and bent down on one side, and the top of the embryonic whorl is, with one exception, that of *Murex scolopax* Dillw., always rounded. The embryonic whorl is in some species sharply carinated, in others rounded with a thread-like carina, and in not a few it is simply rounded. The varix at the ending of the embryonic whorl, may be either triangular, rounded, large or scarcely visible; the presence of this varix indicates, without doubt, the point where the shell began its independent existence after leaving the egg.

The carina, when present, begins about midway of the whorl, and after traversing the whorl in an oblique direction finally terminates in the suture above the whorl below, or is continued in the lowest spiral thread of the succeeding whorl. The whorls succeeding the embryonic are generally rounded and provided with from nine to thirteen small, rounded longitudinal ribs, which in turn are usually crossed by four fine spiral threads.

In comparing specimens with the following descriptions, they should be held with the varix of the embryonic whorl toward the left hand. The aperture of the shell is no guide, inasmuch as each turn of the shell brings the apex in a different position.

In the present communication I have restricted my observations to the typical *Murex*, or *Tribulus* group.

The only author who has described the apices of *Murex*, so far as known to me, is Watson, who, in the Report on Gasteropoda of the Challenger Expedition, has given valuable remarks on several of the species treated below, as well as some others.

Genus **MUREX** Linn.

Subgenus MUREX (Sensu stricto).

Murex scolopax, Dillw. (Fig. 1).

The embryonic nucleus consists of two smooth, glossy fulvous whorls, of which the second is twice as large as the first; a carina begins at the apex and after traversing the first and second whorls in an oblique direction, finally ends in the suture above the third

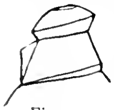
Fig. 1.

whorl. The top of the first whorl is flat; the lateral outline of the whorls descends outwardly in a straight slant to the carina, and from the carina to the suture below it slants inward. The carina of the last whorl is much lower, nearer the suture than that of the first, giving the two whorls somewhat the appearance of a stumpy smoke-stack of a locomotive.

The last nuclear whorl ends with a triangular varix where (presumably) the shell began its growth after leaving the egg; this varix is thick, whitish and semitransparent; from this point the shell continues to be nodulous until the spinose varices appear upon the fourth whorl; the suture between the first and second embryonic whorls is very distinct. There are ten longitudinal ribs to each whorl until the varices appear upon the fourth whorl.

This species is separated from *Murex occa* Sowb., by the top of the first whorl being flat instead of round, as in the latter species. The varix is triangular and well developed in *scolopax*, whilst in *occa* it is rounded and not so well developed. It is separated from *Murex tribulus* Linn., by the lateral outline of the second whorl being straight instead of rounded as in the latter species.

Murex occa, Sowb. (Fig. 2).

The embryonic nucleus consists of two nearly white, smooth whorls; the first is a little rounded knob, and the second is distinctly carinated and about twice as large as the first; the carina commences


Fig. 2.

about midway of the first embryonic whorl and continues in an oblique direction until it finally disappears in the suture above the third whorl; the lateral outline of the first whorl is rounded while that of the second is carinated as in the first whorl of *scolopax*. The carina of the second whorl is about midway of the whorl. Looking at the whorls from above they are seen to increase regularly, the succeeding whorl being twice the size of the one before it.

The last apical whorl ends with a small thread-like varix; from this varix the whorls are nodulous until the spinose varices appear upon the fourth whorl; there are nine ribs to each whorl until the spinose varices appear; the suture between the first and second embryonic whorls is quite deep; the apex is a little flattened or immersed, and bent down on one side.

This species is separated from *Murex tribulus* Linn., by the first whorl being not so compressed, the carina not so near the suture below, and in the terminal varix being low, inconspicuous and not triangular.

Murex tribulus, Linn. (Fig. 3).

The nucleus consists of about one and a half glossy, horn-colored whorls; a carina begins at the apex and continues round the apical whorl until it finally disappears in the suture above the second whorl; the lateral outline of the first part of the whorl descends outwardly in a straight slant to the carina, and from the carina to the suture below it slants inward; the outward slant is three times the length of the inward slant; the lateral outline of the second part of the whorl descends outwardly in a slight curve to the carina, and from the carina to the suture below it slants inward. The carina is situated but a short distance above the suture of the whorl below, almost concealed by the following whorl.

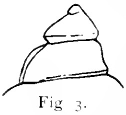

Fig 3.

The apical whorl ends with a small thread-like varix; from this varix the whorls are nodulous until the spinose varices appear upon the third whorl; there are nine ribs to each whorl until the spinose varices appear; the suture between the first and second whorls is a little impressed.

Separated from *Murex occa* Sowb., by the carina being nearer the suture below and by the varix being slightly shouldered instead of rounded as in *occa*. The lateral outline of the whorl is convex in *tribulus* whilst in *occa* it is straight.

Murex rectirostris, Sowb. (Fig. 4).

The embryonic nucleus consists of about one and one-fourth, smooth, polished, rounded whorls; a carina begins after about one-half a whorl, traverses the whorl in an oblique direction, and finally runs into the lowest spiral line of the succeeding whorl; the lateral outline of the whorls shows a more or less rounded appearance; the carina runs just above the suture of the whorl below; the top of the whorl is rounded. The last apical whorl ends with a distinct, well-devoloped, horn-colored varix, succeeded by three rounded, high whorls of slow increase, each crossed by about fourteen small, rounded ribs, and having four spiral cords; the spinose varices appear upon the fifth whorl; the suture between the embryonic whorls is impressed.

Fig. 4.

Separated from *Murex recurvirostris* Sowb., by the more oval outline of the first part of the first whorl and by the carina being nearer the suture in the latter species. It is also more depressed in form than that species.

Murex brevispina, Lam. (Fig. 5).

The nucleus consists of one and a half rounded, polished, brownish whorls, of which the first part is a little rounded knob becoming larger and acquiring a sharp spiral carina which encircles its base; the carina begins about midway of the whorl, and finally runs into the lowest spiral line of the succeeding whorl. A lateral view shows a rounded outline; the top of the whorl is rounded; the tip is a little depressed.

Fig. 5.

There is no decided varix at the end of the embryonic whorl; the ribs of the succeeding whorls commence abruptly and continue until the spinose varices appear upon the third whorl; there are about ten small, rounded ribs to each whorl. These whorls are shouldered and have a spiral thread below the shoulder; the sutures are distinct.

This species is separated from *Murex nigrispinosus* Reeve, by the whorl being more depressed.

Murex nigrispinosus, Reeve (Fig. 6).

The embryonic nucleus consists of about one and a half polished, rounded whorls; the first is a little rounded knob, and the second is provided with a fine, thread-like carina close to the suture below; the lateral outline of the whorls descend outwardly in a curve to the carina, and from the carina to the suture below it slants inward in a straight line; the second whorl is but little higher than the first.

Fig. 6.

The last apical whorl ends with a thread-like varix, after which they are succeeded by about two unarmed, high, unvarixed, rounded whorls of slow increase, each crossed by thirteen small, rounded, longitudinal ribs and scored by four fine, spiral lines; the spinose varices appear upon the fourth whorl; the suture between the first and second embryonic whorls is distinct.

Separated from *M. brevispina* Lam., by its more elongated form and less impressed suture.

Murex ternispina, Lam. (Fig. 7).

The nucleus consists of one and a half brown whorls; a carina begins near the end of the last embryonic whorl and runs into the lowest spiral thread of the succeeding whorl; this carina is a very faint thread and is scarcely noticeable unless looked for very closely; the lateral outline shows a very decided rounded appearance; the extreme point of the embryonic whorl is a little depressed and bent down on one side.

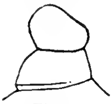

Fig. 7.

There is no varix at the end of the embryonic whorl; the succeeding ribs commence gradually even before the end of the embryonic whorl, and slowly increase in size until the spinose varices appear upon the fourth whorl; there are nine ribs to each whorl and these are crossed by four fine, spiral lines; the suture between the embryonic whorls is impressed.

This species is separated from its congeners by the presence of a thread-like carina near the ending of the embryonic whorl.

Murex tenuispina, Lam. (Fig. 8).

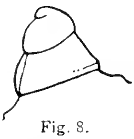

Fig. 8.

The embryonic nucleus consists of two faintly yellowish-white whorls; the carina is quite close to the suture of the whorl below and is almost concealed.

The varix at the end of the nucleus is small and rounded; this is followed by close set, rounded ribs which continue until the spinose varices appear upon the fourth whorl; there are nine of these ribs to each whorl crossed by four fine, spiral lines; the suture between the embryonic whorls is impressed.

This species is separated from *Murex brevispina* Lam., by the less rotund outline of the first embryonic whorl and by the outline of the second being straight instead of rounded as in *brevispina*.

Murex recurvirostris, Sowb. (Fig. 9).

The nucleus consists of about one and a half rounded, polished, brownish whorls, of which the second part is but little larger in outline than the first; a lateral view of the outline shows a rounded appearance; the top of the first part of the whorl is rounded; the tip of the embryonic whorl is depressed and a little bent down on one side; a carina commences near the last half of the apical whorl and runs into the lowest spiral thread of the succeeding whorl.

Fig. 9.

The varix at the end of the embryonic whorl is scarcely larger than the succeeding ribs; after the varix the whorls continue to be nodulous until the spinose varices appear upon the fourth whorl; there are about thirteen small, rounded ribs to each whorl, crossed by four spiral threads; the suture is impressed.

Separated from *Murex rectirostris* Sowb., by the more rounded outline of the first part of the embryonic whorl and the absence of the shoulder upon the second part.

Murex similis, Sowb. (Fig. 10).

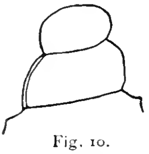
Fig. 10.

The nucleus consists of one and a half whitish, smooth, rounded whorls; the lateral outline shows a rounded appearance; the first part of the whorl is a little rounded knob.

A sharp and well-defined varix appears at the end of the embryonic whorl, and this is followed by a number of high, rounded ribs, which cease at the appearance of the spinose varices upon the fourth whorl; there are thirteen of these ribs to each whorl crossed by four fine, spiral lines.

This species is separated from *Murex ternispina* Lam., by the absence of the thread-like carina near the ending of the embryonic whorl. The sutures are not so deep as in the latter species.

Murex tryoni, Hidalgo.

Upon examining this shell I was much surprised to find that it had an apex identical with that of the preceding species. This may prove to be but a variety of *M. similis* as was thought by Dr. Dall.

Murex cailleti, Petit.

The embryonic apex of this species is identical with both *similis* and *tryoni*. I have not been able, through lack of perfect specimens, to examine the apex of the typical *motacilla* of Chemnitz.

Murex aduncospinosus, Beck. (Fig. 11).


Fig. 11.

The nucleus consists of 2½ blunt, conical, glossy, fulvus, flat-sided whorls, which increase regularly from the apex; the last whorl is margined below by a very fine thread just at the suture; the lateral outline shows a cone of about two regularly increasing whorls, of which the second is twice as large as the first.

There is a rounded varix of considerable size at the end of the last embryonic whorl after which they are nodulously ribbed until the hollow spines appear upon the sixth whorl; these are crossed by four fine, thread-like spiral lines; the sutures of the embryonic whorls are distinct. This is the largest apex of the *Tribulus* or typical *Murex* group.

The present species differs wholly from all the other members of this group in having two and one-half whorls instead of one as in those hitherto described. The whorls are of a glassy texture, a feature not possessed by the other members of the group.

ON ARENICOLA CRISTATA AND ITS ALLIES.

BY J. E. IVES.

During the month of July of last year, my friend Mr. Uselma C. Smith collected some specimens of a polychaetous worm, belonging to the genus *Arenicola* at Anglesea, about ten miles N. E. of Cape May, on the New Jersey Coast. The first specimens seen by him lay upon the beach, apparently dead, having perchance left their burrows in the endeavor to reach the water. Upon further examination he discovered a large colony concealed in the sand, along the edge of a pool of water formed by the washing over of the sea. Four of these specimens were obtained and subsequently handed over to me in alcohol for identification.

They correspond closely to *Arenicola cristata* described by Stimpson[1] in 1856 from Charleston, South Carolina, and which, with a doubtful exception,[2] has not since been reported from the United States. In his recent paper "On *Arenicola* specimens from the Gulf of Naples," Dr. R. Horst[3] has given a detailed account of this species from specimens obtained in the Mediterranean. The forms from Anglesea answer both in general and microscopical characters to Dr. Horst's description, the only difference being that they possess on the ventral surface of the caudal segments small papillæ, which will be referred to again later. Dr. Horst has suggested the identity of this species with *Arenicola antillensis* described by Lütken[4] from the West Indies, and upon examination I find that the New Jersey specimens correspond as closely as possible to Lütken's description. As already stated, there are on the ventral surface of the caudal segments small papillæ, and these doubtless represent those observed by Dr. Lütken in *Arenicola antillensis*. These papillæ, however, Dr. Horst did not find in the Mediterranean specimens, but their presence or absence should not, in my opinion, be considered a specific character. The length of the longest specimen is about 250 mm.

[1] Proc. Bost. Soc. Nat. Hist., Vol. 5, p. 114.

[2] Webster, "Annelida Chætopoda of New Jersey," 32d Ann. Rep. New York State Mus., 1879, p. 117.

[3] Notes from the Leyden Museum, Vol. xi, p. 43.

[4] Vidensk. Meddel. fra Naturk. Forening i Kjöbenhavn, 1864, p. 120.

In the collection of the Academy are six specimens from the Manatee River on the West Coast of Florida, which, although presenting some slight differences, I regard as a variety of *Arenicola cristata*. They have no papillæ on the ventral surface of the caudal segments; the distal ends of the ventral bristles are not serrated and the secondary branchiæ have fewer tufts and are less regularly arranged. The specimens are small, the longest about 140 mm. in length, and may be immature. Ehlers[1] in his work on Florida-Annelids has already recorded this species from Florida under the synonym of *Arenicola antillensis.*

On account of the impossibility of drawing any sharp lines of demarcation between the forms from the Mediterranean, New Jersey, Florida and the West Indies, I venture to believe that they must be regarded as representing one species, having an unusually wide distribution.

From my study of the other species of the genus in connection with these forms from the New Jersey coast, I incline to the view put forward by Dr. von Marenzeller,[2] who, not including *Arenicola cristata* and its synonym, *Arenicola antillensis,* reduces all the species of the genus to two:—*Arenicola marina,* L. and *Arenicola ecaudata,* Johnston. The sixteen species of the genus which have been described may therefore be reduced to the following three:

Arenicola marina L. 6 prebranchial and 13 branchial segments, secondary branchiæ with 3 or 4 pairs of lateral tufts. Europe, Greenland, New England, Vancouver Island, Mediterranean, South Africa, Chili (Coquimbo).

Arenicola ecaudata, Johnston. 11–15 prebranchial and 13–40 branchial segments; secondary branchiæ, arborescent.

Europe, Mediterranean, Black Sea.

Arenicola cristata, Stimpson. 6 prebranchial and 11 branchial segments; secondary branchiæ, plumose.

West Indies, Florida, South Carolina, New Jersey, Mediterranean.

The occurrence of *Arenicola marina* on the northwest coast of Alaska renders it probable that it will also be found upon the arctic shores of Europe and Asia. From northwest Alaska it has undoubtedly passed southward to Vancouver Island through Behring Strait, the western Gate of the North. Its distribution north and

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1 "Florida-Anneliden," Mem. Mus. Comp. Zool., Vol. xv, p. 173.

2 Zoologische Jahrbücher, Bd. 3, pp. 12–15.

south of the Tropics is very anomalous, but future study of the intervening regions may throw some light upon the subject. The presence of the three species in the warm waters of the Mediterranean is interesting, and worthy of note.

Our present knowledge of the distribution of the species of the genus may be summarized as follows: *Arenicola marina*, occurs in the temperate seas of both hemispheres, and in the arctic seas of the north; *Arenicola ecaudata* is confined to the temperate seas of Europe, and *Arenicola cristata* is found in the temperate and tropical Atlantic, and in the Mediterranean.

References to the complete literature of the subject will be found in Quatrefage's "Histoire Naturelle des Annelés," and in the papers by Drs. von. Marenzeller and Horst, already referred to.

NOTES ON THE GENESIS AND HORIZONS OF THE SERPENTINES OF SOUTHEASTERN PENNSYLVANIA.

BY THEODORE D. RAND.

Except the serpentine and steatite of Chestnut Hill, north of Easton, Pa., the outcrops considered in these notes lie not far from the Laurentian anticlinal which enters the State at Morrisville, opposite Trenton, N. J., and extends in an almost unbroken belt to the Maryland line. In width it varies. Generally narrow northeast of the Schuylkill, but usually a prominent ridge, it sinks near Abingdon to appear again southwest of Jenkintown for two or three miles. At Chestnut Hill and the Wissahickon it again disappears for a short distance, rising again to great elevation (350–400 feet) with a width of nearly a mile at the Schuylkill.

Mr. Hall's map shows the Laurentian crossing the Wissahickon on the southwest flank of Chestnut Hill, Philadelphia, northwest of Thorp's lane, and Dr. Hunt[1] speaks of the schists appearing on the *north* side of the narrow Laurentian belt at Chestnut Hill. I have been unable to find a trace of Laurentian along the Wissahickon or at Chestnut Hill except on Paper Mill Lane on the northwest flank of Chestnut Hill.

Southwest of the Schuylkill it preserves its elevation, its summits nearly or quite 500 feet above tide, and it widens, until at Darby Creek it is at least three miles wide, and north and south of Newtown Square at least six, though in this longitude there may be included some schist areas; but the margins at Devon Inn, and south of Berwyn, on the north, and Sycamore Mills on the south, are well defined and exhibit the steep slopes with abundant outcrops so characteristic of this group. Southwest of this the northerly margin trends about S. S. W., passing West Chester one mile north of the Court House, while the southerly margin, defined between Ridley and Chester Creeks along Dismal Run by a precipitous hill of 200 to 300 feet elevation, becomes ill defined, but as observed by Prof. Rogers[2] probably takes a direction nearly west through or near Howellville, Delaware Co., and Westtown, in Chester Co., the belt narrowing to less than three miles.

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[1] Min. Phys. and Phys: p. 437.

[2] 1st Geol. Survey of Pa., Vol. 1, p. 77.

Mr. Hall regards the rocks along Chester Creek from a mile south of Lenni to Cheyneys station, except a narrow belt at Glen Mills, as Laurentian underlying the schists and exposed by the deeper erosion along the creek,[1] but they are so unlike any of the rocks in the admitted Laurentian belt and bear so close a resemblance to the harder gneisses of the Manayunk series that I believe Prof. Rogers' observations to be correct and that the Laurentian is included between gently curved and almost straight lines and that it does not present the contorted outline shown on Mr. Hall's map. These rocks are more fully described in connection with the Glen Mills serpentine. In the northwesterly boundary also of the Laurentian my observations confirm those of Prof. Rogers. Mr. Hall's map makes a schist area overlie the Laurentian from Bryn Mawr to Wayne.[2] In this area, I have described[3] many outcrops of typical Laurentian, well exposed, with not a trace of the schists west of Rosemont except the narrow belt on the northwest of the Laurentian along the bottom of Cream Valley.

To define these areas more exactly will require very close and careful observations of excavations hereafter made, for the covering of soil in many places is so great that only thus can the underlying rocks be known.

This Laurentian belt is the third of Prof. Rogers. Immediately southeast of it lies his second belt, and southeast of the second his first. Of these he writes, and most accurate are his descriptions:—

THE FIRST or most southern general division or group, may be approximately defined as extending from the lowest exposures on the river, or those near Gray's Ferry, to the upper end of Manayunk: the second or middle belt, extending from Manayunk past the serpentine and soapstone range to a line a little north of the upper boundary of the County or City of Philadelphia; and the third or northern extending thence to the northern edge of the whole gneiss formation, and it is overlaid or limited by the older primal rocks in the vicinity of Spring Mill.

FIRST BELT. The southern or Philadelphia belt contains the following chief descriptions of ordinary gneissic rock, with many subvarieties. The most common or typical variety of all is the gray, bluish, rather finely laminated triple mixture of quartz, feldspar and mica, the quartz for the most part, white or transparent; the feldspar usually white, and very generally somewhat chalky from incipient decomposition; and the mica most commonly black or dark brown and in small plates. This rock occasionally includes small insulated garnets.

The next most common species is a dark bluish-gray, sometimes greenish-black gneiss, composed of hornblende and quartz, with sometimes a little feldspar, the hornblende always greatly predominating. The rock is very usually fine grained and thinly bedded, its fracture and structure being controlled by the general parallel crystallization of the prevailing hornblende.

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[1] 2nd Geol. Survey of Pa., C^5 p. 2.

[2] C^5 22.

[3] 2nd Geol. Survey of Pa., An. Rep. 1886, IV, p. 1573, etc.

A third common variety of the gneiss of this group is a micaceous quartzose rock, generally of a light gray color. Some beds of this species contain such a predominance of the crystalline quartz, in minute granular divisions, and such a subordinate amount of minutely disseminated mica, as to have a character of ordinary gray whetstone; but this species of the gneiss is much more abundant in the middle belt than in the southern one. A much coarser kind of gray micaceous gneiss, consisting of a predominance of rather large flakes of mica, with a subordinate quantity of feldspar and quartz, occurs interstratified with all these other species, as a very usual transition variety between the standard gray gneiss and the highly micaceous kinds verging toward mica-slate.

It is very usual to find the typical gneiss, of a three-fold constitution, alternating with the hornblende species, and both of these alternating with the quartzose micaceous variety. As a general fact, not without exceptions, however, the more micaceous the rock is, the greater is the abundance in insulated crystals of common garnet.

Interposed among the above varieties of true gneiss are beds, more or less thick, of kinds so abounding in mica as to be entitled to the designation of true mica-slate. This rock prevails in two or three outcrops, both above and below Columbia Bridge, and it may be stated generally, that the further north we advance across the southern division of the gneiss, the larger is the proportion of the more micaceous varieties of the ordinary gneiss, and the greater the frequency of these bands of mica-slate.

An interesting variety of the ordinary or more feldspathic kind, is one containing large, more or less insulated segregations of crystalline feldspar, the longer axes of whose crystals lie generally parallel with the lamination of the rock. This variety may be designated as a porphyritic gneiss, having that feature of an excess of crystalline feldspar which is accepted by geologists as a distinctive character of the porphyritic rocks and being, moreover, essentially similar to those well-known and beautiful granites which geologists agree to call Porphyritic.

A band of this porphyritic gneiss occurs at the Falls of Schuylkill, just below the quarries, and ranges toward Nicetown in one direction, and toward the tollgate at the Lancaster Road, five miles west of Philadelphia, in the other. Another outcrop of the same feldspathic variety of the gneiss may be seen crossing the West Chester Plank Road just east of Darby Creek.

THE SECOND OR MIDDLE BELT. The middle zone of the gneiss of Southern Pennsylvania, as it crosses the Schuylkill, consists of an alternation of four principal varieties. Perhaps the most abundant of these is a very micaceous species of the ternary or mica, quartz and feldspar rock, holding garnets in greater or less profusion. A very common feature in this rock is a wavy or minutely undulated lamination, arising apparently from a contorted or wavy structure in the coarsely crystallized mica, its predominant mineral. This would seem to proceed from the interference of the innumerable planes of cleavage, or—what is the same thing—of crystalline lamination, with the original planes of the deposition of strata. The twisted forms of the flakes of mica are frequently seen to be due to the displacing effect of grains, or crystalline bunches of included quartz. It would seem as if these minerals had crystallized or segregated, from their parent sedimentary materials, under a conflict of forces, the newly awakened crystalline energies being not always parallel to the original bedding of the deposit, but more frequently oblique to it.

Perhaps the most common subdivision of the gneiss of this middle tract is a variety consisting almost exclusively of the above described wavy mica. This rock graduates into the more micaceous sorts of gneiss, by containing a less or greater mixture of finely granulated crystalline quartz or feldspar or hornblende. The southern half of the gneissic zone before us is characterized on the Schuylkill and Wissahickon, by containing an alternation of the above two varieties of micaceous gneiss or mica-slate, with beds of hornblende gneiss, the last-named rock being, from its thin lamination, sometimes entitled to the name of hornblende slate. The northern half of the zone consists largely of a fourth variety of the more schistose class of the gneissic rocks. This is a gray fine grained binary mixture of granular quartz and minutely crystallized scales of mica, the quartz being the prevailing element. It is a species of whetstone and some of the more quartzose bands would furnish masses well suited for employment as whetstones for scythes. A very common, indeed a characteristic of this quite remarkable and extensive division of the micaceous gneiss group, consists in its peculiar fracture; the rocks breaking into long narrow chunks, comparatively smooth on their sides, but excessively ragged on their ends; a style of fracture strongly resembling that of half rotted fibrous wood. This peculiar rock is in greatest force toward the northern side of the middle gneiss belt, or between the serpentine or steatite, and the hard feldspathic gneiss of the southern margin of the third or northern gneissic belt. It is interstratified toward its southern side, with more or less frequent and thick bodies of the other variety of mica slate possessing mica in large and twisted scales, with an abundance of garnets. On its northern side it alternates to some extent with a greenish talcose slate, or, what is the same thing, the talc in this quarter replaces the mica in whole or in part in certain divisions of the group."

There is probably in the rock termed by Rogers "altered primal" (whatever may be its geological age) a key rock, for this seems to lie quite persistently along both edges of the Laurentian though only occasionally visible. West of the Schuylkill it is well exposed, but it may be seen also at Willistown and near Westtown, Chester Co. It is thus described by Prof. Rogers, p. 154:—

"In the district of the Schuylkill and Wissahickon, the three members of which the primal series there consist, present the following aspects and dimensions:

The lowest or semi-porphyroidal group, evidently an altered sandy-slate or argillaceous sandstone, is remarkable for the regular parallelism of its lamination and bedding; the laminæ alternately light and dark, being exceedingly thin, many of them usually packing within the thickness of an inch. These laminæ consist, where the rock wears its most metamorphosed form, of white earthy imperfectly developed feldspar, and perfectly developed hornblende. Besides these alternate whitish and dark streaks, the cross fracture of the rock displays a multitude of ovoidal concretionary crystallizations, generally only specks in size, but sometimes of the dimension of bullets, the larger and better formed concretions being frequently genuine crystals of feldspar. In some of the layers certain laminæ are studded with isolated crystallizations of hornblende." 1st Geological Survey of Pennsylvania, Vol. 1, Page 68.

Mr. Hall divides Rogers' first and second groups into three, inserting a belt (the Manayunk schists) between Rogers' first and second [1] and states that it contains "alternations of the varieties of gneiss characteristic of the first belt and a predominance of sandy gneiss composed of quartz and a small amount of feldspar and mica in minute flakes. Mica schists and hornblendic slate alternate with finer grained gneisses, the mica usually light colored." He further states that it includes part of Rogers' second belt.

It is possible that this arises from a misunderstanding of Prof. Rogers' use of the term "upper end of Manayunk," which is evidently used loosely. Rogers says "approximately defined." In-

[1] 2nd Geol. Surv. Penna. C^6 p. 2.

asmuch as just above Manayunk the more massive and less garnetiferous schists of the first belt are well exposed, while about two miles above the centre of Manayunk the rocks of his second belt occur in most characteristic form, is it not most probable Prof. Rogers intended to refer to this point, especially, as when he wrote there was no well known place nearer than Manayunk? Mr. Hall's term, however, is convenient, but I regard it, and use it in these notes, rather as a synonym for all of Rogers' first belt except the Fairmount gneiss, and the porphyritic gneiss.

By far the best exposure of these rocks as described is along the Schuylkill, but the structure is far from clear. The Fairmount gneiss, identical with the gneiss at the Chester, Leiperville and Avondale quarries is generally supposed to underlie the more micaceous rocks to the northwestward, yet almost everywhere is a pretty uniform northerly dip. There are alternations of soft highly micaceous schists passing by an increase of quartz and feldspar and decrease of mica into gneissoid schists and gneiss, also hornblende schists and gneisses, but in no case, except perhaps northwest and southeast of the porphyritic gneiss can a repetition be found to prove the apparent monoclinal to be, as it has been supposed to be, a succession of compressed synclinals and anticlinals.

To the southeastward, the rocks as a rule are highly micaceous, and in these the Fairmount gneiss appears to rise as an anticlinal. In the cut of the Pennsylvania Railroad, about 33rd Street, the southeasterly dip at a moderate angle was clearly shown; the northwesterly edge has not been uncovered, but the strata were nearly horizontal and were succeeded by mica schist within a hundred yards.

The mica schists are visible southeast of the Fairmount gneiss, with gentle undulating dips, on the west side of the Pennsylvania Railroad near Powelton Avenue, and on both sides, at the approach to the tunnel at 31st and Market Streets; northwestward of the Fairmount gneiss are alternations of mica schists, micaceous gneiss, hornblendic gneiss and allied rocks to the Falls of Schuylkill.

On the Schuylkill a short distance west of the Girard Avenue bridge there was exposed a rock, mica schist on the outside, hornblende schist within, and the passage of the one into the other was evident. At the quarry (now a coal yard) on the Germantown road at the crossing of the Germantown branch of the Reading Railroad, a similar change was apparent, the micaceous mineral here being the Philadelphite. May not these occurrences throw light upon the fact that the hornblende rocks are more abundant in the deeper valleys and upon the remarkable alternation of hornblende schist and mica schist?

At the Falls of Schuylkill we find the porphyritic gneiss before spoken of. This porphyritic gneiss Mr. Hall does not mention. Prof. Rogers regards it as a mere alternation, but its great difference from any other of the rocks of the region, its surprising uniformity over long distances, both with and across the strike, in a region in which the alternations are as numerous as in this, as well as the fact that it widens rapidly southwestward, preserving all its characters, points to it as more than a mere stratum.

On the east side of the Schuylkill its visible width is not over two or three hundred feet. On Cobb's Creek it is nearly four miles. Its visible length is over eight miles; the southwesterly part much covered with soil.

On Cobb's Creek it is very well exposed. The southerly part is most porphyritic; in the central parts, and north of the centre, schists appear with characters of the Manayunk, and also of the Chestnut Hill series, while to the northwest the true porphyritic hard gneiss is well exposed about a quarter of a mile from the Chestnut Hill schists, near St. Denis Church, with no Manayunk schists visible intervening.

The hardness of this rock makes it everywhere prominent, and next to the Laurentian ridge, it is by far the most distinct formation of the region. While at the Schuylkill apparently monoclinal, and interstratified in the mica schists, I am disposed to regard it as an anticlinal, and at Cobb's Creek as two anticlinals, with an included synclinal of the schists. On each side of it, the schists exhibit certain peculiarities alike on both sides, and on the northwest side near Wynnewood, and on Cobb's Creek, it appears to dip beneath the schists.

In this porphyritic belt there is granite, unlike any other granite of the region. This granite is usually very coarse, composed of a flesh colored orthoclase and a peculiar chalk-white feldspar apparently not at all decomposed, but with very little lustre. It contains but little mica and quartz, much the larger part being the two feldspars, and it seems to be in small segregated masses in the schists rather than in beds or veins. Part of it is schistose. Sometimes it is a graphic granite, the structure developed by weathering and not conspicuous otherwise. Rarely it contains tourmaline, and no other mineral so far as I have observed, thus differing greatly from the granite of the Fairmount gneiss.

Some narrow bands of this gneiss are not porphyritic and are a very fine grained hard gneiss. Near Merion Station, Pennsylvania Railroad, one stratum closely resembles the helleflinta of Dannemora. In the old quarry at the Falls of Schuylkill, immediately west of the stone bridge of the Reading Railroad there was quarried a gneiss, somewhat resembling the Fairmount gneiss, but porphyritic, which the Fairmount gneiss is not. The Falls rock contains more feldspar and much less mica, and is much more compact.

In a quarry on the west bank of the Schuylkill, about a quarter of a mile above the Park bridge, at the Falls, a great variety of rock may be seen, and it is not certain whether this quarry is in the porphyritic belt, or in the Manayunk gneiss. There is much coarse granite like that of the porphyry, also highly feldspathic gneiss like that of the lower quarry, but some beds show the mica so abundant as to make a true mica schist, and the curved and twisted feldspathic layers hereafter referred to are found. In this quarry, pyrite and magnetopyrite occur with epidote which appears to be changing into hornblende.

On both sides of the porphyry, at the Schuylkill and west of it, the rocks are not essentially different. On the southeast they are somewhat softer and more evenly bedded and hornblende schist is more abundant, but in both there is the same evidence of folding and contortion, particularly exhibited by certain narrow feldspathic veins or beds, compressed sometimes to less than one-sixth their original length. So far as this region is concerned, this seems to be confined to the schists lying on each side of the porphyritic gneiss, and, on Cobb's creek, within it. It is in these schists that the serpentine rocks of Cresheim creek on the Wissahickon occur and also probably all, or nearly all, of the southerly Delaware county outcrops. While the Manayunk schists contain garnets they are not abundant, but often large.

There is one gneiss in Philadelphia which presents many points of difference from the other schists and gneisses of the region. This is the Frankford gneiss, best exposed at the quarries on Frankford creek. This gneiss is distinctly stratified. It contains comparatively little mica and hornblende, some specimens are strictly felsite and granulite. It is extremely hard and of even texture making excellent paving stone when properly broken for that purpose. Its granite veins, or more properly segregations, are chiefly orthoclase which contains at times Göthite in minute crystals; muscovite occurs in the granite, but not in large quantities, also a highly lustrous black mica, which Prof. Lewis determined to be lepidomelane.[1] The gneiss is considerably jointed, and many of these joints are filled with stilbite in radiated crystallizations. Heulandite and apophyllite, the latter in very fine specimens, also occur in these joints.

Calcite occurs in small quantity apparently filling joint fissures, and in the calcite, fine crystals of epidote. Copper minerals occur, also molybdenite, at times abundantly, and sometimes in remarkably fine crystals showing the planes of the dome as well as the prismatic planes, perfectly bright and sharp. Sphene and uranium minerals occur, but the Autunnite so common in the Fairmount and Chester gneiss has not been detected, while sphene and molybdenite have not been found in the Fairmount gneiss.[2] The strike of this gneiss is nearly due west, and outcrops of it occur at Wayne station, Germantown, and at McKinney's quarry on the Wissahickon. The late Prof. H. Carvill Lewis regarded this gneiss as "a highly metamorphosed intrusive dyke of Lower Silurian age." [3]

There is another rather insignificant outcrop of a rock which does not fall within the description of any of the group, exposed on the Pennsylvania Railroad at 59th Street. It is chiefly a very compact felsite when not weathered, but some portions seem to be a mica schist. It is peculiar in containing a large percentage of pyrite, in some of the beds causing rapid disintegration on exposure, while others equally pyritiferous, but more compact, are perfectly stable. It apparently occupies a synclinal just southeast of the porphyritic gneiss, the axis of the synclinal pitches downward northeastward about thirty degrees.

The rocks of Rogers' second group, Mr. Hall's Chestnut Hill schists, are in certain areas very well marked, especially the garnetiferous variety, and that in which the wood-like structure is most developed, but there are areas difficult indeed to distinguish from the Manayunk schists. This may be well seen along the Wissahickon where the exposures are excellent yet no line can be drawn between the two, and in the Chestnut Hill schists, at Middleton's quarry, about

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[1] Proc. Min. and Geol. Sec. A. N. S. No. 1, p. 11.

[2] Molybdenite however occurs at Upland near Chester, perhaps in the Fairmount Chester gneiss.

[3] Nature, Oct. 8, 1885, p. 560.

1000 feet northwest of Thorp's Lane and the steatite belt, is a bed of porphyritic granite, or granulite, clearly interstratified in the schists. Just below Thorp's Lane the peculiar contorted structure is well shown.

It is in these Chestnut Hill schists that the soapstone or steatite belt is found, and these rocks bound it on both sides, though at the Soapstone quarry on the northeast bank of the Schuylkill, at considerable depth, there was a hornblendic gneiss as the southeast wall, which, next to the steatite, passed gradually into chlorite.

It is to these schists that I understand Mr. Hall to believe[1] that all the serpentines of the district are confined (except the Cresheim Creek, the Flushing and the steatite of the northerly Radnor belt near Gulf Mills) and it is these which he continues along the line of the Pennsylvania Railroad from the Lafayette belt at Rosemont to the Radnor belt at Radnor station so as to include them both. But I have shown that this region is Laurentian and that schists are absent.[2]

Mr. Hall suggests that Mill creek may be the boundary between the Manayunk and Chestnut Hill schists, but it is remarkable that though Mill creek rises in these soft schists and the slopes of the Laurentian bordering them to the northwest, it crosses the border into the harder rocks and has cut through them a deep narrow valley to the river, close to, but S. E. of, the border line of the soft schists.

In the Chestnut Hill schists, west of the Schuylkill, are strata of white quartz becoming rusty on exposure. Seen occasionally in place, as on the Roberts road, and in the Railroad cut at Bryn Mawr, they are more frequently the only rock in the soil, and sometimes are very abundant, affording a guide to these schists, where they have decomposed out of sight, but not a certain guide, for in some places, as north of Morton, they seem to overlie the Manayunk schists. Perhaps the Chestnut Hill schists did overlie, and have been eroded, the hard quartzite only being left. This quartz occurs in large quantity at the narrow exposure of the schists in Marple.

Southwestward of the Schuylkill the divisions given above are not so distinct. The section on Cobb's Creek shows the porphyritic gneiss within a quarter of a mile of the soft garnetiferous schists, but here rocks, apparently of the Manayunk series, but much resembling

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[1] C^6 p. 3.

[2] 2nd Geol. Survey of Pa., An. Rep. 1888, Part iv, p. 1573.

some of the Chestnut Hill rocks, occur between outcrops of the porphyritic gneiss, all dips seeming to be northerly. Among the schists there are outcrops of a granite differing from that of the Fairmount gneiss as before described.

Examining the section exposed along Darby creek, we find mica schists and gneisses of the Manayunk varieties, both feldspathic and hornblendic; indeed some of the hornblendic variety is almost entirely hornblende with a little quartz, or a diorite. The porphyritic gneiss occurs, and not far from it the soft mica schists, here in many of the beds, little more than granular quartz with a little mica forming whetstone, but in these occur beds of hard granitoid gneiss and of hornblendic gneiss.

Along Crum creek we find at Avondale an outcrop of the Fairmount gneiss well exposed by quarries, it being the most valuable building stone of this part of the State and at this point and on Ridley creek can be well seen the segregated masses of coarse granite which have here, as well as at Fairmount, yielded to mineralogists fine cabinet specimens of interesting minerals most of which are confined to this stratum.

Above this, near Swarthmore, is a considerable exposure of micaceous gneiss and mica schist, some of it very compact and hard and some of it containing garnet and andalusite. In this neighborhood occur also hornblendic schist and gneiss in considerable quantity. Northwest of this is the most westerly outcrop of the porphyritic gneiss of which the writer is aware. It is on the road leading north from Morton station one hundred yards north of the turnpike and about a mile from Morton. The strike is N. 10° W. dip 75° N. E. North of this are decomposed schists, with no good exposures. The strike near Trout Run was N. 10° E., the dip 30° to 60° S. E., and the schists were apparently of the Chestnut Hill group. Here, interbedded in the schists, are narrow beds of a syenitic gneiss which seems to be characteristic of this horizon. Rarely seen in place, it is found southeast of the Laurentian from the Schuylkill to Crum Creek strewn over the fields and along the roads, conspicuous by reason of the hornblende in it being very evident on the exposed surfaces as small crystalline masses, and by its invariably undecomposed condition. It occurs also northwest of the Laurentian in schists on the property of the late Moro Phillips, about half a mile from the Schuylkill on the southeastern side of Cream valley near Conshohocken. I have observed this rock in place in three localities only, that on Trout Run, on the Roberts road at the crossing of the old Lancaster road, and at Moro Phillips'. In none of these were the outcrops over two or three inches wide.

On Crum creek the porphyritic gneiss has not been observed nor the Chestnut Hill schists, though the latter may be under cover northwest of Palmer Mills. The visible rocks seem all to be of the Manayunk group.

Along Ridley creek the Fairmount gneisses are exposed and have been largely quarried. On the right bank near the road from Philadelphia to Chester there is a large quarry in hornblendic gneiss directly opposite (about one-eighth of a mile west of) two of the largest quarries in Fairmount gneiss. Above this are schists and gneisses similar to those along Crum Creek, except that north of Media, and also northwest of Media, enstatite appears in the schists. The softer Chestnut Hill schists with their garnets and ragged fracture are not to be recognized. It appears probable that they narrow in Marple township so as to occupy but two or three hundred feet, between the enstatite-serpentine near the Marple Barren Hill school house, and the antholite-serpentine to the south-east and that they then disappear. The exposures however are poor, and this is not certain.

Along Chester Creek, similar Manayunk schists and gneisses occur, but more massive, and harder, containing more feldspar, hornblende and quartz and less mica. From Bridgewater Station northward, hornblendic gneiss increases in quantity and the feldspathic gneisses become harder and more massive, but everywhere they are more or less schistose and distinctly stratified, and do not at all resemble the Laurentian of the Radnor-West Chester belt, which, with all its distinctive characters, is found within two miles of them east of Glen Mills.

Occasional hand specimens resemble some of the Laurentian, but in the field the differences are striking.

On the high ground adjacent to all these creeks the decomposition of the rocks has been so great that in comparatively few places can outcrops be observed. The mica schists and softer gneisses become a micaceous and kaolin-like earth. The hornblendic and harder feldspathic gneisses break up into schist-like pieces and these again, when containing much hornblende, into a very deep reddish-yellow soil, in which at moderate depths hornblendic fragments may be found.

Mr. Hall[1] thinks that what has been taken for the dip of the gneisses and schists in southern and southeastern Delaware County is cleavage, and that instead of their lying at high angles, they are not far from horizontal, overlying each other, the Philadelphia gneisses the lowest, the Manayunk schists the next, and the Chestnut Hill schists the highest. He places the serpentines, except those of Flushing and of Cresheim creek, all in one horizon and above the Chestnut Hill schists.

The hard hornblendic gneiss, as heretofore stated, he deems Laurentian underlying unconformably the other rocks and exposed by erosion along the streams. So far as my examination has gone, and I have examined many hundreds of outcrops, I have been unable to verify Mr. Hall's conclusions, and I believe the dips to be almost without exception at high angles generally towards the northwest, except along Chester Creek northward of Lenni, where the prevailing dip is southeast and less steep. Rejecting the segregated granitic veins often found, the distribution of the rock-making materials will be found not at low angles, but nearly vertical. Very evident is this when one of the many hornblendic beds occurs between micaceous and feldspathic rocks, but careful search has shown it in nearly every locality where the exposure was at all good. The want of uniformity in the various strata makes this all the more distinct. There is one exposure in Deshongs' quarry on Ridley creek, west of the Philadelphia and West Chester road at which mica schists appear to rest unconformably upon the Fairmount gneiss, but the exposure is far from good, and there is no other to my knowledge.

If Mr. Hall's theory is correct, we should find in ascending the hills from the creeks a decided change in the rocks; but, except that due to decomposition, no such change exists; on the summits, where exposed by road cuttings, the decomposed rocks are identical with those in the adjacent valleys. Besides this, the harder gneisses, both feldspathic and micaceous and hornblendic, which occur beyond all doubt interstratified in the mica schists, cannot be distinguished lithologically, from those of the areas about Chester creek colored Laurentian on the map in C^5. The peculiar weathering of the Laurentian is absent, there is no blue quartz, and there is no line of demarkation between the areas colored Laurentian, and those colored schists on Mr. Hall's map, beyond what would be easily and

[1] Second Geolog. Survey Pa., Vol. C^5 pp. 2 and 59, etc.

wholly accounted for by the greater hardness and want of decomposition of the rocks where deep erosion has taken place.

The question of the relative age of these rocks seems most difficult. Prof. Rogers' view is given as follows, p. 79:—

"If we now review these interesting features in the structure of this broad zone of gneiss, we can hardly resist the conclusion, that in the three belts passed over by our section, there are really but two groups of rocks, a lower and a higher; that the entire zone, viewed broadly, constitutes but one wide synclinal wave or basin, the harder feldspathic and hornblendic gneiss dipping northward throughout the whole southern belt or outcrop and reappearing in steep and multiplied contortions on the other side of the trough, and compressed into the lesser foldings which it exhibits, by the lateral force of the wide crust undulation, within which it has been caught and folded."

That is, that the Fairmount and Manayunk gneisses formed the southeasterly leg of the synclinal, the Laurentian the northwesterly, with the Chestnut Hill schists overlying. Dr. T. Sterry Hunt refers to the identification of the rocks of Rogers' third belt with the Laurentian and, in his valuable contribution to American Geology published by the Second Geological Survey, Vol. E., seems to regard the Chestnut Hill schists as Huronian, the Manayunk and Fairmount gneiss and schists as Montalban overlying them, and in these views the lamented Prof. Lewis who made considerable study of these rocks is well known to have coincided,[1] though later[2] he concludes that they are of purely eruptive origin, that a re-crystallization of the old material under the influence of pressure-fluxion has taken place, by which the feldspar has been re-crystallized, the biotite made out of the hornblende, garnets have been developed and the quartz granulated and optically distorted by the pressure.

Dr. Hunt's description of the Montalban as given in Min. Physiology and Physiography, p. 411, will be found to accord in every particular except the "dichroite gneiss and crystalline limestone," with the rocks described in the Manayunk and Chestnut Hill groups. It is as follows:—

"As regards this younger gneissic or Montalban series in North America, it need here only be said that it contains fine-grained white gneisses, sometimes porphyritic, but distinct from the granitoid gneisses of the Laurentian, and passing into granulites, on the one hand, and into very quartzose coarse-grained mica schists, on the other. It also includes hornblendic gneisses and black hornblende schists, together with serpentine chrysolite rocks, dichroite-gneiss

[1] Geol. of Phila., a lecture before the Franklin Inst., Jan. 12, 1882, p. 18.

[2] Proc. British Assn. in Nature, Oct. 1st, 1885, p. 560.

and crystalline limestone. The mica schists of the series often contain garnets, staurolite, andalusite, fibrolite and cyanite, while in the granitic veins which traverse the series are found tourmaline beryl and cassiterite. The total thickness of the Montalban is apparently much greater than that assigned to the Huronian, upon which it sometimes rests unconformably, or in the absence of the Huronian, as is often the case, directly upon the Laurentian."

Mr. Hall's views have already been given, viz., that the Philadelphia gneisses are the lowest except the Laurentian, the Manayunk, schists next, the Chestnut Hill schists above and the serpentines the highest.[1] He further states:—

"I think there is no possibility of assigning the rocks of the Philadelphia Manayunk and Chestnut Hill groups (the First and Second belts of Prof. Rogers) to any place below the slates of the South Valley Hill or Hudson River groups. But to what horizon in the palaeozoic column they belong must remain for the present uncertain." C^6 p. 9.

This generalization is derived chiefly from the finding of Potsdam and No. 2 Limestone between the Laurentian and the schists. Prof. Lewis described itacolumite southeast of the Laurentian, east of the Schuylkill and the writer found a similar rock west of the Schuylkill.[2] Mr. Hall's observation has been doubted, but it would seem without reason except that he gave no exact locality to enable others to confirm his observation. A full description may therefore be of interest.

Passing southeastward along the North Pennsylvania Railroad from Edge Hill Station, we pass through the well-known deep cut through the Potsdam of the Barren Hill belt. We then pass for a mile through a valley, and then come to the garnetiferous schists of the Chestnut Hill belt at Jenkintown.

In this valley, a mile northeastward of the railroad, Laurentian is abundant in the form of large masses on the surface. Southwestward, high ground is soon reached on which the fields are full of Laurentian fragments. About .6 miles W. 5° S. of Glenside station is a wood in which is a small quarry exposing about 50 feet vertically of Laurentian rocks, some N. 30° E. dipping 55° N. W. in the southeasterly part of the quarry. In the northwesterly part the rock is much jointed, the joints irregular.

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[1] C^5 pp. 2, 59, etc.

[2] 2nd. Geol. Survey of Pa., An. Rep. 1886, Part IV, p. 1595.

W. 20° S. .4 miles from Glenside, on the east side of the Limekiln Pike, the Potsdam is best exposed. This is in a quarry about a hundred yards south of the Waverly road, but the same belt is conspicuously exposed on the Waverly road southeast and southwest of the pike, the Waverly road changing its direction from northwest to southwest at the pike and hence crossing the belt twice. The Potsdam here makes a ridge or hill, known as Waverly Heights, southeastward of the Laurentian hill. In the quarry it looks exceedingly like that in the quarries to the northwest (Barren Hill belt) except that the bedding is less regular, the quartz more cherty, and the rock harder. In the quarry the strike was N. 80° E. dip 70° S. E., on the road southeast N. 70° E. dip S. E., and on the road southwest N. 65° E. 70°–80° S. E. Southeast of this no exposures were seen, but there were schistose fragments. The strike of the Potsdam carries it into the bold hill to the northwest, the southeast hill of the Whitemarsh or Montgomery valley, Potsdam entirely at Edge Hill, but further southwest covered with Laurentian fragments and continuing (of schists) to form Chestnut Hill. The soil seems deep, and no exposures were observed. One mass of Bryn Mawr gravel was seen.

On the Paper Mill road, which skirts the hill on the northwest, southwest of the road which southeastward forms the northeast line of Philadelphia, the ground is low until within a half mile of the turnpike. Here is a spur of Chestnut Hill, and on the road cutting at the summit is Laurentian, poorly exposed, consisting of one large mass, and eight smaller, all having exactly the same strike about N. 35° E., and therefore I believe in place. 200–300 feet S. W. is Potsdam abundant, striking N. 80° E.; following this, are schists interbedded apparently with Potsdam; mostly soft and decomposed but showing the same strike and probably a steep easterly dip.

These schists resemble very strongly the schists southeast of the Laurentian west of the Schuylkill which include a white rock closely resembling the Potsdam.

I believe this to be an unconformable contact between the Laurentian and the Potsdam and that the schists immediately southeast of the Laurentian are Potsdam.

It is, of course, possible that these schists are more recent than the Potsdam, and formed from its debris, but the evidence seems very strong that here at least they are not older.

These schists continue about one-eighth of a mile to low ground and a creek, southwest of which schists resembling the spangled mica schist occur, and continue, poorly exposed, to the turnpike. The strike of a bed of hard gneiss in the schist is N. 85° E. Here the Paper Mill road ends, though shown on maps to continue. In fact Thorp's Lane about .1 mile northwest continues to the Wissahickon. On this, schists are seen with a strike N. 65° E. and soon the steatite and serpentine N. 55° E. The road is nearly on this strike but a little more southerly, so that near the creek it lies to the southeast of the steatite which here appears to be synclinal, the schists to the southeast regularly bedded dipping N. 40° W. 50° while the serpentine rocks on the northwest side dip slightly S. E. The schists to the northwest are about vertical. Here, as at the North Pennsylvania Railroad, there has been an ancient gap in the Laurentian ridge which further southwest appears as a very bold hill united with the schistose hill at the Ridge turnpike, but toward the Schuylkill separated from the schists by a valley in which the Lafayette serpentine makes its appearance at its extreme northeast outcrop.

If we study the rocks of Cream Valley, the corresponding rocks on the northwest side of the Laurentian anticlinal, we find evidence that the schists there are in connection with the Potsdam.

In this narrow valley we find garnetiferous schists strongly resembling some of those southeast of the Laurentian. Close to these, but beyond them, is Potsdam, beyond it Rogers' altered primal, and limestone. All seem to be conformable, and the schists and the Potsdam appear at one locality northeast of Wayne to be interstratified. The exposures are very poor.

The altered primal includes pebbles of Laurentian, some of large size.

The Radnor serpentine appears to lie between the Laurentian and these schists, and the northerly belt of steatite to lie in the schists, similar to the relation southeast of the Laurentian, except that on the S. E. there is a thin bed of spangled mica schists bearing very strong resemblance to the mica schists of Cream Valley, between the Laurentian and the serpentine. There is a connecting link between the schists and the altered Primal of Rogers in peculiar nodules, looking like pebbles, usually of a vitreous semi-transparent colorless feldspar with perfect cleavage, apparently orthoclase. While not uncommon they are not abundant in the rock. The garnets are confined to the mica schists but much of the schist is not garnetiferous. This is the same schist that is found with the limestone northwest of West Chester (Cope's), as it may be traced almost continuously along the southerly edge of the South (Chester) Valley Hill.

THE SERPENTINES.

The serpentines of these areas may be conveniently arranged with reference to the Laurentian axis above referred to. So arranged, except the first, and in a general direction from northeast to southwest they are as follows:

A. The serpentine and steatite of the southeast slope of Chestnut Hill (Laurentian) north of Easton, Pennsylvania.

B. The great Radnor belt, lying on the northwest of the Laurentian, including the belt north of West Chester, with which it is apparently identical and almost continuous.

C. The La Fayette belt, lying on the southeast of the Laurentian, including the outcrops from northeast of the Schuylkill, southwestward through Lower Merion, southerly Radnor, southeasterly Newtown and the southwestwardly part of Marple township, and the outcrop at Blue Hill.

D. The outcrop, in the western part of Newtown township, and in the easterly part of Edgemont, including Castle Rock.

E. The outcrops at Willistown, Chester county, extending a short distance into the northerly part of Edgemont, Delaware county.

F. The soapstone quarry, or steatite belt extending from Chestnut Hill, Philadelphia, to a point about three-quarters of a mile northeast of Bryn Mawr nearly parallel to, and about a half mile southeast of, the LaFayette belt (C).

G. The northerly Radnor belt, nearly parallel to the northeasterly part of the great Radnor belt (B) and about a thousand feet northwest of it.

H. The outcrop on the Wissahickon near the mouth of Cresheim creek, southeast of Chestnut Hill, and certain small areas in Marple and Upper Providence, southwest of the large Marple outcrop.

I. The numerous adjacent outcrops in Middletown Township west of Media.

K. Certain small areas south and southwest of the Media outcrop, and the outcrops near Glen Mills on Chester creek.

These serpentines have been studied by many geologists but the conclusions reached have not been uniform. The following extracts from the reports of the Second Geological Survey of Pennsylvania will show some of these conclusions. I have added to each the letter indicating the outcrop referred to in the list above given.

C[4] p. 84 (B). "The southern edge of the South Valley hill belt of talc mica slates is defined upon the map, by a chain of dots and stripes of two colors representing outcrops of serpentine and outcrops of crystalline limestone.

Were these outcrops ranged in more than one line [1] the task of explaining their appearance at the surface would be much easier. But a *single line* of them necessarily places them either at the top or at the bottom of the talc-mica schist formation; Mr. Hall choosing the former, Mr. Rogers the latter alternative.

The case is complicated by the fact that the outcrops along this one line are sometimes serpentine, sometimes limestone. It looks as if the serpentine might be a subsequent modification of the limestone; or else that one and the same original magnesian sediment was heavily charged with carbonate of lime in some places, and was a non-calcareous silicious mud in others."

C[4] p. 85 (B). "The subject is crowded with embarrassment; and all the more seeing that the serpentine-limestone range along the south edge of the talc-mica belt ought to hold some discoverable relation with other ranges of serpentine crossing Delaware, Chester and Lancaster counties; as well as with the famous serpentine outcrop between limestone and gneiss on the Delaware river, north of Easton, in Northampton county." (A.) See Report D[3], 1882.

C[4] p. 85 (A). "The fact that the Northampton county serpentine underlies the Great Valley limestone formation in connection with Potsdam sandstone supports Mr. Rogers' views in Chester county, and strongly opposes Mr. Hall's conjecture that the Chester serpentine may be Upper Silurian. On the other hand the fine serpentine outcrops on Lake Memphremagog, at the Canada Vermont line, are clearly Upper Silurian, but they are far removed from any gneissic region. Mr. Hall after examining the Easton serpentines, considered them altered calcareous slates lying at the base of the limestone formation, over the Potsdam sandstone." (Foot note.)

C[4] p. 87 (B). "It is evident that even a synclinal belt of serpentine 2,000 feet wide, or even 400 feet wide, can mean nothing else than a great thickness of the talc-mica schist formation metamorphosed more or less completely into serpentine. And a good cause for such alteration is present in an extensive outburst of *trap* close by; and everybody familiar with the surface of Delaware and Chester counties knows how almost invariably its trap and serpentine appear together.[2] This of itself effectually divorces the serpentine outcrops of Chester county from the limestones."

C[6] p. 26 (F). "The southern belt of serpentine extends from Chestnut Hill tothe Delaware county line, crossing the Schuylkill river below Lafayette station. It has not been proven to be a continuous belt; and the color indicates the steatite or serpentine where its existence is beyond dispute. This range or belt of serpentine belongs, undoubtedly, to one horizon, although the deposits may be in lenticular masses.

C[6] p. 26 (C). "The northern belt of serpentine extends from a point a short distance east of the Schuylkill river to the neighborhood of the Delaware county line, north of Bryn Mawr. This belt seems to be a repetition of the southern belt, being on the north side of a synclinal basin.

East of the Schuylkill the extent of the outcrop is not definitely known. The outcrops designated are the only ones positively known to exist. If there was no faulting along the northern edge of the belt, between the Schuylkill and Chestnut

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[1] In Radnor Township they are in two lines. T. D. R.

[2] My observations do not confirm this. Proc. Acad. Nat. Sci. 1883, p. 241.

Hill, the northern and southern belts ought to join at the eastern end of the synclinal basin; but they apparently do not."

C^5 p. 15. "The serpentine and associated rocks lie in synclinal basins. This is the rule in regard to all serpentine areas in Delaware county and probably with most of the serpentine in this district."

C^5 p. 57 (C & I). "The serpentine crosses the northern portions of the township (Upper Providence) in two belts which indicate shallow synclinal basins and the erosion between these areas or basins exposes the underlying mica schists."

C^5 p. 13. "The Delaware county deposits demonstrate the fact that the serpentine areas are shallow synclinal basins, many of them saucer-shaped."

C^5 p. 13 (G). "There is a small area of steatite close to Gulf creek and near a limestone deposit. I think that there is no question that the steatite belongs to the same horizon as the serpentine. The belt of serpentine" (B) "which makes its appearance in Radnor township belongs geologically to the serpentine belt which extends across the Schuylkill river and through Lower Merion township, Montgomery county" (C), "and is a direct continuation of the belt which passes through the corner of Tredyffrin township, Chester county, and passes north of West Chester" (B).

"The serpentines throughout the central portion of Delaware county" (I. K. L.) "belong to the same horizon as those in Lower Merion Township, Montgomery county" (C. F. G.).

From the above facts it will readily be seen that all the serpentines through this region belong to the same geological horizon."

C^5 p. 14. "It is safe to assume that the serpentines are one of the most recent deposits."

C^5 p. 65 (K). Middletown Township. "There are numerous small areas of steatite, anthophyllite, and actinolite, indicative of the serpentine horizon, through the southern and southwestern portion of the township but these rocks seem to be confined to very small areas lying upon the schists and gneisses which are exposed in the escarpments."

C^5 p. 64 (I). "Light feldspathic granite is formed in this township (Middletown) associated with the serpentines."

"" The geological position of this granite is below the serpentines."

The term "talc mica" is applied above to the hydromica schists of the South (Chester) Valley Hill, sometimes called chlorite schists. In fact they contain neither talc nor chlorite unless in very minute quantity.

Upon studying the relation of these serpentines to the adjacent rocks the fact is at once apparent that most of these outcrops, and those most extensive, occur along the margin of the Laurentian rocks, and very close to that margin, while some of them, generally small in area, seem with equal certainty to be some distance from the Laurentian, and to have no connection with it.

To the former belong:

A. Easton. *B*. Radnor—West Chester. *C*. LaFayette. *D*. Southwest of Newtown. *E*. Willistown.

And to the latter:

F. Steatite. *G*. Northerly Radnor. *H*. Cresheim Creek. *H*. Southeast of Marple schoolhouse. *K*. Southwest of Media.

And probably *I*. West of Media.

The Media outcrop as delineated on Mr. Hall's map would be nearly continuous on its northwestern edge with the Blue Hill outcrop of the LaFayette belt and on its southwestern with the outcrops southeast of the great Marple outcrop.

This region is much covered with soil and it may be possible that the two parallel belts exist with a schist area between. The results of a careful examination of this outcrop are given hereafter.

The close connection of one series of these serpentine areas with the margin of the Laurentian being apparent, it would seem that the serpentine at Chestnut Hill on the Delaware, one mile north of Easton should afford us a key, the exposures there being much greater and better than any in Delaware or Chester County. As to these in addition to the quotations above given the Second Geological Survey states as follows:

D^3 p. 252 (A). "Along the southern escarpment of Chestnut Hill steatite and serpentine extend from the Delaware river to a point about one-half mile west of Bushkill creek. The belt has a width of about four hundred feet.

The serpentine and steatite have generally a greenish color; associated with the steatite massive, coarse quartzose feldspathic rock (granulite) occurs.

The rock is different in character from the feldspathic rocks of the gneissic belt which form the mass of Chestnut Hill. The feldspathic rock associated with the steatite belongs evidently to the steatite belt."

D^3 p. 256 (A). "On the southern slope of Chestnut Hill the Upper Primal slates (hydro-mica slates) appear to have been altered into steatite and serpentine (§251). No limonite occurs on the flanks of Chestnut Hill."

D^3 p. 253. "The steatite and serpentines of this belt appear to be equivalent to the slates overlying the Potsdam sandstone. (Upper Primal Slates.) I see no explanation for the alteration of the hydro-mica slates of the Upper Primal into steatite and serpentine in this locality." (Rogers, p. 94–5.)

D^3 p. 58. "Whether the serpentine and other magnesian minerals found at the base of the formation along the south flank of Chestnut Hill, north of Easton, belong to this formation" (Chazy and Calciferous Limestone) "or not is still an open question."

Visits to the locality forced me to a conclusion differing from the above. Passing up the west bank of the Delaware from Easton the limestone appears for a distance of nearly a mile dipping southeastwardly 60° to 80° then 200 feet are under cover, and then a narrow bed of steatite appears. The southeast wall is not visible, the northwest wall is Laurentian and were this the only exposure there might be no reason to question the conclusion that the steatite is an altered slate between the Laurentian and the limestone.

East of this quarry may be seen Laurentian in place and the contact with the talc schist may be seen.

Immediately north of it is another quarry apparently within the Laurentian, and here may be seen masses of tons weight having all the appearance of Laurentian but converted in part or in whole into talc.

One mass, five or six feet long, was nearly pure talc schist at one end, while at the other, much quartz remained and to the eye the rock looked like unaltered Laurentian.[1]

Northwestward of this quarry all visible rocks are Laurentian for about two hundred feet to a quarry of similar talcose rock quarried on a slope up and into the hill somewhat over one hundred feet. The quarry when visited had not been wrought for some time and large masses of the south wall had fallen in. These masses were Laurentian, the north wall was the same. Some of the fallen masses showed a change from syenite, or more strictly granulite, into steatite.

Northwestward from this, the Laurentian was apparent for three hundred to four hundred feet, where another and much larger outcrop of steatite is quarried. The contacts here were not visible.

Northwestward from this followed two hundred to three hundred feet of Laurentian including one very prominent overhanging cliff and then another exposure of steatite, in which was a considerable quarry. Northwestward of this the Laurentian again appeared. The dips were not clear but from what could be observed are not far from vertical. The hill adjacent to these quarries probably exceeds four hundred feet in height. It seems incredible that these four outcrops are an overlying stratum in three successive compressed synclinals. It is much more rational to conclude that they are interbedded in the Laurentian.

On the Bushkill, which cuts the same hill about one and a half miles from the Delaware the outcrop is not so distinct but here also the steatite and serpentine are between walls of Laurentian, and in these hard unaltered Laurentian rocks may occasionally be found masses of rock apparently changing into steatite and serpentine.

Dr. Hunt in his Mineral Physiology and Physiography seems to regard the change of gneiss into serpentine or steatite as almost an absurdity, and before visiting this locality I should have agreed with him, but here we certainly have Laurentian gneiss changing into steatite, or steatite changing into Laurentian gneiss.

Considering the Delaware, Chester and Montgomery county serpentines in detail we find as follows:

At the northeastern end of the Radnor–West Chester belt there is Laurentian on the strike line, and on both sides of the belt, but the exposure does not show the walls in place. About a

[1] A piece of this is in the collection of the Academy.

quarter of a mile northwest is garnetiferous mica schist in place, and one hundred yards further northwest Potsdam sandstone.

At the outcrop northwest of Radnor station garnetiferous schist and gneiss were disclosed in a well not over two hundred feet north of the serpentine. In the strike line (southwest) and to the southeast Laurentian fragments abound. About five hundred feet northeast of the northeast end of this exposure runs the Radnor and King of Prussia road. On this, to the northwest of the line of strike is an outcrop of Laurentian in place, while to the southeast and very close to the strike line is a very hard porphyritic contorted mica schist unlike any other outcrop of the region.

Further west, between Radnor and West Chester, the serpentine is much concealed, but there are some outcrops of interest.

The most important of these lie a little less than a mile south of the Pennsylvania Railroad, near Paoli, Green Tree and Malvern stations and among the headwaters of Crum creek. Southeast the Laurentian is apparent, here and there in conspicuous outcrops. On the road leading to Malvern, we find, going north northwest, as follows:

	feet.
Laurentian.	
Low ground,	100
Serpentine,	250
Low,	50
Garnet staurolite schist,	100
Low,	500
Garnet staurolite schist,	100
Trap,	50
Garnet staurolite schist,	200
Serpentine,	400
Low,	300
Garnet staurolite schist,	200
Concealed,	300
Hydromica schist of the South (Chester) Valley Hill,	5000

Showing here two distinct outcrops of the serpentine, with mica schist between them, and beyond the northernmost.

About half a mile east of the Malvern road is a nearly parallel road leading to Green Tree. On a road connecting the two, just south of the serpentine, Laurentian is conspicuous. Going N. N. W. on the Green Tree road, the belt is again divided, the southerly outcrop being close to where the two branches of Crum creek unite, the northerly just below where the road turns abruptly E. N. E., and exposed more conspicuously at a quarry an eighth of a mile W. S. W. of the bend. Here white quartz is abundant, much like that which abounds at certain places in the mica schists southeast of the LaFayette belt, and the garnetiferous schist is visible in the E. N. E. part of the road. About a quarter of a mile east of the Green Tree road is another road leading also to Green Tree and joining the former road where the east northeast direction changes to north northwest. Two small branches of Crum creek cross this road, and unite just below it. Southeast of the east one there is serpentine which extends about sixty feet beyond the northwest side of the creek. The ground is then low to the west branch, beyond which is an area of serpentine probably eight hundred feet wide, but it appears to end very abruptly, for on the line of strike the road mentioned just previously to this is not over six hundred feet distant, and in it mica schists appear, while the serpentine is to be found only by careful search. On the strike line northeasterly (N. 35° to 52° E. wherever it can be observed) the serpentine outcrops are extensive but their margins are all concealed.

Immediately southeast of the serpentine just mentioned southeast of the east branch of Crum creek, a road runs to Paoli, in a direction nearly northeast. Going northeast we find serpentine followed by fragments of loose trap, fragments of garnet-staurolite schist, then serpentine, trap, serpentine, trap, garnetiferous schist and finally hydromica schist.

While it is impossible to fix the boundaries of these rocks with any accuracy, there can be no doubt that we have here an area of the garnetiferous schists included within serpentine areas and bordering the northernmost on the north. This schist appears nowhere on the south unless at one point in the road last mentioned southeast of the east branch of Crum creek, but the outcrop is merely of loose rock and garnets in very small quantity and may not be actually in place.

All observed dips in the serpentine were northwest 60° to 90°, but few dips seemed trustworthy and in the schists no exposures whatever giving trustworthy dips were found.

Within a quarter of a mile of the northwesterly margin of the serpentine and garnetiferous schists are the hydromica schists of the South (Chester) Valley Hill very readily distinguishable from the garnetiferous schists, and throughout the whole distance Laurentian rocks are found close on the southeast.

North and northwest of West Chester Laurentian also appears close to the serpentine on the southeast side, while in many places on the northwest side fragments of garnetiferous schists and loose garnets are found in the soil with occasionally staurolite.

About a mile and a quarter N. N. W. of West Chester, the bold serpentine ridge ends abruptly, the mica schist fragments appearing in its line of strike, here S. 45° W. with an unusually uniform dip in the serpentine about 45° S. E., or toward the Laurentian. The Laurentian is not sufficiently exposed to give its dip, but the strike seems to be about the same as that of the serpentine.

Southwest of this is a small outcrop of serpentine, a little south of the line of the strike of the former, and beyond are outcrops nearly five hundred feet apart to the northwest and southeast of a stream and low ground, evidencing a wide outcrop or two narrow ones. Northwest of the serpentine is garnetiferous schist.

Southwest of this outcrop is a ridge geographically the continuation of the serpentine ridge, but apparently of Laurentian rocks, not visible in place, but abundant as loose masses, but on the road southeast of this hill garnetiferous schists with staurolite are exposed. The great mass of the Laurentian lies still further southeast, so that if the ridge is Laurentian, we have an included valley of the schists. No serpentine is visible. The ridge ends at the road from West Chester to Downingtown. At the time of my visit an alteration of this road had caused a cut to be made making a cross-section of the end of this ridge, showing to the southeastward Laurentian, dipping northwestwardly about 22,° overlying which was a bed of slaty steatite, or impure talc schist, and overlying this, mica schist and quartz, much contorted, the lowest part dipping conformably with the steatite and Laurentian, the upper so contorted that no structure was apparent. To the northwestward the Laurentian appeared dipping southeastwardly about 30° the middle being occupied by the mica schists but no steatite or talc appearing to the north. The exposure is probably two hundred feet wide. The rock which I have termed Laurentian at this exposure I believe to be such, but it is not so characteristic as to be beyond doubt.

Further southwest on the line of this hill, after 400 to 500 feet of low ground, is another hill which contains two outcrops of limestone (Caleb Cope's). The southerly one has been excavated some two hundred feet into the hill, exhibiting a stratum of crystalline limestone probably 60 feet wide bounded on the northwest by garnetiferous mica schists, with feldspar nodules, most closely resembling those of Cream Valley, Radnor. On the southeast is a rock closely resembling the Laurentian, containing interbedded limestone. This is not far north of undoubted Laurentian, and is either that rock, or as Dr. Frazer has suggested,[1] a more recent formation made up of the fragments of the underlying rocks. In this quarry a satisfactory exposure gave strike N. 40° E. dip 55° S. E. Northwest of this outcrop are 100 feet of the schists, and then a very small exposure of saccharoidal limestone, apparently an anticlinal in the schists. The steatite outcrop is 450 feet N. 50° E. from the southerly limestone, N. 65° E. from the northerly.

A short distance northwest are the hydromica schists of the South (Chester) Valley Hill.

Dr. Frazer[2] thinks it probable that the serpentine of this belt is a metasomatized portion of the hydromica schists with which he regards it as lying in contact; but towards the northeast we find between the hydromica and this serpentine, limestone, Rogers' altered primal, garnetiferous mica schists, Potsdam sandstone and steatite, the garnetiferous mica schists much more nearly continuous (apparently) than the serpentine. North of Radnor station fully a thousand feet of the above rocks intervene between the hydromica schists and the serpentine. I have nowhere seen the hydromica schists of the South Valley Hill in contact with the serpentine.

The LaFayette Belt.

On the southeast side of the Laurentian anticlinal is the LaFayette belt, but along nearly its whole course there intervenes visibly between it and the Laurentian a schistose rock, including crystals of mica like the feldspar crystals in a porphyry and more rarely visible a thin bedded gneiss resembling the altered primal of Rogers so largely exposed on the northwest side of the anticlinal. The schist is very uniform and persistent but it is nowhere well exposed. At times, as on the southwest bank of Meadow Brook north of

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[1] C 4 p. 294.

[2] "These results seem to lend a high degree of probability to the theory that at least this belt (Radnor-West Chester) is a metasomatized product of a layer or layers of the hydromica schists in contact with which it lies and with which its relations are abundantly made out by very different processes of comparison, viz., stratigraphically, geographically and chemically." Trans. Am. Inst. M. E. Troy Meeting, Oct. 1883.

Roberts' road a mile and a half south of the old Lancaster road, and also on the Coopertown road (or Roberts' road as they run together) west of the bridge over Darby creek, it becomes a coarse granite or porphyry, containing, however, but little quartz. Some portions exactly resemble part of the garnetiferous schist, northwest of the Laurentian, but I have nowhere observed garnets in it, though a loose fragment of rock found on the Roberts road near Meadow brook contained staurolite.

The rock in contact with the LaFayette belt on its southeastern margin is rarely visible at the point of contact. It may however be seen at Rose's quarry, and also on the Roberts road east of Meadow brook. It is a fine-grained mica schist, not contorted, not wood-like in its fracture, like that near the steatite belt to the southeast. It occasionally contains garnets but it is not distinctly garnetiferous like that further southeast.

It contains strata of schistose hornblende rock which, at one locality 200 feet north of the West Chester and Philadelphia road, a mile east of Newtown Square near the south line of Newtown Township, appears to be changing into serpentine and these hornblende rocks are quite persistent, being found as far southwest as the Willistown outcrop.

The best exposure of this belt is at Rose's quarry near the Schuylkill. Here the dip is 45° to 55° S. 30° to 40° E. and beds of serpentine above may be traced into enstatite below. Southwest are large masses of enstatite in great quantity. This is also the case at the outcrops on Darby creek and in Marple. Chromite was mined near Darby creek in this belt. (Moro Phillips Chrome Mine.)

The LaFayette belt may be traced by distinct outcrops from a point about half a mile north of the Schuylkill to Rosemont station P. R. R. Southwest of Rosemont, the outcrops are more indistinct but careful search will disclose them between the old Lancaster road and the Radnor and Chester road; on this road a wide outcrop suddenly appears and continues (except at Darby creek where some low ground intervenes, beneath which it is doubtless concealed) to the Philadelphia and West Chester road about a mile and a half east of Newtown Square. Beyond this for a short distance it becomes inconspicuous or absent, but the ground is level and there are no good exposures of any kind. About half a mile further southwest it is again exposed as the great Marple outcrop, about a mile and a half northwest of Palmer's Mill on Crum creek.

Southwest of this, the next exposure of the serpentine which I have seen is at Blue Hill between Crum and Ridley creeks. This outcrop lies near Sycamore or Bishop's Mills on Ridley creek and nearly in the strike of the LaFayette belt. The Marple outcrop lies south of this line, probably indicating a curve in the Laurentian, but the adjacent rocks on the northwest are not visible in place at Marple. The elevation of the region immediately northwest is indicative of the Laurentian. At Blue Hill the Laurentian again seems to almost surround the serpentine. Just north of the school-house the Laurentian appears in place with a strike nearly south, immediately west of abundant fragments of honeycomb quartz perhaps indicative of underlying serpentine, and not over 300 feet northwest of abundant serpentine in place. Further northeast the Laurentian occupies the entire hill, which here is quite elevated, with steep slopes on the northwest and southeast, and a more gentle one on the northeast to Crum creek.

In the serpentine where it has been quarried on the Providence road opposite the Blue Hill school-house is a small quantity of granulite apparently a dyke. On the road along the creek south of the serpentine a decomposed granite or granulite appears, the indications being quantities of small masses of crystalline feldspar.

The locality southwest of Newtown Square is not well exposed. Laurentian, unaltered, may be seen at the fork of the roads three-quarters of a mile west of Newtown Square and its strike would bring it northwest of, but very close to, the serpentine. The Castle Rock enstatite seems to be continuous with this serpentine, separated from it only by Crum creek and the immediately adjacent low ground. This locality is not far from the Willistown exposure next described and is probably identical with it.

The Willistown outcrop, like that northeast of Radnor station, appears to be largely within the Laurentian, which extends from West Chester eastward as close to it as any rock can be observed. To the northward Laurentian is everywhere. Following the serpentine table land eastward, the serpentine fragments in the soil suddenly, within less than 100 feet, are replaced by hornblende fragments and, a short distance beyond, Laurentian rocks form a steep bluff. This bluff rises precipitously from the north branch of Ridley creek on the east, and from the Philadelphia and West Chester road on the north. The Laurentian dips S. 25° E. 65°. The rocks are partially exposed along the road and going west are as follows:

First. Laurentian.

Second. A porphyritic gneiss resembling Rogers' altered primal as found northwest of the Laurentian.

Third. A micaceous schist in very small quantity.

Fourth. Hornblende fragments.

Fifth. Serpentine.

The serpentine extends along the road several hundred feet. North of it is Laurentian, but no contacts are visible. About a quarter of a mile west of it appears the same rock spoken of as resembling Rogers' altered primal, striking, like the former, N. 65° to 70° E. but the dip not certain. Beyond this west to West Chester and north for several miles the whole region is Laurentian.

It will be seen that all these outcrops of serpentine are close to the margin of the Laurentian, two of them at least within its margin, though there is no sufficient evidence to prove whether they are of that age or more recent.

Mr. Hall, as before stated, thinks it safe to assume that they are among the most recent deposits, but the section of the Radnor belt shows going northward from the Laurentian axis several rocks between the serpentine and the Potsdam sandstone, seeming to indicate that here at least the serpentine is the oldest except the Laurentian, and that the steatite is more recent than the serpentine but below the Potsdam, unless in a synclinal.

On the southeast side of the Laurentian the existence of the Potsdam is not certain where the serpentine occurs, but as above stated it does occur at Waverly Heights in Montgomery county, between the Laurentian on the northwest and the schists on the southeast and there are in Radnor and Lower Merion certain rocks in the same relative position which closely resemble Potsdam. If this is Potsdam then the serpentine is again between the Laurentian and the Potsdam, but the very position of the serpentine, so very close to the Laurentian, would indicate that it was an older rock than the mica schists to the southward.

We come now to the consideration of the outcrops which are not near the Laurentian. Of these perhaps the most important are the steatite belts N. W. & S. E. of the Radnor and LaFayette serpentines.

THE NORTHERLY RADNOR BELT.

Outcrops of this belt lie nearly parallel to the great Radnor belt but extend a mile further northeast and all lie within a lineal distance of about two miles, ending about three-quarters of a mile southwest of the northeast end of the Radnor belt, bearing precisely the same relation to it and to the Laurentian axis as does the steatite of the better known Soapstone quarry belt to the LaFayette belt. The exposure of the northerly belt is poor, but it is of no little interest on account of its similarity to the soapstone quarry belt and to the fact that along its line occur garnetiferous schists followed by Potsdam sandstone and limestone. A trench dug for water pipe on the property of Judge Hare about a mile northeast of Radnor Station afforded a tolerable section. The trench was about N. 75° W. while the strike of the belt is probably N. 60° E.; the distances given are corrected so as to approximate the dip line.

Foot of hill E. 40 feet	Mica schist, decomposing steatite with numerous cavities filled with ferric oxide exactly resembling that of the soapstone quarry below LaFayette where the ochre is due to weathering of Breunnerite. With this was chlorite schist.
90 feet	Slaty serpentine.
200 "	Hard serpentine.
300 "	Talc schists and hard serpentine.
350 "	Rogers' altered primal.
375 "	Mica schist.
425 " W.	Rogers' altered primal.

A half mile southeast of the LaFayette belt, lies the steatite belt, in which quarries for soapstone have been wrought for over a century. The LaFayette belt appears to end northeastwardly in a small valley of an affluent of the Schuylkill, not far from the river. The steatite belt however extends further northeast, and crosses the Wissahickon near Chestnut Hill, Philadelphia, ending in the schists of Chestnut Hill, near Thorp's lane a short distance southwest of the turnpike.

This is another, but probably purely accidental resemblance between the two belts, both being much shorter, but beginning much more northeastwardly than the corresponding parallel serpentine belt.

The characteristic of this belt is a steatite including masses of very hard black serpentine. These have resisted erosion and sometimes appear along the outcrop like huge boulders, some of them, near the soapstone quarry, being separate and of many tons' weight. Some of the black masses are pseudomorphs after staurolite.[1]

[1] Proc. Acad. Nat. Sci. Nov. 21st, 1871.

Prof. Rogers, whose plutonic views as to most of the serpentines are well known, recognized this belt to be an altered schist though he regarded it as "metamorphosed by infusion of magnesian matter from the dyke of intrusive serpentine which everywhere adjoins it."[1] But it is this "intrusive serpentine" which contains the pseudomorphs after staurolite.

This belt has afforded more minerals than any other serpentine of the region, except, probably, Wood's mine in Lancaster county, perhaps because of the more extensive quarrying in it. Dolomite is abundant, sometimes in peculiar crystallizations. The following also have been found, Breunnerite in fine crystals, chalcopyrite, bornite, magnetite, tremolite, staurolite, actinolite, chalcanthite, epsomite, Millerite, apatite and Hallite. Southwestward of the Schuylkill it appears at numerous outcrops ending on the Black Rock road about a mile northeast of Bryn Mawr.

The Cresheim Creek Outcrop, and Small Outcrops near Media.

Near the mouth of Cresheim creek on the Wissahickon in Fairmount Park, Philadelphia, are two small outcrops of actinolite and antholite. The southeasterly, about 700 feet S. E. of the mouth of Cresheim creek, is well known. It lies about two miles southeast of the steatite belt, and is wholly within the schists. Mr. Hall mentions a similar outcrop at the Flushing school-house in Bucks county, and excepts these from his generalizations as to the serpentines. The outcrop is immediately in the Manayunk schists, is quite insignificant and appears to be a local alteration of hornblende-like rock. About 500 feet N. W. of Cresheim creek is another similar outcrop much better exposed, which, I believe, has never been described. It appears undoubtedly interstratified in the schists with a dip of about 45° N. 40° W. The schists can be seen almost in contact (within one foot) and the dip and strike of the antholite and of the schists seem the same. The schists contain garnets and staurolite. It is with these I should class all or nearly all the outcrops southwest of the Marple Barren Hill school-house and also those southwest of Media, including a part if not the whole of the great outcrop west of Media.

In Mr. Hall's map of Delaware county published in C^5 are shown a number of outcrops of serpentine extending southwestward

[1] Geol. of Pa., Vol. 1, p. 71.

from the large Marple outcrop south of Newtown Square, most of them in two lines the continuation of which marks the northwestern and southeastern margins of the many adjacent outcrops west of Media. He also maps several south and southwest of the latter. It is not an easy task to map these serpentine areas, their margins are ill defined, and generally covered with soil. While, therefore, their general location may be correct, in some minor points they do not agree with my observations, but accurate mapping would require a topographical survey and numerous excavations.

I have visited most but not all of the minor outcrops. At some I was unable to find the serpentine, but wherever found it was apparently a small bed of hornblende-like rock interstratified in the Manayunk gneisses, altered more or less into antholite, steatite, serpentine and honeycomb quartz, except the outcrop on the east bank of Ridley creek northwest of Media where there is unaltered enstatite, also apparently a narrow interstratified bed.

On Mr. Hall's map a small area of serpentine is shown as almost a continuation of the great Marple outcrop and both are represented to be in the schists. I believe the Laurentian to bound the Marple serpentine on the northwest as it certainly does a short distance to the northward. Between the two areas intervene Chestnut Hill schists with the characteristic quartz in large quantity. The rocks of the small area are steatite and antholite and very unlike the enstatite and hard black serpentine of the large outcrop.

At this locality and southwestward many of the outcrops of serpentine are accompanied by outcrops of a granite, or granulite, often coarse, sometimes fine grained, containing orthoclase, oligoclase, quartz and mica, the latter in small quantity but at times in large crystals, the quartz also in small quantity, the mica being rarely disseminated. This will be more fully described in the consideration of the Media outcrop.

The Large Outcrop West of Media.

This outcrop, or rather series of outcrops, occurs in or on the borders of an elevated table-land, occupying the greater part of the area lying between Ridley and Chester creeks, extending southwardly a little south of the railroad from Philadelphia via Media to West Chester. On the northwest, the road from Lenni, through Lima, to Sycamore Mills is on it, but near the edge, while on the north, Dismal Run marks the boundary and on the east, Ridley creek. Within this area are several outcrops of serpentine, and scattered over a large part of its surface, amidst the soil, is the honeycomb quartz which usually results from the alteration of serpentine. This has given rise to the impression that the underlying concealed rock is serpentine. On Mr. Hall's map certain areas are marked serpentine without question, and between the areas so marked the map is lined green. My observations are that in much of the area colored serpentine, while that rock may exist, it constitutes but a small proportion of the area, while in much of the lined portion serpentine does not exist. It is true that it is impossible to define the areas of serpentine and other rocks in the table-land. The covering of soil is deep and the exposures very few, but there are some that throw much light on the structure. The region lies directly in the strike of the schists so well exposed near Media and north of it and resembling the Manayunk series. Mr. Hall, as already stated, believes these schists to lie at low angles and to overlie the harder gneisses which appear over a large area further west, but in the cut at Media, which Mr. Hall quotes in support of this, [1] the alternations of differing materials certainly dip about 70° to 90° southeast and I think this steep dip is, the rule, with very few exceptions.

The only section through this table land, and that by no means satisfactory, is afforded by the excavations of the railroad, which crossing the valley of Ridley creek by a very high bridge, passes southwestward to Chester creek at a grade usually below the level of the adjacent land. Decomposition of the rocks has, however, gone on to so great a depth, that undecomposed rock is rare, and the walls of the cuts, in many places are little more than loam, but there has evidently been no transporting of material, the rock having decomposed in place. Usually the falling down of the upper part of the slopes obscures the lower, but the excessive and violent rains of the past season have washed the sides so that the rocks are very clearly exposed, the stratification is clear and distinct, and the sections are as convincing as if of hard rock. Indeed the opportunity for observation is exceptionally good.

On the west bank of Ridley creek the railroad enters a cut about a hundred yards from the bridge. This is in schists much like those on the east with a strike about N. 40° E. and a nearly vertical dip. The strike and the railroad tangent are here nearly parallel, the railroad

[1] Vol. C [5] p. 59.

bearing 5° or 10° north of the strike going westwardly. Here may be seen some very hard compact gneiss, both granitic and hornblendic, interstratified in the schists. About a mile from Ridley creek, a short distance west of Elwyn station, the schists are very feldspathic and dip 70° to 90° southeast. West of this is a deep cut, the schists continuing very feldspathic with coarse crystalline feldspar in thin beds, all much decomposed, some hornblendic gneiss and some included quartz, and some massive beds of a granite almost granulite, the strike and the dip about the same. Suddenly, on the north side of the cut, honey-comb quartz appears, followed by serpentine, and this by a coarse hornblende rock, containing grains of a yellow mineral, probably chrysolite, and this is followed by serpentine to the end of the cut probably 200 feet.

On the south side of the railroad the feldspathic schist continues without a trace of serpentine, but the hornblendic rock does appear on the south side. This will be referred to hereafter.

West of this, the ground is lower, and there are no exposures for about a quarter of a mile to Chrome Run, which rises on the extreme northern edge of the table-land, and flows nearly south into Chester creek. On the east side of the creek are large serpentine areas, but there is evidence too of much granulite, here being the celebrated Black Horse moonstone locality. Along the creek the ground is low, but near where the State road crosses it, its bed is a granulite excessively jointed, hence easily quarried and making a good building stone. The dip and strike are not clear. On the west side of the creek at the railroad, much earth has been removed to construct embankments and here the granulite is in large quantity but poorly exposed.

On the east side of the creek a similar removal of earth lays bare a ridge of diorite, part of it very compact, part schistose, with the unusual strike N. 30° to 40° W. and a dip of 70° to 90° northeast. This is cut off by large masses of granulite striking N. 20° E., some of it fine grained, some containing large crystals of feldspar, in fact almost a porphyry. The contact is concealed, but the diorite is visible within a foot of the granulite. It would seem difficult to explain this except by regarding the granulite as intrusive, and perhaps the diorite here is similar to that of the hornblende rocks in the cut to the east before mentioned.

The close correspondence of these occurrences with the observations of the Canadian geologists as to the Black Lake serpentines hereafter mentioned is apparent.

Between Chrome Run and the next creek west is a cut, in the easterly part of which serpentine and honeycomb quartz occur. Toward the middle of the cut, decomposed granulite appears, embedded in which are masses, sometimes pebble like, sometimes bedded, of actinolite, all much decomposed. Following this the granulite is distinctly stratified, mostly regular, some of it contorted, striking S. 20° E. nearly vertical, looking much like that west of Elwyn. It contains some hornblende and actinolite. The valley of the creek beyond is quite deep, with steep banks, and the floor of the valley rises very rapidly northward. On the hill between Chrome run and this creek, near the railroad, honeycomb quartz is visible in the soil, but, going northward, schists soon appear in quantity, succeeded by masses of granulite; and this, near the source of the creek, and near the point at which the Lima road forks to Lenni on the west and to Glen Riddle on the east, gives place to honeycomb quartz. None of these rocks seem absolutely in place, but their quantity is so great, that their existence under the surface cannot be doubted.

Returning to the railroad, the next cut is that in which Glen Riddle station is located. In this the chief rock is the decomposing granulite with serpentine and honeycomb quartz, the serpentine and granulite so intermixed and so decomposed, that it requires close examination to distinguish them, but the serpentine can be seen in unquestionable granulite, and the granulite in unquestionable serpentine-like rocks. In this cut there appears to be a gentle westerly dip and the proportion of the granulite to the serpentine seems to increase as the depth increases.

The cut west of that at Glen Riddle and east of Lenni, the locality of vermiculite, actinolite, yellow quartz, Delawarite and Lennilite, shows the granulite much more massive and less decomposed than any of the preceding. This cut is a curve on the southerly slope of a steep hill, so that the south bank is comparatively low, that on the north rising steeply probably 100 feet. The top of the hill is honey-comb quartz, then there is a terrace, probably made in the grading of the railroad, apparently almost entirely granulite, and then on the slope to the railroad is granulite, some of it with crystals of feldspar an inch or more in size (Delawarite, Lennilite), some very fine grained, much of it very heavy bedded and compact, very hard and entirely undecomposed, and some of it soft and decomposed.

In this occurs vermiculite, or Hallite, and actinolite, apparently the result of the decomposition of an interbedded mineral, sometimes in lenticular masses, sometimes in narrow beds, and in some places looking as if the granulite itself had changed into serpentine. One measurement gave strike N. 45° E. dip 65° N. W. The only certain thing, however, was a general northeast and southwest strike. On the north side of the cut there was much more granulite than serpentine, on the south side more serpentine than granulite, but both were intermixed on the two sides.

In the road which skirts this hill, south of and generally lower than the railroad, the same intermixture of granulite and serpentine may be seen, the granulite greatly in excess.

In the hill northeast of the cut is an abandoned serpentine quarry. Here also the granulite occurs in the serpentine, looking more like a dyke than elsewhere except on Chrome Run, and at Crump's quarry hereafter mentioned, but the exposure does not decide the question.

West of the Lenni cut and near Lenni station, the Manayunk rocks, or rocks very like them, appear in a large quarry, the rock here being a schistose gneiss.

From Lenni and Glen Riddle roads lead northwestward and joining, run through Lima to Sycamore Mills, on Ridley creek, near Blue Hill.

On the Lenni road the gneisses appear, followed by loose masses of the honeycomb quartz ; on the Glen Riddle road, the quartz only is seen at the surface, but where the underlying rock is exposed by washes in the road gutters, it is seen to be gneissic or schistose and not serpentine or quartz. The honeycomb quartz is visible along this road nearly to Sycamore Mills, in other words from near Chester creek, to near Ridley creek, but not immediately on either. About a mile west of Sycamore Mills is a road close to the Middletown public school, or the Barren Hill school-house. It covers a considerable area visible on the south bank of Dismal Run, but on the Lenni road it is not visible, the surface being a loam with intermixed honeycomb quartz.

On the Lima-Lenni road, northeast of the school-house, on the descent from the table land to Ridley creek, near the mouth of Dismal Run, the granulite suddenly appears in great quantity and evidently in place. Northwestward of Dismal Run the Laurentian with all its characters occurs in abundance, forming a steep ridge probably

200 feet high divided by a branch of Dismal Run into a smaller hill on the northeast known as Roundtop and a much longer one toward the southwest called Poplar Hill. Dismal Run seems to be the boundary between the Laurentian on the northwest and the serpentine on the southeast, flowing in a remarkably straight course about N. 60° E. The road mentioned as crossing the Lenni-Lima road at the Barren Hill schoolhouse shows the serpentine in quantity with its characteristic vegetation immediately southeast of Dismal Run, but as soon as the higher land is reached the serpentine disappears, and honeycomb quartz is found in the soil in greater or less quantity, but no rocks in place.

To avoid confusion I should state that there is another "Barren Hill Schoolhouse" in Marple about a mile and a half north of Palmer's Mills. The authorities, with characteristic economy, seem to have selected the serpentine outcrops in this vicinity as sites for Public Schools, perhaps upon the theory that knowledge would grow where nothing else would, but a worse education for the young can hardly be found than the surroundings of the three contiguous schools of Marple, Blue Hill, and Middletown. They are a disgrace to our civilization.

Eastward along this road, about a quarter of a mile from the schoolhouse, on an affluent of Ridley creek, occur great quantities of the honeycomb quartz, completely covering the ground, but even here the vegetation is not characteristic of the serpentine. About a quarter of a mile further east a steep bluff on the north of the road discloses the schists and in them a large mass of kaolinized feldspar, whether a bed or dyke is not clear. A short distance beyond, the road runs into the road from Lima to the Rose Tree Inn, and on this also the schists are seen. This brings us about a half mile northwest of our point of departure at Ridley creek and the railroad.

Examining now the more central part of the area we find on the State road, east of the road from Lima to Glen Riddle, loose honeycomb quartz, but at the foot of the hill, where Chrome Run crosses, two quarries in granulite. This rock lies in beds from a few inches to a foot in thickness, rarely more, and it is excessively jointed.

East of this is more honey-comb quartz and a little serpentine. On the same road east of the Black Horse tavern there is more quartz. About a quarter of a mile east of the tavern a small stream flows northeastwardly into Ridley creek. Its valley and the next valley to the north, form the locality known as Mineral Hill. Leaving this for a moment, we find along the road indications of serpentine and about a quarter of a mile west of Ridley creek large and abundant masses of enstatite, east of which are again the schists.

The Mineral Hill locality consists chiefly of the bed of the stream above mentioned which rises south of the State road and flows northeastwardly into Ridley creek. The descent is rapid and the stream has cut quite a gorge. Its bed is full of the fragments of the rocks, but the exposures of the rocks in place are not satisfactory. Serpentine, actinolite and granulite, the latter containing the moonstone and sunstone which have made the hill famous, are abundant. At one place the serpentine could be seen apparently interbedded in decomposed granulite.

A section on this creek where there had been a deep wash shows very much the same as in the cuts near Glen Riddle, viz.:

N. W.	1.	Granulite decomposed into fragments but the fragments hard and seemingly unaltered growing harder southeastward, strike N. 40° E. dip northwest irregular but steep.	6 feet.
	2.	Hallite (?).	6 "
	3.	Honeycomb quartz.	6 "
	4.	Granulite like (1).	3 "
	5.	Hallite (?).	2 "
	6.	Granulite decomposed.	6 "
	7.	Granulite decomposed including lenticular masses of actinolite decomposed and in same stratum 7 feet N. W. serpentine and quartz.	6 "
	8.	Hallite (?).	3 "
	9.	Granulite including lenticular actinolite.	1 "
	10.	Soft green. (Serpentine? Chlorite?).	1 "
	11.	White soft rock including curved crystals (of serpentine?).	1 "
	12.	Soft serpentine.	2 "
	13.	Hard serpentine.	10 "
	14.	Concealed.	10 "
S. E.	15.	Large masses of undecomposed granulite.	

About a quarter of a mile above the mouth of the stream is Crump's quarry. Here the serpentine, rather light in color and comparatively soft has been quarried, largely by machinery, toothed wheels rotated by steam power cutting deep grooves in the rock and forming slabs. The numerous joints in the rock cause many of these to break up into pieces too small for use, and the quarry has not been wrought for some time. The whole quarry is in serpentine, but the north wall is granulite. At the contact there is a stratum about one foot thick of soft micaceous rock like Hallite or Jefferisite. In the granulite are lenticular masses of the Hallite. Farther southeast is a section of this granulite, and there appears on the northwest, serpentine, then a thin stratum of Hallite, then granulite fragmentary, then a V-shaped mass of Hallite and fragmentary granulite, then serpentine. The strike is about N. 50° E. and the dip curves 70° southeast on the southeast side, to 80° northwest on the northwest side. Some of the granulite resembles the Leelite of southern Chester county which passes into Deweylite. This exposure is 10 or 12 feet across and the appearance is that of a dyke. About fifty feet southeast of this is a similar exposure, of similar character, with strike about the same, dip 70° southeast, and on the northwest of it, Hallite enclosing decomposed granulite.

The ravine northwest of this shows few exposures, but granulite is abundant, here inclosing sunstone and Amazon stone.

South of the Black Horse Inn is one of the largest areas of serpentine, and in this, a large quarry was wrought for many years. In this vicinity large masses of granulite are abundant, some of them containing very beautiful moonstone. Here occurs also corundum in crystals in albite, the locality being about a quarter of a mile south of the Black Horse Inn on the road to Elwyn. On this road the chief rock is the schists, with serpentine close to the Inn, and also about a quarter of a mile north of the railroad, the latter apparently not over 50 feet wide.

For brevity, I have used the term granulite to indicate the feldspathic rock so abundant in this region. Most of it is strictly granulite, a mixture of feldspar and quartz, the feldspar frequently oligoclase and greatly predominating, some of it probably containing no quartz at all. In some of it hornblende occurs but usually in very small proportion, as in the so-called granite quarries on Chrome Run near the State road. In the schistose varieties mica occurs, but it is probably absent in the compact varieties. Some of it is very fine grained, some coarse with crystals of feldspar an inch or more across, in fact a porphyry. In decomposing some of it breaks up into small angular fragments, which are quite hard, and some of it passes into kaolin, while in some places it appears to be changing into a serpentine-like mineral.

I have described the region thus minutely because my conclusions in regard to it differ from Mr. Hall's, and because the exposures at any one place are not convincing.

Mr. Hall's theory requires a lower region of schists, lying at low angles, overlaid by the serpentines in one or more synclinal basins. I have been unable to find an instance of a dip under 70°, while there are hundreds 70° and upwards.

Where the schists and granulites, and the serpentines, occur in contact, and both walls can be seen, one is included in the other in a mode precluding any theory of synclinal or anticlinal folding and to make interbedding the only possible explanation.

Whether the granulites are all stratified, or whether some of them are igneous is a more difficult question. It is certain that some of them are stratified, as in the cut west of Elwyn and that east of Glen Riddle station, but others, as on the east side of Chrome Run and in Crump's quarry, have a plutonic aspect and resemble very closely the granulite dykes which penetrate the chrysotile bearing serpentines near Black Lake and Thetford P. Q. At this place the explorations for chrysotile have well exposed the rock, which Dr. Ells of the Geol. Survey of Canada informs me is an altered intrusive diorite. Penetrating the serpentine are frequent dykes of granulite from a foot wide upwards, with the dyke character distinctly marked. The serpentine being hard and undecomposed, the effect of the dykes was apparent in slickensides and slaty, fibrous and jointed structure. Two small dykes which I examined were decomposed next to the serpentine and the whole appearance was almost a counterpart of that shown at Crump's quarry at Mineral Hill above described. Of these exposures Dr. R. W. Ells writes.

"In all these areas (Thetford, etc.) the serpentines are closely associated with the diorites, of some portions of which they are undoubtedly, in part at least, an alteration product, in contact with the black Cambrian slates on the one hand, and with hard whitish granulite on the other. The latter, which sometimes assumes the nature of a granite, frequently occurs in huge masses, or dykes, cutting the serpentine rocks both here, and at Black Lake and Thetford." Geol. Can. 1886, J. 29.

Speaking of the asbestus (chrysotile) mines of Belmine, he says:

"The serpentine is associated with considerable masses of whitish granulite * * * * in places * * * * a true granite. This appears in places to cut the serpentine after the manner of true dykes. * * It is presumable that in most cases at least the rock is to a great extent an alteration product of some form of dioritic rock rich in olivine." Id. p. 43.

I think the weight of the evidence is, that underlying this region are highly feldspathic schists inclosing beds of enstatite and perhaps other hornblende-like minerals, that through this probably penetrate dykes of granulite, that the enstatite, etc. have become serpentine and allied minerals, while the schists and granulite have decomposed. The serpentine also in many parts has changed into quartz, and this quartz now lies strewn upon the surface as the most abundant rock, simply by reason of its stability. Were a section of rock from the Glen Riddle cut spread upon land and exposed to the weather for a few seasons, probably nothing would be left but soil and the honey-comb quartz, which last would probably appear to be the chief, if not the only rock, while in fact it does not constitute two per cent of the volume. This theory would account for the excellence of the soil in most parts of this area, indeed over nearly all of it where the serpentine is not actually visible at the surface. This was well described by an intelligent farmer with whom I conversed, in the words, "where the serpentine lies deep the ground is good." I am informed that in nearly all the wells, even where the honey-comb quartz is quite abundant at the surface, the rock reached is a gneiss or schist.

In one respect this Media outcrop is anomalous. It appears to be the only one away from the Laurentian in which enstatite appears. On the east branch of Ridley creek, that is northeast of the table-land, there is a small outcrop of this rock with a strike which would carry it into the area under consideration. This enstatite is in the schistose gneisses, apparently as an interbedded mass, and is in the direct line of the outcrops arranged in line to Palmer's Mills as shown on Hall's map. The exposures are poor, but that they are all within the schists is unquestionable and with them in some cases a coarse granite is associated, apparently interstratified in the schists.

It is further true that the northwestwardly part of the Media outcrop, or rather series of outcrops, does border the Laurentian, and that the serpentine lying along Dismal Run may be a continuation of the Blue Hill serpentine, and may be entirely distinct from the southerly outcrops which are certainly in the schists.

The Serpentine of Glen Mills on Chester Creek.

Mr. Hall finds a narrow synclinal of schists with serpentine overlying the gneisses of Chester creek which he regards as Laurentian.

I have already stated my reasons for thinking these gneisses a part of the Manayunk group. A recent careful examination confirms me in this and indicates that the serpentines of this vicinity, like those farther east, are altered beds in the Manayunk gneisses.

The serpentines are shown on Mr. Hall's map as four distinct outcrops, one on each side of the creek, on a line passing N. 50° E. through Glen Mills, and two on a parallel line about three-quarters of a mile S. E. near Sharpless' feldspar quarry.

The outcrop west of the creek nearest Glen Mills is confined to a very trivial exposure in the road. That southwest of it I could not find. East of the creek were trivial exposures of honey-comb quartz loose on the surface, but I believe considerably north of Mr. Hall's line.

At Glen Mills, the topographical base of Mr. Hall's map is incorrect or the roads and railroad have been changed since it was made. The road to Sharpless' quarry is correct and the green spot at its westerly termination correctly indicates the location of the serpentine there. The railroad north of this crosses the old creek bed as shown, diverting the creek to the west side of the railroad, which, however, does not continue on the east side, but crosses immediately below Glen Mills station, and thence continues on the west side. This crossing and the station are about a half mile north of the road to Sharpless' quarry, and at this point there is another bridge over the creek connecting four converging roads, or more accurately, permitting the road along the creek to cross, going northwardly, from the west bank to the east, and a northeast and southwest road to cross the creek. It is on this last road I observed the honey-comb quartz east of the creek. On Mr. Hall's map these roads are located a considerable distance north of their true position.

Beginning at the creek about a half mile north of Glen Mills station and this bridge, at the point at which on Mr. Hall's map, trap in Laurentian is indicated, a very compact garnetiferous gneiss is found. South of this, a recent cut for a railroad to the new House of Refuge shows the same gneiss interbedded in the Manayunk gneisses, some decomposed, some not, some contorted, some regular, showing a strike about N. 20° E. with a southeasterly dip of 20° to 50°. South of this is another excellent exposure on the railroad and about here should be the northerly margin of the schist area, but the same rocks appear, and continue with constant exposures, down the creek to and beyond the Sharpless road. Close to the road and to the north of it is a quarry evidently not wrought for many years.

The hard gneisses appear in the bottom and side. The face of the quarry shows alternations of the hard gneisses with decomposed rock.

At the north wall of this quarry a very regular stratum gave strike N. 30° W. dip 50° N. E. West of this, along the railroad there is a prevalent easterly dip 45° to 70°. The strike is quite irregular, owing to contortions in the strata; N. 0° E., N. 30° E., N. 20° W. were observed.

South of the Sharpless road is low ground and a creek flowing from the northwest; south of this is a hill showing the gneiss with a cut 150 feet long through part of it. At the north end the gneiss is very massive and irregular. In the middle it is coarse and very feldspathic, over this part a southeast dip is visible, at the south end there is a northwest dip of 70° to 90° with a strike N. 60° E.

On the Sharpless road, east of Chester creek the same gneisses appear much decomposed.

Along the bottom of the creek mentioned as flowing from the northwest into the Chester creek at the Sharpless road the same gneiss is quite abundant in loose masses.

On the west bank of Chester creek close to the serpentine, no outcrops are visible but there are loose masses of the gneiss, and 300 feet south, it occurs in place.

The outcrop at Joel Sharpless' is shown as two in a line N. E. and S. W. I found but one, at the summit of a high hill about one hundred yards south of the road and approximately parallel to it (N. 70° E). The only rock visible is the honey-comb quartz but it is in large quantity over several acres of ground. The gneiss is visible in the road and occurs also in large loose masses in the next field south of the quartz.

The Sharpless feldspar and mica quarry is not to the north of the serpentine but to the southeast, and on the east side of the small creek shown on the map. This quarry is in an exceedingly coarse granite containing much orthoclase and mica, the latter crystallized, the orthoclase in the upper part kaolinized. Some crystals of the mica are more than a foot in length and breadth, but the larger crystals seem very irregular, and I am informed that much of the mica was unmerchantable. The quarry has not been wrought for years and evidently the work was not systematically conducted. Very large beryls occurred in the granite.

All the Delaware and Montgomery county outcrops close to the Laurentian are characterized by the general very dark color and great hardness of the serpentines, and by the rarity of minerals, except varieties of serpentine, and asbestus, enstatite and quartz, the latter resulting from the alteration of the serpentine. At nearly all the outcrops there is evidence, and at some of them almost absolute proof, that the serpentine results from the alteration of the enstatite. Chromite, Genthite and Ripidolite occur rarely.

The pseudomorphism of enstatite into serpentine may be most clearly seen at Rose's quarry on the La Fayette belt about one thousand feet west of the Schuylkill, where the same stratum is enstatite below, serpentine above, but rocks in process of change may be found at many of the other outcrops, especially along the great Radnor belt, also at the outcrop S. W. of Newtown Square and where the LaFayette belt crosses Darby Creek near the southwest corner of Radnor Township.

It is true that Dr. T. Sterry Hunt [1] contends that the origin of the serpentine and related magnesian rocks was to be found in deposits of hydrous silicates like the magnesian marls of the Paris basin and that the enstatite, etc. are derived from the serpentine.

In the region under discussion, the evidence is that the enstatite and the serpentine are pseudomorphous one of the other. Inasmuch as there frequently occur serpentine pseudomorphs after other minerals, in which the crystalline form of the original mineral is present, *e. g.*, after chrysolite, enstatite, staurolite, pyroxene, hornblende, etc., while there is no evidence whatever that any of these minerals, or probably any others, except quartz, have resulted from the decomposition of serpentine, I incline to the other view. This is supported too by the mode of occurrence. The enstatite at Rose's quarry on the Schuylkill opposite LaFayette station is found at the bottom; as the stratum rises it can be seen to be more and more changed gradually until, near the top, true serpentine results and the enstatite disappears. There is, throughout, evidence of great pressure in a slaty structure and slickensides, proof that the forming mineral occupies the greater bulk, which would be the case if serpentine is the resulting mineral. Enstatite being a crystalline mineral would it not, if formed by dehydration from a hydrous magnesian silicate change abruptly into more or less crystalline masses rather than in the uniformly progressive mode in which we find it, whereas the latter is exactly as we should expect to find hydration occur.

[1] Min. Phys. & Phys., p. 432.

It will be instructive in this connection to quote observations of of Dr. Genth and others in regard to these and like serpentines.

Speaking of the corundum of Chester, Mass., Dr. F. A. Genth[1] says:

"The whole deposit lies in a talcose slate and serpentine between gneiss and mica slate in the centre of the Green Mountains."

Dr. Genth [2] shows that the chromiferous and nickeliferous serpentines and talc slates owe their existence to the decomposition of chrysolite rocks.

"In Pennsylvania, where the unaltered chrysolite rock has never been observed, a rock has been found which is its representative and contains the same constituents, only in different proportions. In North Carolina the granular chrysolite always contains small quantities of enstatite (bronzite), in Pennsylvania on the contrary we have an enstatite (bronzite) rock containing small grains (from 5 to 10%) of chrysolite. It is best developed at Castle Rock, Delaware county, also near Wood's Chrome Mine in Lancaster county.

In all the chrysolite rocks small grains or crystals of chromite are disseminated through the mass of the rocks; in the serpentine, which has resulted from the alteration of the chrysolite, these crystals or grains are still present and give evidence of the original mineral" [3]

Dr. Julien [4] writing of the dunyte beds of N. C. says, "the dunyte beds are everywhere and exclusively found inclosed in a stratum of hornblende gneiss black and slaty. This forms the upper layer and largely occupies the central zone of the mass of gneisses and schists entirely of types identical with those found in the White Mountains of New Hampshire."

Dr. R. W. Raymond, [5] speaking of the Jenks corundum mine in Macon Co., N. C., and quoting Prof. Kerr says, "This mountain tract of Laurentian rocks * * * along the middle of the belt now specially under consideration a discontinuous line of outcrops appears at intervals from Cane creek in Mitchell county through the intervening counties of N. C. into Union county, Ga. These are called in the State Geological Report dykes of chrysolite or dunite," and adds, "I should not be surprised if future careful study of all the localities should show these chrysolite beds to be intercalated members of the formation in which they occur."

He then concludes as a result of his studies that the rock is undoubtedly sedimentary in character, the dunyte sometimes inter-

[1] Am. Phil. S.. September 19th, 1873.

[2] Sill. Jour. Vol. 2, pp. 111–202.

[3] Dr. Genth, Am. Phil. So., Aug. 18th, 1882, page 394.

[4] Proc. Boston Soc. of Natural History, Vol. XX, p. 11, Dec. 6th, 1882.

[5] Trans. Am. Inst. M. E. 1876.

bedded in the gneiss in large layers one to six meters in thickness and that four modes of alteration of this dunyte occur, viz.:—

1. Chalcedonic. "When all the bases have disappeared and the chalcedony remains as an exceedingly cellular mass of thin scales and plates parallel or anastomosing with the greatest irregularity, a chalcedonic schist or siliceous sinter is the result, often bearing some resemblance to a buhrstone."

2. Hornblendic. "The final result is a green actinolite rock or schist or grayish-white amphibolyte or tremolyte schist.

3. Talcose.

4. Ophiolitic.

5. Dioritic."

One prominent feature of the most of the Pennsylvania outcrops above described is the abruptness of their appearance and disappearance, in this respect resembling far more plutonic masses than interstratified beds or synclinal basins. If interstratified they should be somewhat lenticular in outline. If synclinal the adjacent dips being steep as seems to be always the fact they should also show a more or less lenticular or boat-shaped outline. On the contrary, where exposed they often appear abruptly and end abruptly, well shown at the outcrops east and northwest of Radnor station, on the Radnor and Chester road near Darby creek, in Marple, at Blue Hill where a hill or ridge of considerable height is serpentine to the southwest bounded by Laurentian on the northwest and wholly Laurentian on the northeast, the strike of the Laurentian being nearly south, that of the hill nearly northeast and southwest.[1] Nevertheless the position of the serpentine belts close to the Laurentian on the one side and with mica and hornblende schists on the other, seems to forbid our regarding them as intrusive rocks. The subject is beset with difficulties but the theory of interbedding, notwithstanding the difficulty of explaining the want of continuity and the abrupt appearance and disappearance, seems the only one tenable. It is true that the great Conshohocken trap dyke strikes almost with the adjacent rocks, but nevertheless it does not do so exactly, its bearing westwardly being more southerly, so that at the Schuylkill it is in the hydromica schist of the South (Chester) Valley Hill. It then cuts at a very acute angle the limestone, Potsdam and mica schists of Cream

[1] The outcrops of the Radnor-West Chester belt are on a line nearly east and west but the outcrops themselves all cross this line bearing more N. E. and S. W. except that northeast of Radnor station.

Valley, reaching the Laurentian at Devon, southwestward of that seeming to retain no longer its rectilinear aspect.

I believe, therefore, that there are in this region certainly two, and perhaps four horizons of serpentine; one in the Laurentian, a second, perhaps in, but certainly if not in, almost immediately above, the Laurentian, a third of altered schists, probably a synclinal in mica schists of the Chestnut Hill series and the fourth altered hornblende-like rocks in the Manayunk schists. It may be that the first should be grouped with the second, and the third with the fourth. It would seem probable that at the close of the Laurentian period in this region magnesian silicates were abundant, possibly derived from the trap rocks so common in the Laurentian of Delaware County, or from volcanoes whose existence the trap dykes indicate; that subsequently, portions of the rocks were eroded and probably sorted by wave action, and owing to their high specific gravity formed beds in the more recent schists similar to the magnetite beds of the Laurentian.

As to the age of these schists much more must be learned before we can feel any certainty. Lithologically they are Montalban and Huronian, but if there is no fault and the sandstone at Waverly Heights and vicinity is Potsdam, the schists adjacent to the Laurentian are of that age or more recent. This the exposure on the Paper Mill road at Chestnut Hill seems to confirm. I have seen no evidence of the supposed fault and much to lead me to believe that it does not exist—at least that it does not exist as an extensive fault. Minor faults are common.

The belief that the Potsdam is absent west of the Schuylkill has, I believe, led to this error and to the connecting of the North (Chester) Valley Hill with the Barren Hill ridge[1]; whereas they are, apparently, as shown on the map in C^6, parts of the opposing legs of a synclinal underlying the Chester–Montgomery limestone valley, and my observations make the structure west of the Schuylkill almost precisely that shown in C^6, at Spring Mill, viz., going northwest from the 1–Laurentian; 2–Rogers' altered primal; 3–Potsdam; 4–limestone No. 2 of Cream Valley; 5–Hydromica schist (South Valley Hill); 6–Limestone No. 2 (of Chester Valley); 7–Potsdam of

[1] Prof. Lesley, Notes of the Geol. of the Schuylkill river, 1884, p. 6, says: "On the east side of the river at Spring Mills the limestone is evidently faulted against the azoic rocks of the Philadelphia belt." But the visible succession is southeast, 1–Laurentian, 2–Roger's altered primal, 3–Potsdam sandstone, 4–limestone, 5–hydromica (with trap), 6–limestone, 7–Potsdam northwest.

North Valley Hill, 8–Conglomerate probably lower Potsdam, 9–Laurentian. Nos. 2 and 8 are not on the map in C[6]. This would indicate a broad synclinal, the Laurentian at the base, the hydromica schists at the centre and the limestones of Cream Valley and of the Chester Valley identical.

There is one fact not easy of explanation. The South Valley Hill on a line from Radnor station to the King of Prussia is over two miles wide and is a broad elevated table-land. Close to this line two valleys begin, draining northeastward, dividing the table-land into three hills. Of these the middle and the northernmost end west of the Gulf road, forming promontories projecting as it were into bays. East of these promontories the whole region is limestone. The southernmost division of the hill preserves its elevation and crosses the Schuylkill at Conshohocken, but it is less than half a mile in breadth.

Now if the limestone were in strata nearly horizontal, we could readily explain this by supposing a deposition subsequent to the elevation and denudation of the hydromica, but on the contrary all observable dips are vertical or nearly so. This seems opposed to the theory of a simple synclinal.

Is it possible that the limestone underlying the hydromica has been folded and crumpled up with it, in minute compressed anticlinals and synclinals like that exposed on the Schuylkill below Potts Landing, that the hydromica has been removed by erosion, leaving the ridges of limestone? This is but conjecture. The structure, however, is quite evident, and no other explanation seems to satisfy the conditions.

In the cut of the Pennsylvania Schuylkill Valley Railroad through the hydromica schist hill at Conshohocken, what appeared to be decomposed hydromica schist was underlaid by limestone.

In this connection may be mentioned the fact that the basin of the Conshohocken Water Works, on this hill of hydromica schist, has two or three times suddenly emptied itself through holes in the bottom without visible outlet—easily explicable if the limestone underlies, but difficult otherwise.

If the hydromica schist overlies the limestone, then the sandstone on the north side of the hydromica hill, and on the south side of the Chester Valley cannot be Potsdam, as Prof. Rogers, Prof. Lewis and the writer supposed, but must be more recent.

Except the Conshohocken trap dyke, and the numerous dykes of the Laurentian, mostly small and apparently of limited length, I have nowhere found trap in the region. I have visited the localities at which the trap is shown on the map in Vol. C^5 except Howellville, Delaware county, which is in Laurentian, and I believe that on Chester creek and also on Colleen brook near Darby creek a very compact gneiss has been taken for trap.

In the schists and gneisses east of the porphyritic and especially in the Fairmount gneiss the granite is usually segregated, but it is probable that intrusive masses occur.[1]

[1] 2nd. Geol. Survey of Pa. Ann. Rep. 1886, IV, 1602, & plate 1570.

CATALOGUE OF THE OWLS IN THE COLLECTION OF THE ACADEMY OF NATURAL SCIENCES OF PHILADELPHIA.

BY WITMER STONE.

In the following list I have not followed Mr. Sharpe's Catalogue of Birds in the arrangement of the genera and species as was done in the Catalogue of the Muscicapidæ (Proc. Phila. Acad. 1889, p. 146), since his work seems to differ in this respect from most of the recent works on the subject. But, having adopted the names and arrangement of the North American species, as given in the A. O. U. Check List, I have endeavored to interpolate the foreign genera and species in their proper places, and to make the nomenclature conform, as nearly as possible, to the code of the American Ornithologists' Union.

The total number of species and subspecies of Striges seems to be somewhat over 200 and of these the Academy collection contains 113, represented by 525 specimens including the types of 14 species.

The principal individual collections to which the specimens belong are as follows:

Massena collection, covering the whole world.
Gould collection, Australia.
Boys collection, India.
DuChaillu collection, West Africa.
Prince Momfanoi collection, Siam.
Pease and D'Oca collections, Mexico.
Townsend collection, Western N. A. and Sandwich Islands.
Cassin and Krider collections, mainly N. A.
Abbott collection of skins, North America and West Indies.

The majority of these were contained in the private collection of Dr. Thomas B. Wilson and were presented by him to the Academy.

After each species are given the localities from which the Academy has specimens.

Family STRIGIDÆ.

STRIX ALUCO Linn. (=*S. flammea* of authors.)
Specimens from France and Liberia.

STRIX ALUCO JAVANICA. (Gm.)
India, specimens collected by Capt. Boys.

STRIX ALUCO DELICATULA. (Gould.)

Types, from Australia, Gould's collection.

STRIX PRATINCOLA Bonap.

Specimens from Penn., N. J., N. Y., Dist. of Col. and Cal.

STRIX PRATINCOLA PERLATA. (Licht.)

One from Brazil and two from Nicaragua, probably the latter belong to the race *guatemalae* Ridgw., but I cannot distinguish them from the South American bird.

STRIX PRATINCOLA FURCATA. (Temm.)

Several specimens from Cuba.

STRIX NOVAE-HOLLANDIAE Steph.

A series from N. and S. Australia and N. S. Wales, Gould collection.

STRIX CASTANOPS Gould.

Types of the species from Tasmania, Gould's collection.

STRIX TENEBRICOSA Gould.

Type of the species from New South Wales; also one from the Massena collection.

STRIX CANDIDA Tick.

One specimen from India.

STRIX CAPENSIS Smith.

Three specimens from Cape of Good Hope.

RHODILUS BADIUS. (Horsf.)

One specimen from India, Capt. Boys' collection.

Family BUBONIDAE.

ASIO OTUS. (Linn.)

A series from Europe, Rivoli collection.

ASIO WILSONIANUS. (Less.)

A series from Pennsylvania and New Jersey.

ASIO MADAGASCARIENSIS. (Smith.)

One male, Madagascar.

ASIO CAPENSIS. (Smith.)

Specimens from South Africa and Morocco.

ASIO ACCIPITRINUS. (Pall.)

Specimens from Pennsylvania, New Jersey, California; South America, India and France; also one specimen from the Sandwich Islands (*A. sandvicensis* Blyth.) collected by J. K. Townsend, M. D.

PULSATRIX PERSPICILLATA. (Lath.)

Young in various stages of plumage also adult male and female, from Brazil, Nicaragua and Jalapa, Mexico. There is also a specimen from Peru which seems to differ from any described phase of this species. It is uniform chocolate brown above, lighter than *perspicillata* and showing a tendency to darker coloration on the head, the breast and throat are chocolate uniform with the back, the white being confined to a spot on the chin, the rest of the under surface is fulvous, the white spots on the wing coverts are much less marked than in *perspicillata* and are suffused with fulvous. Mr. Ridgway, whom I consulted about this specimen, writes me that there is in the National Museum "one specimen with no white whatever on the chin, while a large majority have no trace of white or light colored markings on the wing coverts." I think it probable, therefore, considering the variation in this group, that this is merely a phase of *perspicillata* rather than a distinct species or race.

CICCABA HULULA. (Daud.)

Several specimens from South America.

CACCIBA NIGROLINEATA. (Scl.)

Jalapa, Mexico, from the D'Oca collection.

CICCABA VIRGATA. (Cass.)

Specimens from Mexico, Cayenne, Bogota and Trinidad. Some of the South American specimens are in all probability Mr. Cassin's types, but there are no data to show which they are.

CICCABA SUPERCILANS. (Peltz.) Brazil.

CICCABA ALBOGULARIS. (Cass.)

Several specimens from South America including the types of the species.

CICCABA HYLOPHILA. (Temm.) Columbia and Brazil.

[The species of the old genus *Syrnium* form a very perplexing group when a subdivision is attempted. The northern genus *Scotiaptex* is easily separable; then there are the typical Syrniums from the more northern portions of both continents, the species varying more and more from the type as they go south. I have followed Sclater and Salvin in grouping the South American naked-toed species together in the genus *Ciccaba*. The African forms seem to vary in much the same way, but for convenience I have left them as well as all the other old world species in the genus *Syrnium*. The synonymy of the generic names which have been applied to these species seems to be considerably involved.]

Syrnium nuchale Sharpe.

Rivers Moonda and Ogobai, West Africa collected by DuChaillu.

Syrnium woodfordi. (Smith). Cape of Good Hope.

Syrnium leptogrammicum. (Temm.) Sumatra.

Syrnium newarense. (Hodgs.) Malabar.

Syrnium ocellatum Less. India.

Syrnium sinense. (Lath.) Java.

Syrnium nivicolum Hodgs. India.

Syrnium stridulum. (Linn.) (=*S. aluco*, authors.)

Specimens from France, Sweden and Algeria.

Syrnium nebulosum. (Forst.)

Specimens from Pennsylvania and New Jersey.

Syrnium uralense. (Pall.)

Sweeden, from Kinberg's collection.

Syrnium uralense fuscescens. (Tem. and Schl.)

One specimen from Japan.

Scotiaptex cinereum. (Gm.)

One specimen collected by J. K. Townsend in the Rocky Mts.

Scotiaptex cinereum lapponicum. (Retz.)

One typical specimen from Russia, and another marked "Northern Europe" which is darker with considerable rufous on the hind neck.

Nyctala tengmalmi. (Gm.) France.

Nyctala tengmalmi richardsoni. (Bonap.)

"Fort Resolution, HudsonBay Terr.," presented by the Smithsonian Institution.

Nyctala acadica. (Gmel.)

Pennsylvania and other parts of the United States. Also one from Cassin's collection marked Bogota.

Nyctalatinus harrisi (Cass.)

One specimen which is in all probability the type though it bears no label whatever.

Megascops scops. (Linn.)

Specimens from France, Senegal and one from the Himalayas which seems to be identical with European specimens, though it should perhaps be referred to the race *pennatus*.

Megascops scops capensis (Smith.)

A distinct dark race represented by several specimens from Cape of Good Hope.

Megascops scops hendersonii. (Cass.)

Types. A male and female marked "Off Novo Redonda, came on board." These birds are smaller than any other specimens of

Megascops in the collection and seem to constitute a distinct race. They are very bright in their markings and are much lighter on the back than South African specimens.

MEGASCOPS SUNIA. (Hodgs.) India.

MEGASCOPS ELEGANS. (Cassin.)

One specimen from Japan, type of the species. I do not think this is the bird described by Sharpe under *Scops elegans* from China, as his description does not suit the type before me. *M. elegans* seems to me to be more nearly related to *M. menadensis* from the Celebes. (See also Stejneger, Proc. U. S. Nat. Mus. 1886, p. 640.)

MEGASCOPS MAGICUS. (Müll.)

A specimen from Siam is doubtfully referred to this species.

MEGASCOPS MAGICUS MENADENSIS. (Q. & G.) Celebes.

MEGASCOPS MAGICUS LEUCOSPILUS. (Gray.) India.

MEGASCOPS LETTIA. (Hodgs.)

Specimens collected in India by Capt. Boys and compared with the type by Dr. T. B. Wilson. July 1851.

MEGASCOPS LEMPIJI. (Horsf.)

Specimens from Java, Borneo and India.

MEGASCOPS RUFESCENS. (Horsf.)

Specimens from Sumatra.

MEGASCOPS SAGITTATUS. (Cassin.)

Three specimens from Malacca, types of the species.

MEGASCOPS LEUCOTIS. (Temm.)

Four specimens from Fazogloa. This is a very distinct species and reminds one of an Indian Bubo in miniature.

MEGASCOPS ASIO. (Linn.)

Series from Pennsylvania and New Jersey.

MEGASCOPS ASIO MACCALLII. (Cass.)

One immature bird from New Mexico.

MEGASCOPS ASIO SEMITORQUES. (Schl.)

Specimens from Japan.

MEGASCOPS BRASILIANUS. (Gm.)

Series from Cayenne, Brazil, etc.

MEGASCOPS BRASILIANUS GUATEMALAE (Sharpe)?

Several specimens doubtfully referred to this race.

MEGASCOPS BRASILIANUS USTUS. (Scl.)

Specimens from Peru and Columbia.

MEGASCOPS BRASILIANUS WATSONI. (Cassin.)

Type of the species from Orinoco.

Megascops barbarus. (Scl. and Salv.)

One darkly colored specimen from Mexico.

There is another Megascops (No. 2442) from Panama, reddish-brown above with very fine transverse markings, and marked below with rufous cross bars, very fine and very close together so as to appear nearly uniform on the breast. This specimen does not agree well with any described phase, but is perhaps related to *barbarus*.

Megascops cooperi. (Ridgway.)

One specimen agreeing well with Mr. Ridgway's description and easily distinguished by the bristly toes from any member of the *brasilianus* group to which it approaches in coloration.

Lophostrix cristata. (Daud.)

Four specimens from Cayenne representing both phases of plumage.

Scotopelia peli. Bp.

One immature specimen from W. Africa collected by DuChaillu.

Ketupa ceylonensis. (Gm.)

Specimens from Bengal and two from Capt. Boys' collection.

Ketupa javensis Less.

Specimens from Java, Sumatra and India.

Bubo bubo. (Linn.) France and Switzerland.

Bubo virginianus. (Gm.) Pennsylvania and New Jersey.

Bubo virginianus subarcticus. (Hoy.)

Specimens from Iowa and California and also the type taken in Wisconsin, presented by Dr. Hoy.

Bubo virginianus magellanicus. (Gm.)

Specimens from South America.

Bubo mexicanus. (Gm.)

Specimens from Cayenne.

Bubo bengalensis. (Frank.)

India. Collected by Capt. Boys.

Bubo ascalaphus Sav. Morocco and Egypt.

Bubo capensis Smith. Cape of Good Hope.

Bubo maculosus. (Vieill.) Cape of Good Hope.

Bubo cinerascens Guér. Fazogloa.

Bubo lacteus. (Temm.) Senegal, W. Africa.

Bubo coromandus. (Lath.) India, collected by Capt. Boys.

Bubo nipalensis Hodgs. Himalayas.

Bubo orientalis. (Horsf.) India and Java.

BUBO LEUCOSTICTUS Hartl.

Moonda river, W. Africa, collected by DuChaillu.

NYCTEA NYCTEA. (Linn.)

Specimens from New Jersey, and some from northern Europe.

SURNIA ULULA. (Linn.) Europe.

SURNIA ULULA CAPAROCH. (Müll.) Nova Scotia.

SPEOTYTO CUNICULARIA. (Molina.) Bolivia and Peru.

SPEOTYTO CUNICULARIA HYPOGAEA. (Bonap.)

Specimens from California, Oregon and New Mexico.

SPEOTYTO CUNICULARIA FLORIDANA. Ridgw.

One specimen from the west coast of Florida.

GYMNASIO NUDIPES. (Daud.)

Two specimens from St. Thomas, W. I.

GYMNASIO LAWRENCII. (Scl. & Salv.) Cuba.

ATHENE NOCTUA. (Scop.) France and Algeria.

ATHENE BRAMA. (Temm.) India.

NINOX LUGUBRIS. (Tick.) India.

NINOX SCUTELLATA. (Raffl.) Sumatra.

NINOX BOOBOOK. (Lath.)

S. and W. Australia, from Gould's collection.

NINOX NOVAE-ZEALANDIAE. (Gm.) New Zealand.

NINOX MACULATA. (Vig. & Horsf.) Tasmania.

NINOX PUNCTULATA. (Q. & G.) Celebes.

NINOX CONNIVENS. (Lath.)

New South Wales. Gould's collection.

NINOX STRENUA. (Gould.)

Types of the species from New South Wales, Gould's collection. Also the type of *Athene rufa* Gould, which seems to be a phase of this species, from Pt. Essington, North Australia.

GLAUCIDIUM PASSERINUM. (Linn.) France.

GLAUCIDIUM GNOMA. Wagl.

California and Washington Territory.

GLAUCIDIUM PUMILUM. (Temm.)

Two specimens, one from S. America and the other with no locality. These are the specimens described by Ridgway, Proc. Bos. Soc. Nat. Hist. 1873, pp. 97 and 98.

GLAUCIDIUM SIJU D'Orb. Cuba.

GLAUCIDIUM NANUM. (King.) South America.

GLAUCIDIUM JARDINII. (Bonap.)

New Grenada and Brazil including the types of *G. langsbergii* Ridgw. (Proc. Boston Soc. Nat. Hist. 1873, p. 98). Dr. Wilson's name is written "*lansbergii*" on the stands.

GLAUCIDIUM PHALAENOIDES. (Daud.)

A large series of specimens in both phases of plumage, varying in both size and coloration.

GLAUCIDIUM BRODIEI. (Burton.) India.

GLAUCIDIUM PERLATUM. (Vieill.) Senegal and South Africa.

GLAUCIDIUM RADIATUM. (Tick.) Himalayas.

GLAUCIDIUM CASTANOPTERUM. (Horsf.) Java.

GLAUCIDIUM CUCULOIDES. (Gould.) India.

MICROPALLAS WHITNEYI. (Cooper.)

One specimen from Arizona, presented by the Philadelphia Zoological Society.

GEOLOGY OF ARTESIAN WELLS AT ATLANTIC CITY, N. J.

BY LEWIS WOOLMAN.

During the past three years there have been drilled for the Consumers' Water Company at Atlantic City, N. J., four artesian wells. These are of various depths as will be more particularly noticed further on. As the work progressed I have been studying it from a geological stand-point, believing that a careful record of the succession of strata penetrated and of their included fossils would, in connection with information yet to be obtained by developments at other localities, lead to valuable results. Among these would be the construction of a true vertical section across the State from Camden to the sea, showing the amount of dip and the thickness of each of the various Quaternary (?), Miocene, Eocene and Cretaceous beds including also the determination of the number and location of the different water-bearing strata.

Whatever results have been arrived at, their attainment is due primarily to the co-operation of three members of the company, Dr. T. K. Reed, Jos. H. Borton and F. Helmsley, who have afforded every facility for geological investigation. Credit is also due J. H. Moore, contractor for the first three wells and P. H. & J. Conlin, contractors for the fourth well, for much information and for the care they and their assistants have taken to preserve specimens every few feet. These they placed in small dairy salt sacks with Dennison's shipping tags attached, on which they marked the depth and description of material. In scientific circles thanks are due Prof. A. Heilprin for valuable assistance in paleontology and geology, to C. Henry Kain and his co-laborer, E. A. Schultze, for authoritative identification of diatoms, to Dr. D. B. Ward of Poughkeepsie, N. Y., for photo-micrographs of the same which have aided the author in their study, and to C. L. Peticolas of Richmond, Va., for cleaning and separating the diatoms from numerous specimens of earths.

Well No. 1 is situated at the S. E. corner of Michigan and Arctic Avenues; the other wells are grouped within a radius of 100 feet of each other upon a knoll within the meadows about one-fourth of a mile nearly N. W. of No. 1.

Well No. 1 was sunk to a depth approximating 1150 feet. At about 1100 feet a plentiful supply of fresh water flowed to five feet or more above the surface. This water since 1887 has been furnished through street mains to many hotels and cottages.

Well No. 2 was abandoned at 325 feet, on account of an accident.

Well No. 3 was then sunk to 1400 feet, or lower, but without success in obtaining water. Drilling was suspended at this point and the pipe is now being withdrawn in the hope of developing some of the water strata that were undoubtedly passed through probably in a partially closed condition.[1]

These three wells were bored by the process usually used in rock countries by means of the drill and sand pump. The succeeding well, No. 4, was put down by the hydraulic method in which the drill has a hollow body with perforations near the cutting end. To this drill, as the work proceeds, are added section after section of tubing. Down this tubing water is forced by pressure through the perforations above noted and rising between the tube and the casing flows out at the top, continually carrying mixed with it the loosened material from the bottom in finely divided form. This process is much used along the New Jersey coast and is well adapted to soft strata and where no solid rock occurs.

In well No. 4, water flowing above the surface was found at 328, 406, 429 and 554 feet. By pumping, the 328 feet level yielded about 50 gallons a minute, but the 406 feet, only about five gallons.

The water from each of these, although fresh at first, proved salty on being pumped and these strata were therefore cased off. Owing to the toughness of the clay, the pipe—a ten-inch one—could not be driven further than 424 feet; the boring was therefore continued without casing, the walls remaining intact without such support until a total depth of 578 feet was reached. In sand at 429 to 430 feet, a very small flow of fresh water was obtained, but at 554 to 560 feet a gray water-bearing sand was pierced, from which, I am informed, there flowed 50 gallons a minute. By pumping, this yield was at once increased to 150 gallons, and afterwards to 200 gallons. This water has now been pumped several weeks. It proves pure and fresh and is pleasant to the taste.

From well No. 3, there were preserved 184 specimens of earth from as many different depths. These were compared with a carefully kept record of strata furnished by J. H. Moore and the upper

[1] As this article was going to press information was received that a water-bearing stratum was opened at about 720 feet that flowed 10 gallons a minute.

part collated with 37 additional specimens from well No. 4. From this the accompanying section has been constructed, which it is believed is an accurate representation and grouping of strata.

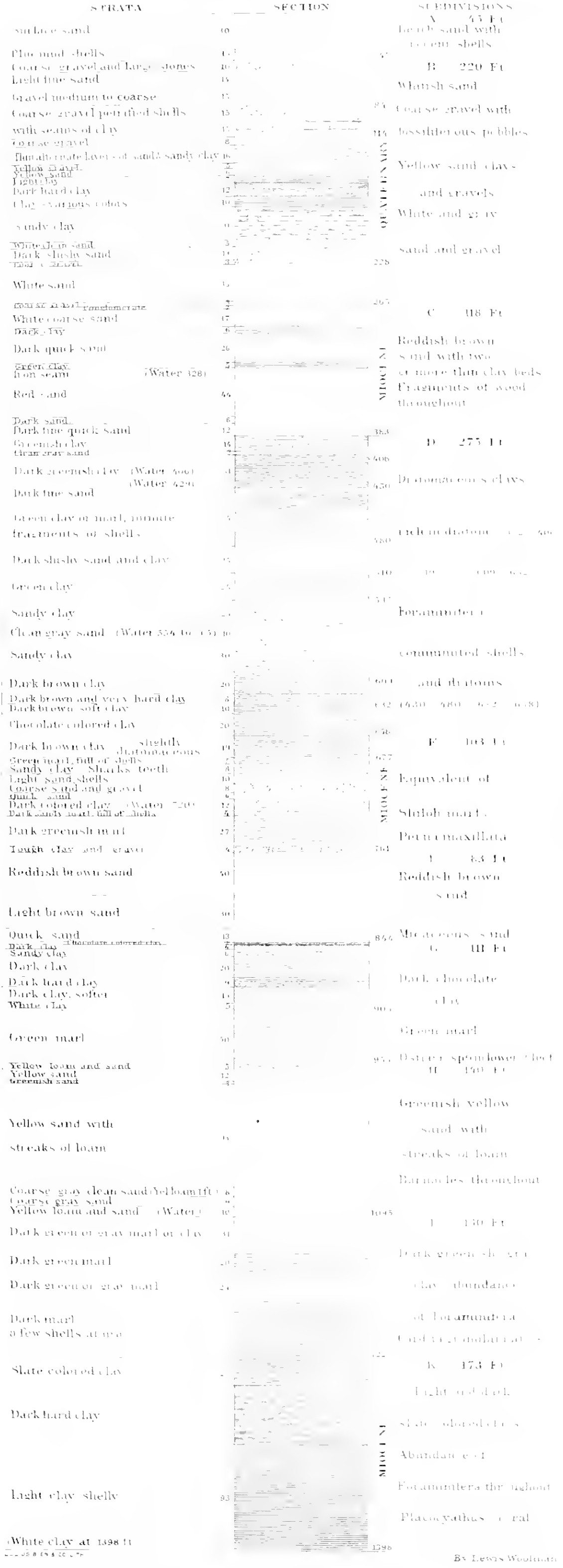
Upon the left is a minute description of the various changes in material copied verbatim from a record furnished by J. H. Moore, with the insertion, however, in brackets of the depths of the various water-bearing horizons, as learned from the development of the other wells. Upon the right the section is subdivided so as to show the grouping of the strata into larger beds having certain characteristic features. For convenience, each of these is marked by a letter, and a corresponding letter heads each paragraph relating to the same in the succeeding detailed description.

A—Underneath 30 feet of ordinary beach sand there exists 15 feet of blue mud. This was probably the bottom of an old thoroughfare or channel. It contains the usual shells of the coast, the oyster, the clam and the scallop, and also one single minute organism belonging to the foraminifera and identical with the only living species—a *Nonionina*—now found on the beach.

B—Beneath this is a series of sands and gravels 220 feet in thickness, varying from whitish to yellow in color and alternating from very fine sand to very coarse gravel.

At 84 to 116 feet and again at 228 feet, these gravels exhibit pebbles containing fossils that show them to be of Devonian and Silurian origin. Similar fossiliferous pebbles are plentiful at Straffordville north of Tuckerton, and also in the cuts of both the Camden and Atlantic and the Reading Railroads, at about 14 miles from Atlantic City. All of these localities are about 60 feet above tide. Certain yellow gravels and sands at 135 to 160 feet, may be seen apparently matched on a hill N. E. of Ellwood, 120 feet above tide and 21 miles distant. Specimens from the hill and the well are quite undistinguishable. These data indicate a dip of from 12 to not over 15 feet per mile for these gravels. The gravels and underlying white sands of this section are the same respectively as are referred to in the New Jersey survey reports as the yellow gravels and the glass sands. The former have been named by Prof. H. Carvill Lewis, the Glassboro gravels. They are spread over the Atlantic seaboard in this and other States southward and are regarded by many geologists as Quaternary in age. This section terminates in the well at about 265 feet.

COLUMNAR SECTION OF ARTESIAN WELLS AT ATLANTIC CITY NEW JERSEY
Scale of 100 feet to 1 inch



C—The depth last named marks the passage from these nearly horizontal Quaternary strata to the commencement of a long series of Miocene beds with slightly increased dip. The uppermost bed of this series consists of 118 feet of reddish-brown sand ranging from light to dark in color.

It contains a dark clay seam at 289 feet and another at 320 feet described as "green clay;" each of these is about 5 feet thick; from beneath the latter the first flow already noted in well No. 4, was obtained. This red sand bed contains wood throughout that was continually brought up by the hydraulic process in very small fragments, otherwise it is nonfossiliferous.

D—Below these red sands, or from 383 to 658 feet, occurs the most remarkable development of diatomaceous clays yet discovered in the world, being 275[1] feet in vertical extent. Excepting a few pure sand beds, not over from one to ten feet in thickness, this entire horizon is more or less made up of this low order of microscopic plants. As might be expected the diatoms of this deposit are marine forms.

Associated with the diatoms are also a number of sponge spicules, many of them of the pin-head forms that are characteristic of salt water sponges.

At 540 feet were found a few clam and other shells in fragments, but so worn and broken as to be unidentifiable specifically. One, however, was either a *Modiola* or a *Mytilus*.

This deposit is already especially interesting to microscopists, and will become increasingly so until it will attain world-wide publicity. On this account a minute description is here inserted:—

383 to 390, Clay; 390 to 391, Sand, pure white; 391 to 406, Clay.	Rich in diatoms except the sand layer.

406 to 410, Gray sand—No diatoms.
410 to 429, Clay—Moderately rich in diatoms.
429 to 430, Dark sand—No diatoms.
430 to 480, Clay—Diatoms associated with about 5 forms of foraminifera and much comminuted shell.
480 to 510, Sandy clay—Moderately diatomaceous.
510 to 535, Clay—Very rich in diatoms.

[1] Since the preparation of the section, diatoms have been noticed, though very sparingly, in the next lower 20 feet. This would increase the total thickness of the diatom beds to nearly 300 feet.

535 to 554, Sandy clay—Moderately rich in diatoms.
554 to 560, Clear gray sand—No diatoms. Water bearing stratum.
560 to 575, Alternations of pure clays and sandy clays. } More or less diatomaceous.
575 to 600, Sandy clays—Moderately diatomaceous.
600 to 620, Brown clay—Rich in diatoms.
620 to 632, Brown clay—Diatoms in greatest abundance.
632 to 658, Chocolate clay and comminuted shell. Poorly diatomaceous.

The forms from the richest portions at 400, 525 and 625 feet, have been most carefully observed under the microscope and identified by C. Henry Kain and E. A. Schultze.

They have determined 149 species which are distributed among 49 genera. This includes a number of new species, named, described and figured by them in the Bulletin of the Torrey Botanical Club.[1] They are indicated in the following enumeration which includes all so far listed. There will probably, however, be a few forms yet to add. Forms marked rare, are of rare occurrence in the well and not necessarily so elsewhere.

Actinocyclus Ehrenbergii, Ralfs.

Actinocyclus subtilis, (Grev.) Ralfs.

Actinocyclus interpunctatus, Bright. Rare.

Actinocyclus Ralfsii, W. Sm.

Actinodiscus Atlanticus, n. sp., Kain & Schultze.

Actinoptychus areolatus, Ehr.

Actinoptychus Grundleri, A. S.

Actinoptychus splendens, (Ehr.) Grun.

Actinoptychus undulatus, Ehr. var. Halionyx, Grun. Several varieties.

Actinoptychus vulgaris, Schuman, var. Virginica, Grun. Several varieties.

Amphitetras minuta, Grev. Rare.

Anaulus birostratus, Grun. Very rare.

Asterolampra Marylandica, Ehr.

Aulacodiscus Crux, Ehr. Two varieties.

Aulacodiscus Petersii, Ehr.

Aulacodiscus Sollittianus, Norman.

Auliscus Caballi, A. S.

Auliscus cælatus, Bailey.

[1] Vol. xvi, pp. 71 to 76 and pp. 207 to 210; Plates LXXXIX., XCII., and XCIII.

Auliscus pruinosus, Bailey.
Auliscus (Glyphodiscus?) spinosus, Christian.
Biddulphia aurita, (Lyngb.) Breb.
Biddulphia alternans, Christian.
Biddulphia Baileyi, W. Sm.
Biddulphia Brittoniana, n. sp., Kain & Schultze.
Biddulphia Cookiana, n. sp., Kain & Schultze.
Biddulphia Woolmanii, n. sp., Kain & Schultze.
Biddulphia decipiens, Grun. Rare.
Biddulphia elegantula, Grev.
Biddulphia pulchella, Gray. Rare.
Biddulphia rhombus, (Ehr.) W. Sm.
Biddulphia seticulosa, Grun.
Biddulphia Tuomeyi, Bailey.
Biddulphia turgida, (Ehr.) W. Sm.
Biddulphia longispina, Grun.
Biddulphia Weissflogii, Grun.
Cerataulus (Californicus? var.) n. sp., Kain & Schultze.
Cocconema lanceolatum, Ehr. Rare.
Coscinodiscus Argus, Ehr.
Coscinodiscus Asteromphalus, Ehr.
Coscinodiscus concavus, Ehr.
Coscinodiscus eccentricus, Ehr.
Coscinodiscus elongatus, Grun.
Coscinodiscus excavatus, Grev. Several varieties.
Coscinodiscus gigas, Ehr.
Coscinodiscus isoporus, Ehr.
Coscinodiscus Lewisianus, Grev. Rare.
Coscinodiscus lineatus, Ehr.
Coscinodiscus Nottinghamensis, Grun. Rare.
Coscinodiscus Oculus Iridis, Ehr.
Coscinodiscus perforatus, Ehr.
Coscinodiscus radiatus, Ehr.
Coscinodiscus rhombicus, Castracane.
Coscinodiscus robustus, Grev.
Coscinodiscus senarius, A. S.
Coscinodiscus symmetricus, Grev.
Cestodiscus ovalis, Grev.
Cestodiscus rhombicus, Grev.
Chætoceros (didymus? Ehr.)

CRASPEDODISCUS COSCINODISCUS, Ehr.

CRASPEDODISCUS COSCINODISCUS var. NANKOORENSIS, Grun.

CYCLOTELLA OPERCULATA, Kutz.

CYMATOPLEURA SOLEA, W. Sm.

DICLADIA CAPREOLUS, Ehr.

DISCOPLEA PHYSOPLEA, Ehr.

DIMEREGRAMMA NOVA CÆSAREA, n. sp., Kain & Schultze.

DIMEREGRAMMA NOVA CÆSAREA var. OBTUSA, n. var., Kain & Schultze.

DIMEREGRAMMA FULVUM, (Greg) Ralfs.

EPITHEMIA GIBBA, (Ehr.) Kutz. Rare.

ETHMODISCUS? sp? Castracane.

EUCAMPIA VIRGINICA, Grun. Rare.

EUNOTIA MONODON, Ehr. Two varieties.

EUNOTIA ROBUSTA, (Ehr.) Ralfs. Several varieties.

EUNOTIA AMERICANA, n. sp., Kain & Schultze.

EUPODISCUS ARGUS, Ehr.

EUPODISCUS RADIATUS, Bailey.

EUPODISCUS ROGERSII, Ehr. Varieties with 3, 4 & 5 processes.

EUPODISCUS sp.?

GONIOTHECIUM OBTUSUM, Ehr.

GONIOTHECIUM ODONTELLA, Ehr.

GONIOTHECIUM ROGERSII, Ehr.

GRAMMATOPHORA SERPENTINA, Ehr. var. Rare.

HEMIAULUS AFFINIS, Grun.

HEMIAULUS BIPONS, (Ehr.) Grun.

HEMIAULUS POLYCISTINORUM, Ehr.

HUTTONIA REICHARDTII, Grun. var.

HYALODISCUS LÆVIS, Ehr.

HYALODISCUS STELLIGER, Bailey=(PODOSIRA MACULATA, W. Sm.)

LIRADISCUS MINUTUS, Grev.

MASTOGONIA ACTINOPTYCHUS, Ehr.

MELOSIRA SULCATA, (Ehr.) Kutz.

PLAGIOGRAMMA GREGORIANUM, Grev.

PLEUROSIGMA VIRGINIACUM, Peticolas.

PLEUROSIGMA, Sp.? Fragments of a very large form allied to *P. angulatum.*

PSEUD-AULISCUS RADIATUS, Bailey.

PYXIDICULA CRUCIATA, Ehr.

RHABDONEMA ATLANTICUM, n. sp., Kain & Schultze.

Raphidodiscus Febigerii, T. Christian.
Rhaphoneis gemmifera, Ehr.
Rhaphoneis amphiceros, Ehr.
Rhaphoneis Belgica, Grun.
Rhaphoneis fluminensis, Grun.
Rhaphoneis scalaris, Ehr.
Rhizosolenia Americana, Ehr.
Rhizosolenia styliformis, Bright.
Sceptroneis caduceus, Ehr.
Sceptroneis gemmata, Grun.
Stephanogonia Actinoptychus, Ehr.
Stephanogonia polygona, Ehr.
Stephanopyxis apiculata, Ehr.
Stephanopyxis ferox, (Grev.) Ralfs.
Stephanopyxis Corona, (Ehr.) Grun.
Stephanopyxis Grunowii, Grove & Sturt.
Stephanopyxis limbata, Ehr. Rare.
Stephanopyxis Turris, (Grev.) Ralfs.
Stictodiscus Buryanus, Grev.
Stictodiscus Kittonianus, Grev.
Surirella Febigerii, Lewis.
Tabulina testudo, J. Brun.
Terpsinoe intermedia, Grun. var.
Triceratium Americanum, Ralfs.
Triceratium condecorum, Bright.
Triceratium Ehrenbergii, Grun.
Triceratium Ehrenbergii, (Discoplea undulata, Ehr.)
Triceratium Fisherii, A. S.
Triceratium Heilprinianum, n. sp., Kain & Schultze.
Triceratium Kainii, n. sp., Schultze.
Triceratium indentatum, n. sp., Kain & Schultze.
Triceratium Kainii, Schultze, var. constrictum, Kain & Schultze, n. var.
Triceratium Marylandicum, Bright.
Triceratium obtusum, Ehr.
Triceratium robustum, Grev.
Triceratium semicirculare, Bright. = (Euodia Brightwellii, Ralfs.)
Triceratium spinosum, Bailey.
Triceratium Solenoceros, Ehr. Rare.
Triceratium tessellatum, Grev.
Triceratium undulatum, Ehr.

TRYBLIONELLA HANTZSCHIANA, Grun.

TRYBLIONELLA SCUTELLUM, W. Sm.

Many of the forms are found everywhere from top to base of this section. Among these *Melosira sulcata* is one of the most frequent. Others are found predominating only at certain horizons; among these may be noticed a beautiful iridescent, many-rayed disc form, *Actinocyclus Ehrenbergii* which is characteristically abundant at 625 feet; it occurs sparingly at 525 feet but is scarcely if at all seen at 400 feet.

At about 525 feet the genus *Rhaphoneis*, an elongated form, occurs more frequently than elsewhere and in many varieties. Associated with it at this same depth are a number of rare forms heretofore found only in this country in an Artesian well at Cambridge, Md., at a depth of 275 feet, and again in a well at Fortress Monroe at a depth of 558 feet. The general resemblance seen in strewn mounts from Cambridge and Atlantic City is so great as to suggest an exact identity of strata. More light, however, will be needed to definitely settle this point.

Respecting *Rhaphoneis*, the variety of forms grading almost insensibly from one to the other is so great that it is possible to so arrange a dozen or more side by side in a line that differences are not readily appreciable except by skipping over intermediate forms and comparing those some distance apart. In fact, T. Christian has shown me a slide containing 16 such forms from the Cambridge well, and C. Henry Kain has remarked respecting these same forms at Atlantic City, that they "present such variations of structure as to suggest the advisability of decreasing the number of species usually considered as belonging to this genus."

There is a curious anomaly in connection with a newly described elongated species, *Biddulphia Brittoniana*, found at 525 feet. In this the two frustules composing one individual and usually presenting their convex sides outward, have never been observed in that manner, but instead, two frustules separated from different individuals are found with their convex sides inward and fastened together by the interlocking of curiously hooked setæ at both ends of each frustule.

At 425 feet five foraminiferal forms are associated with the diatoms. After chemical treatment of earth from this depth for the cleaning and separation of the diatoms one species of foraminifera, a *Textularia* remained intact in the form of a siliceous internal cast—the shell having been destroyed by the acids used.

In the sands interbedded between these diatomaceous clays occur the three lower of the water-producing strata noticed in connection with well No. 4. The upper one as before stated proved unsatisfactory; the middle gave but a scanty flow, and the lower yielded an abundant supply of water.

In a letter received by the writer from the late Prof. George H. Cook he says: "I have written the well contractors and also marked on a geological map the location and dip of strata and the depth and location of the wells on the water-bearing stratum from which Atlantic City may reasonably hope to get a supply of good water and have assured them that it should be carefully looked for at 530 to 600 feet below sea level," and in a letter to a member of the company he named 577 feet as the probable depth. This came very close to the fact as was afterwards realized.

In the letter to the writer just quoted he states "that the bored wells at Barnegat, Harvey Cedars, Weymouth, May's Landing and Pleasant Mills have all the same quality of water, have passed through similar strata, and are on a dip of 25 feet per mile."

Assuming as probable that the wells at Pleasant Mills and well No. 4 at Atlantic City draw from the same stratum, and measuring the distance between the two locations at right angles to lines drawn through each parallel to the trend of the cretaceous strata we have 22 miles. The well at Pleasant Mills is of 34 feet depth below tide. This would make the dip for at least the upper portion of the Miocene beds 23 to 24 feet per mile, thus harmonizing with the views of the late State Geologist.

E—Beneath the diatomaceous clays and occupying the next 103 feet, or from 658 to 761 feet, occurs a series of fossiliferous beds as follows:

		Chocolate clay, comminuted shell, slightly diatomaceous. See footnote page 135.	19
677 to 700.	Fossil	5 ft. Green marl full of shell 8 ft. Sandy clay full of shell 10 ft. Light sand full of shell	23
		8 ft. Coarse gravel & sand nonfossiliferous 6 ft. Quicksand nonfossiliferous 12 ft. Dark chocolate clay nonfossiliferous	26
726 to 757.	Fossil	4 ft. Sandy marl and shell 27 ft. Green marl with shell	31
		Tough clay mixed with gravel	4

These beds are probably the same as the Miocene shell outcrops at Shiloh and Jericho near Bridgeton, N. J. The lower of the two fossil horizons within this section showing some of the rarer forms found at these localities. The species found here will be again referred to in connection with those from greater depth.

F—The next interval of 83 feet is occupied by sands, the upper 73 feet being reddish-brown in color and much like those above the diatom beds and the lower 13 feet being a gray micaceous quicksand.

G—Between 844 to 955 feet are included a clay and a marl bed as follows:

844 to 905.	Fossil	Dark chocolate clay; a few fossils at 875 feet.	61
905 to 955.	Fossil	Green marl; lower 2 feet a bed of ponderous oysters so broken by the drill as to be undeterminable as to species.	55

H—The next section from 955 to 1095 feet covers 140 feet of peculiar greenish-yellow sands with many streaks of loam of the same color. It contains barnacles throughout, indicating a shallow sea. This was further corroborated by a few shallow water mollusks at about 1000 feet.

I—From 1095 to 1225 a series of 130 feet includes two marl beds and is best described thus:

1095 to 1126,	Dark greenish-gray clay; abundance of foraminifera.	31
1126 to 1146,	Dark green marl.	20
1146 to 1170,	Dark green marly clays.	24
1170 to 1225, Fossil,	Very dark green marl; *Cardita granulata* at 1180 feet.	55

From this point downward, as far as the boring continued, to 1,400 feet or thereabout, is one continuous bed of tough clay, light to dark slate in color and containing multitudes of foraminifera especially in the lighter colored clays.

There are also from this bed a few mollusks and quite a number of specimens of deep sea corals belonging to the genus *Placocyathus* very similar to an undescribed form from the Miocene deposits of San Domingo and now in the Academy's collection.

The life forms of this division indicate a deepening sea. The foraminifera very closely resemble species described in 1846, by d'Orbigny from the Miocene clays around Vienna.

Forms representing at least 14 genera occur in all the clays below 1,095 feet while about five of the same generic forms have been observed between 430 to 480 feet. The genera are as follows:—

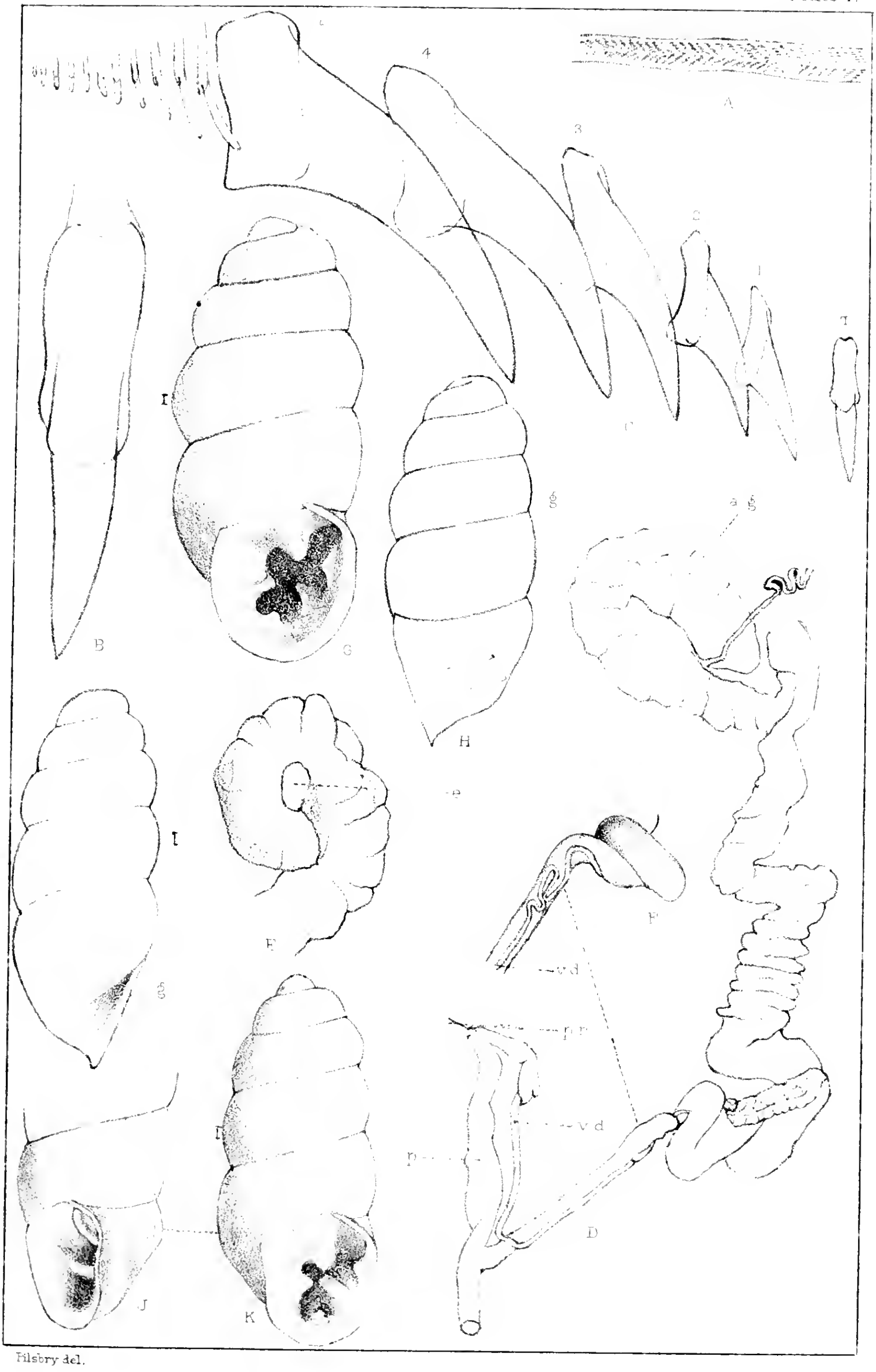
Nodosaria, Dentalina, Cristellaria, Robulina, Nonionina, Rotalina, Rosalina, Bulemina, Urigerina, Amphistigina, Guttulina, Biloculina, Triloculina and Textularia.

It now remains to enumerate the fossils, excepting the microscopic ones already listed. Although generally in very fragmentary condition, it has been possible to name 82 species of mollusks, exclusive of 8 forms determinable by genera only. Besides the mollusks there were representatives of eleven other life forms, among them a few varieties of corals and a bone belonging to an animal of the crocodilian order. Identifications of all the fossils, excepting the microscopic, have been very kindly made by Prof. A. Heilprin. Specimens obtained from both wells No. 1 and No. 3 are included. In those from No. 3 the depth where each was found is given; in No. 1 this is not known. Of the 41 molluscan forms from well No. 1 and noted in the Academy's Proceedings for 1889, all but 12 were again found in well No. 3.

The list is as follows:

Anomia probably ephippium.
Arca centenaria.
Arca subrostrata, 682.
Arca (idonea ?)
Arca lienosa, 725.
Arca plicatura.
Artemis acetabulum.
Astarte obruta, 682.
Astarte perplana, 700.
Astarte Thomasii, 875.
Astarte cuneiformis, 695.
Astarte compsonema, 725, 875.
Amphidesma subreflexa, 750.
Cardita granulata, 682, 750, 885, 1180.
Cardita arata.
Cardium creticuloides or leptopleura, } 700.
Cardium laqueatum, 700.
Corbula cuneata, 750.
Corbula idonea, 700.

Corbula elevata, 752.
Corbula sp.? 900.
Chama congregata, 700, 750.
Crassatella melina.
Cytherea sp.?
Donax variabilis.
Gouldia lunulata or Astarte, 1350.
Lucina trisulcata, 752.
Lucina crenulata, 752, 875, 1350.
Lucina Foremani, 695–730.
Mactra lateralis, 682, 752.
Mytiloconcha incurva.
Mytilus incrassatus, 682, 752.
Mysia acclinis, 752.
Nucula obliqua=proxima, 730.
Neæra sp., 1335.
Ostrea Mauricensis, 682.
Ostrea sp., { 182, 725. 955, 1000. }
Pecten Madisonius, 682, 750.
Pecten Humphreysii, 677, 700.
Pecten vicenarius.
Pecten Marylandica, 726, 1000.
Pecten comparilis.
Pectunculus parilis, 726.
Pectunculus lentiformis, 752.
Perna maxillata, 682, 750.
Saxicava arctica, 740.
Tellina subreflexa.
Tellina declivis, 752.
Yoldia or Leda, 752.
Volvula or Bulla, 1380.
Venus altilaminata 682, 730.
Venus sp.? 687, 750.
Discina lugubris.
Cerithium sp.? 875.
Columbella (Amycla) communis, 740.
Cylichna sp.?
Crepidula sp.? 690, 750.
Dentalium sp.? 690.



Pilsbry del.

PILSBRY ON AEROPE AND PUPA.

Dentalium dentalis, 1400.
Fulgur Shilohensis, 730.
Fulgur sp.? 682, 750, 875.
Fusus devexa, 726.
Murex Shilohensis, 730.
Natica catenoides, 677, 756, 875.
Natica duplicata, 690, 750.
Neptunea migrans, 875.
Neptunea sp.? 730.
Oliva canaliculata,=Carolinensis, 695, 726.
Peristernia filicata, 730.
Pleurotoma Marylandica, 890.
Pleurotoma pseudeburnea, 740.
Pleurotoma limatula ? 875.
Petaloconchus sculpturatus, 1000.
Turritella Cumberlandia, 682.
Turritella æquistriata, 752.
Turritella plebeia, 677.
Turritella indenta ?
Turritella secta, 875, 900, 1400.
Turbinella Woodi.
Tritia trivitata, 726, 875.
Tritia peralta, 875.
Tritia obsoleta.
Trochita centralis, 695, 750.
Turbo eboreus, 750.
Terebra indenta, 730.
Terebra simplex, 690, 730.

Coral { Placocyathus.
Astrea.
Dendrophyllia. }

Fish { Lamna tooth.
Odontaspis tooth.
Mylobates tooth.
Fish scale. }

Gavial—Tooth.
Crocodilian Bone—Femur or humerus.
Echinoid spines.
Opercula of gasteropods.
Crustaceans { Banacles, *Balanus*
Crab's claws. }

Of the molluscan forms named above whose depth is known, 54 were from the two fossiliferous beds included between 677 and 757 feet. Of these 37 were found in the lower of the two divisions—10 of these and 17 others making together 27, were found in the upper of the two divisions. Of the forms in both divisions, 26 have been found at Shiloh and Jericho, and include several species especially characteristic of these localities and probably belong to the same bed.

Five of the above and nine others were found at 875 feet, viz:—

Astarte Thomasii.

Astarte Compsonema. Also at 725 feet.

Cardita granulata. Also 677 to 757 and below.

Cerithium.

Corbula.

Fulgur.

Lucina crenulata. Also 757 and below.

Lyrosoma sulcosa. Also lower.

Natica catenoides. Also 677 to 756.

Neptunea migrans.

Pleurotoma Marylandica.

Pleurotoma limatula. Also lower.

Turritella secta.

Tritia trivittata. Also 725.

The following three shallow water species were obtained at about 1000 feet in association with Balanus.

Ostrea.

Pecten Marylandica.

Petalaconchas sculpturatus.

Cardita granulata occurred at 1180 feet also at 875 feet and in both divisions of the horizon, between 677 to 757 feet.

In the tough clay bed below 1335 feet were the following:

Dentalium dentalis.

Gouldia limatula or Astarte.

Lucina crenulata. Also higher.

Lyrosoma sulcosa. Also at 875.

Neæra sp.?

Pecten comparilis.

Turritella secta.

Volvula or Bulla.

To these should be added the coral (*Placocyathus*) before noted.

The evidence as to the sections from 383 feet to 1225 feet, where the bottom of the very dark green marl bed is reached, is preponderatingly in favor of Miocene age for these strata.

In view of the lack of distinctive Eocene fossils below that depth the occurrence of *Placocyathus* and the still decided Miocene aspect of the few molluscan remains, it may be concluded that the boring has not yet passed through the Miocene.

The occurrence of *Turritella plebeia* and *Pecten Humphreysii* in these wells, and of *Turritella plebeia* in a well at Cape May Point at a depth of about 400 feet, would indicate for the upper portion a Middle Miocene age, while all below would be Lower Miocene.

Reference has already been made to the dip of the yellow gravel and of the diatomaceous clays, the latter being placed at 23 to 24 feet per mile. The shell marl at Shiloh outcrops about 60 feet above tide, and the distance between parallel lines of *strike* for Shiloh and the *well* is 35 miles. The bottom of what is probably the corresponding shell stratum in the well is at 757 feet. A calculation based on these data gives 23 feet to the mile as the dip for the Shiloh beds.

The water from Winslow well, and from Atlantic City Well No. 1 at 1100 feet, are of the same quality as proved by analysis. This favors their being from the same stratum. Winslow is distant 30 miles and the depth of the well there below tide is 215 feet. Based on these figures the dip of strata in that portion of the well is 29 to 30 feet per mile; this increase of dip is probably correct. In fact when we take into consideration the greater thickness seaward of the sands and clays in the lower portions of the well, together with the oscillations of sea level as shown by the character of the fossils, these being alternately shallow sea and deep sea forms, it is quite likely we shall yet find a still greater increase of dip for the base of the Miocene.

The results of this examination indicate a greater thickness for the Miocene deposits of the southern part of the State than has generally been held by geologists, and as a consequence increases the heretofore estimated dip of the underlying Cretaceous and Eocene beds in that section of the State.

These Miocene shell and diatom beds are no doubt closely related to beds of similar character and of the same age in Maryland and Virginia. The author is not however at present able to trace any one stratum continuously. The diatomaceous clays at Atlantic City occur above beds containing *Perna*, while in the States just named similar clays occur below Perna beds. That there are several Perna beds would seem to be the solution of this problem. This however remains yet to be demonstrated.

April 1.

Mr. Thomas Meehan, Vice-President, in the chair.

One hundred and twelve persons present.

The deaths of John Jordan Jr. and Frederick Graff, members, were announced.

Mr. Theo. D. Rand gave before the Mineralogical and Geological Section the substance of his paper on "The Serpentines of South-eastern Pennsylvania," with lantern illustrations.

April 8.

Mr. Gavin W. Hart in the chair.

Seventeen persons present.

April 15.

The President, Dr. Joseph Leidy, in the chair.

Twenty-nine persons present.

Variations in Bulimus exilis.—Dr. Benjamin Sharp called attention to two varieties of *Bulimus exilis* which he had found on the islands of Guadeloupe and Dominica. One variety was characterized by broad dark brown bands, which run parallel with the coil of the shell; while the other was peculiar in possessing small and very faint bands, which in many specimens were entirely absent. The banded variety was found to be common in Guadeloupe, while the bandless one was rare. In Dominica, which is separated from Guadeloupe by a channel of only twenty-three miles, the banded variety was very rare, while the light or bandless one was comparatively common, although individuals were by no means so common in Dominica as in Guadeloupe. He spoke of the probable cause of the variation and suggested that it was due to some environmental action. The island of Dominica being wholly of volcanic origin, would produce a different kind of food from the Grande Terre portion of Guadeloupe, which in formation is purely coral. It was on this portion of Guadeloupe that the specimens of *B. exilis* were collected. It is known that Dominica has many species and some genera of plants that are peculiar to the island, and this difference of food may in some way account for the differences in this species of land snail. Dr. Sharp said that it is probable that the dearth of land shells on the volcanic islands and their comparative plenty on the coral and continental islands of the Caribbean group is due to the absence of carbonate of lime in the former and its presence in the latter.

Remarks on the exuviae of snakes.—DR. BENJAMIN SHARP further spoke on the exuviae of two snakes, which were shed in the laboratory of the Academy two days previously. These snakes, *Eutaenia sirtalis*, B. & G., had been presented to the Academy on the 19th of March, 1890, and had been captured the day before in New Jersey. The whole process of shedding the skin had been observed. One of the snakes was in the water when first seen, and coming out upon the sod it shrugged and shook itself for a moment; then getting between the glass of the vivarium and the box containing the earth, the skin parted at the jaws and the animal crawled out leaving the exuvia. The cerebral portion being fixed, the animal passed through the opening, so that the discarded skin, as is always the case, was turned wrong side out. One of the specimens was interesting as it was entirely perfect, without the slightest rent and not a scale missing. The other was perfect, but there was a considerable rent on each side of the jaw. The operation took less than one minute. The snake was startled about the middle of the process. It crawled away from the exuvia very rapidly.

APRIL 22.

MR. THOMAS MEEHAN, Vice-President, in the chair.

Twenty-three persons present.

The following were presented for publication:—

"New East Indian Land Shells." By H. A. Pilsbry.

"Description of a new species of Helix." By John Ford.

APRIL 29.

The President, Dr. LEIDY, in the chair.

Twenty-six persons present.

The following were elected members:—

Abraham Barker, William K. Shryock and Walter Conrad.

The following was ordered to be printed:—

SYNOPSIS OF AMERICAN CARBONIC CALYPTRÆIDÆ.

BY CHARLES R. KEYES.

There has always been a considerable diversity of opinion as to what term should really be applied to that paleozoic group of gasteropodous shells commonly referred, by most American writers, to *Platyceras* of Conrad. The described species of this group have been variously and indifferently assigned to *Capulus* Montfort,[1] *Pileopsis* Lamarck,[2] *Actita* Fisher von Waldheim,[3] *Platyceras* Conrad,[4] *Acroculia* Phillips,[5] *Orthonychia* Hall[6] and some other genera. Of these *Capulus* and *Platyceras* have become at last generally adopted; the former having preference with most European, and the latter with the majority of American authors.

Generic Considerations. It may be premised here that the two genera just mentioned are practically coextensive; and since the first has precedence—of more than thirty years—it should be used instead of the second. Even if the group to which Conrad gave the name *Platyceras* is a valid one it is very questionable whether the term could stand, inasmuch as it has been preoccupied for three-quarters of a century. It has long been known that Geoffrey in 1764 proposed for a genus of coleoptera the name *Platyceras*, a term which was later employed by Latreille [8] and which continues to the present day in good usage as originally proposed. Taking advantage of this fact Œhlert [9] has recently revived Phillips' name *Acroculia* for the *Platyceras* group of shells; but this of course cannot be adopted.

As regards the actual generic characters of the various species, their specific limitations, range of variation and the distribution in time and space of the different varieties, greater confusion has,

1 Conch. System., vol. II, p. 54. (1810.)

2 Anim. sans Vertebr., t. VI, (2), p. 16. (1822.)

3 Mem. de la Soc. imp. d. Naturalistes de Moscau, t. VI, p. 234. (1823.)

4 Ann. Rep. N. Y. Geol. Sur., p. 205. (1840.)

5 Palæ. Foss. Cornwall, p. 93. (1841.)

6 Rept. 4th Dist. N. Y., p. 172. (1843.)

7 Hist. abrégée des Insectes, 1764.

8 Précis des caractères des Insectes, 1796.

9 Bul. de la Soc. Géol. de France, (3), t. XI, p. 602.

perhaps, nowhere existed among fossil mollusks than in the group under consideration. This utter lack of agreement among writers is directly traceable to a number of causes: the majority of the species have been described from very few or single specimens, with little regard to the forms already known; no attention whatever was paid to variability and indeed the range of the latter has only very lately been made out with any degree of certainty; comparisons with individuals from localities more or less widely distant have been made only in exceptional cases.

General Features. The leading characters of generic value in modern Capulus, as shown by the more typical shells, as *C. hungaricus* Linnè, are the obliquely conical shape, the small, often closely incurved or coiled spire, the broad campanulate apertural portions and the peculiar horse-shoe-shaped muscular impressions. In the paleozoic forms heretofore referred to *Platyceras* these features have been made out most clearly in *C. paralius* (W. & W.) and *C. equilateralis* (Hall); though the affinities are not less striking in many other species.

In a group of more than three hundred described paleozoic species having so few salient characters for classification and such a great range of variation as the forms assigned to *Platyceras* it is hard to foresee the difficulties in attempting to arrange satisfactorily the many different forms. The genus may ultimately admit of a suitable separation into several more or less well marked subdivisions; and the many forms make such an arrangement very desirable. It can, however, only be accomplished after a careful and critical revision of the entire group. The placing of *Platyceras*, *Orthonychia*, etc., as subgenera under *Capulus*, as has been done by Zittel[1] and others, manifestly does not meet the requirements, at least in so far as the American species are concerned. It is probable that all of the described Platycerata cannot be included under *Capulus*. Just which ones, remains for future comparisons to decide. There seems to be good ground for believing that further study will show that a number of the paleozoic forms in question belong more properly to genera closely allied to *Capulus* rather than to *Capulus* itself. This would carry back the antiquity of certain modern genera farther than has hitherto been considered possible. A recent critical examination of certain described Platycerata also discloses that they belong to families entirely different from those supposed.

[1] Handbuch der Palæontologie, II Band, p. 216

General Relations. There is often considerable embarrassment in attempting to separate certain paleozoic Capuli, on the one hand from some forms of *Platystoma*, especially from those species in which there is a greater or less tendency for the shells to uncoil; and on the other hand from various genera of Patelloid shells. As might be expected in a group of gasteropods presenting so few constant characters, which can be satisfactorily relied upon as classificatory criteria, it is often impossible to clearly distinguish between certain of these species. Many structural features long regarded as of much importance in identification have recently [1] been shown to possess very little, if any, specific value, owing to their great variability. It has therefore become necessary to consider as of the utmost significance, the basing of species upon general resemblances rather than upon unimportant varient characters arising from the diverse conditions of environment imposed by a more or less extensive geographic and geologic distribution. Therefore in choosing for classificatory purposes the characters of any group it is evident that only those features exhibiting the least tendency to modification are available. Even the most constant structures appear to lose much of their stability at some period during the existence of the group—whether specific, generic or family; while other characters more or less variant in the earlier stages of development, later become less liable to change. At some time these features blend and thus appear the transitional forms. It may be assumed, then, that in many groups of the same genetic origin some varieties will present features that have remained for a long time practically unmodified; while others exhibit the same characters in a highly specialized, but ever changing condition. And it is of great interest to note that the latter—those having greatly exaggerated features—are the forms whose existence is of comparatively short duration; and that with these intensified structures the development is rather rapid, while their culmination results in a great diminution of the group's vitality, or more commonly its extinction.

Number of Species. Among the first to notice the existence of Carbonic Capuli in the continental interior were Yandell and Shumard, who called attention to the association of a species with an *Acrocrinus* (afterwards described by the former author as *A. shumardi*). These writers attempted to prove that the crinoids were carnivorous in their habits, and that they subsisted on mollusks.

[1] Keyes: Proc. Am. Philosophical Soc., vol. XXV, p. 231.

Capulus acutirostris, however, was the first species of this group of gasteropods described from the Carbonic rocks of the Mississippi basin; and was so denominated by Hall in 1856. The publication of this diagnosis was followed in quick succession by definitions of other forms by Stevens, Hall, Swallow, McChesney, Winchell, White and Whitfield, and Meek and Worthen; so that the total number of species that have been brought to notice from the carbonic rocks of North America is more than two score. A part of this number are, however, to be regarded as synonyms, reducing the actual number of species as now recognized nearly one-half.

I. Habits of the Carbonic Calyptræans.

Variation in Form. It has been noted frequently in the descriptions of various paleozoic species of *Capulus* that the shells often present a more or less well-defined quinquelobate appearance and that the apertural margins are for the most part sinuous or crenate. In the absence of salient classificatory characters these features were regarded usually of much importance for specific distinction. It was not until a comparatively recent date that their true significance was indicated. The fact here referred to is the attachment of fossil Capuli to foreign bodies and particularly to the calyces of crinoids. The observations on this habit of the ancient Capuli has been fully considered elsewhere but may be here briefly summarized by stating that, in all the examples examined—upwards of several hundreds—(1) the gasteropod shell invariably lies over the anal opening of the crinoid; (2) the mollusk remained in this position for a considerable period, probably for the greater part of life, as is shown by the shells on highly ornamented calyces and by the removal of them from their places of attachment and tracing the growth of the shell by the concentric grooves made on the ventral plates; (3) the growing shell followed closely the inequalities of the surface upon which it rested—depressions giving rise to furrows and protuberances to folds or nodes; and (4) shells simply lying on flat surfaces are much more depressed and proportionally broader than those clinging to the vertical or inclined portions of calyces in which the anal opening is situated laterally. The third of these statements is perhaps best illustrated by crinoids having low interradial areas and elevated radial regions and is the probable explanation of the frequent occurrence of the more or less distinctly five-lobed calyptræan

[1] Proc. Am. Philosophical Soc., vol. xxv, 1888.

shells. Heretofore this phenomenon has admitted of no direct causal interpretation.

Attachment to Crinoids. The adherence of gasteropods of the genus under consideration to fossil crinoids was at first thought to furnish conclusive evidence of the carnivorous habits of the Crinoidea; and inasmuch as it was at that time considered that the aperture in the vault was the mouth, this explanation seemed very plausible. Consequently the conclusion was very naturally reached that the crinoid, when it perished, was in the act of devouring the mollusk. Meek and Worthen[1] appear to be the first to question the prevalent opinions regarding the intimate association of crinoid and gasteropod; and to suggest that the mollusk was, in all probability, stationed on the echinoderm for a protracted period, perhaps even for the greater portion of its life. But notwithstanding the fact that the univalve was almost invariably situated over the ventral aperture, and that this opening was recognized as the anus, these writers do not seem to entertain for a moment the idea that the gasteropod may have been nourished upon the refuse matter from the crinoid. The latter view more recently has been preferred by Wachsmuth and is now favorably received by other paleontologists. In every instance of the several hundred specimens lately examined the calyptræan covers the anal opening of the crinoid; and, so far as observable, it is always the anterior portion of the molluscan shell that is directed toward the vault aperture. In those examples where the shell has been removed its impression made on the ventral surface shows that the anterior margin of the peristome was at the edge of the opening in the dome—a position that would have brought the mouth of the mollusk directly over the anus of the crinoid. From an examination of the concentric markings made by the molluscan shell on the vaults of *Strotocrinus* (Plate II, fig. 7) and some other genera, it appears that the forward end of the Capulus was always stationary at the margin of the dome opening; and that, as the growth of the shell continued the posterior portion was removed farther and farther from the ventral aperture of the crinoid.

The food of recent crinoids consists chiefly of animalcules and microscopic plants and the living Calyptræidæ subsist on food of a similar nature. From analogy it might be inferred that the food of fossil crinoids and mollusks must have been like their modern representatives. So far as the echinoderms are concerned there seems

[1] Proc. Acad. Nat Sci., Phila., 1868, p. 340, *et seq.*

to be no serious objections to this inference. But with the univalves their position through life indicates that their sustenance was, in great part at least, of a somewhat different character.

The anatomy of the crinoid and the position of the molluscan shell are not in accord with the supposition that the calyptræan may in any way have been nourished on the food of the crinoid. This would imply that the gasteropod was parasitic in its habits, a view which, though held by most writers, does not appear to be structurally substantiated. While no doubt the Capulus derived the greater part of its food from excrementitious matter, nourishment from other sources may also have been obtained and in all probability it was very similar to that of the crinoids and the living Calyptræidæ. Furthermore there does not seem to be the slightest indication that the crinoid was in any manner inconvenienced by the attachment of the gasteropod, except, perhaps, in a few cases where the molluscan shell had encircled the posterio–lateral arms, which were in consequence slightly pressed outward. The only really noticeable effect of the presence of *Capulus* on the crinoid is a comparatively shallow depression or groove on some of the vault plates—marking the position of the shell lip; though in the majority of specimens even this feature is not well pronounced (Plate II, figs. 6 and 7). There are no grounds for the view advanced by Trautschold[1] in regard to *Cromyocrinus simplex* Trauts. and its adhering *Capulus parasiticus* Trauts. from the lower Carbonic of Russia. He says: "Es ist nicht unmöglich, dass der oben beschriebene cylindrische Processus der Analplatten zum Schutz gegen diese Verfolger des *Cr. simplex* aufgebaut ist." The "cylindrical process" here referred to is manifestly a ventral sac and therefore was not caused by the presence of the gasteropod.

Illustrative Examples. In some crinoids, as *Gilbertsocrinus*, the plates of the vault are more or less convex or nodose. This nodosity of the ventral plates reaches a high development in such forms as *G. tuberosus* Lyon and Casseday, from Crawfordsville, Indiana. Nearly one-half of the known individuals of this species have a gasteropod adhering. The specimens illustrate well the adaptation of the apertural margin of the shell to the irregularities of the crinoidal surface, for it is clearly observable, as first pointed out by Meek and Worthen, that the contact of the gasteropod shell and crinoid is not the result of accidental pressure, but that the mollusk

[1] Die Kalkbrüche von Mjatschkowa, p. 118.

adhered to the surface of the crinoid for a considerable period, as is shown by the sinuosities of the peristome corresponding exactly to the inequalities of the surface beneath. In young shells the sinuosities of the apertural margin are comparatively much more pronounced than in older individuals. Many of the latter exhibit much irregularity in the lines of growth, which might at first appear to be due to a change of station, but closer inspection shows that this is not the case. When the plates of the crinoidal vault are nodose, as in *Gilbertsocrinus tuberosus*, the lines of growth in adult shells, contrary to the more usual manner among gasteropods generally, are far from being even approximately parallel to one another; and in the lip of the shell a sinus caused by a nodose plate at one period of growth may be represented in the next by a projecting lobe which extended into a deep depression between the nodes of two contiguous plates.

In considering the structural peculiarities of the calyptræan shell three features—the general form, the configuration of the aperture, and the surface markings—appear to have been susceptible of considerable modification as the result of the sedentary habits of the mollusk. An examination of a large series of certain species of *Capulus* reveals the fact that the variant tendency in all three of these particulars is much greater than might be supposed; and when the attachment of these gasteropods to foreign bodies is taken into consideration the causes for such varietal development become manifest. It has been shown that the mollusk doubtless remained fixed throughout a greater portion of life, and that the surface upon which it first settled determined in great part both the form of the shell and the shape of its aperture. When the surface of attachment was flat, as in the vaults of *Gilbertsocrinus* and *Strotocrinus*, the molluscan shell was greatly depressed and the peristome ample; but when the foreign body was strongly convex the shell was more conical, with a comparatively much smaller aperture. It has been stated elsewhere that, in regard to the second of the three variant features observable in the calyptræan shell, the margin of the peristome partakes of all the inequalities of the surface to which the gasteropod adheres. Few of the species attached to crinoids may be said to have true surface ornamentation, for the longitudinal folds or plications in the shell are in many cases due chiefly to the character of the surface of attachment. In some specimens of *Capulus infundibulum* (M. & W.) there have been noticed, in addition to the undefined longitudinal folds, several series of small conspicuous nodes; but these in all examples seem to result from the peculiar nodose ornamentation of *Platycrinus hemisphericus* with which the univalves are associated.

It appears, then: (1) that some, if not the majority, of the ancient Capuli were stationary during life; (2) that the nourishment of many of these sedentary gasteropods was derived, in great part at least, from the excrementitious matter from crinoids; and (3) that the form of the peristome and its marginal configuration, being dependent upon the surface of attachment, have small value as characters for specific distinction.

The Carbonic species of *Capulus* in which sedentary habits are positively known from the attachment of the gasteropods to echinoderms, together with the various species of crinoids intimately associated, are given in the accompanying synoptical table, page 158.

Range of Variability. Among modern gasteropods attention of late has been called frequently to the variation in the form of the shell as the result of differences in the local conditions of station. In the extension of this inquiry to fossil groups many difficulties are met with, among which the most formidable, perhaps, is the inability to obtain enough material for an adequate consideration of the subject. Usually the shells of any one species are not abundant locally, nor is the representation from localities, more or less widely separated geographically, sufficient to permit of satisfactory comparisons. Lately *Capulus* has unexpectedly furnished a very interesting series illustrating the range of variation in several species. The comparison is perhaps most striking in the projection of ten specimens of *Capulus equilateralis* as recently[1] graphically represented. The case referred to is only a single one of many to be found among the mollusca. It is very significant in its bearing upon the true basis of species; and indicates plainly that, in attempting to separate specimens specifically, too much stress should not be placed upon individual characters.

Other Causes of Variation. In connection with variation of species it is of great interest to note the apparent effect of gravitation in altering the form of some gasteropod shells. This phase can be more satisfactorily considered in *Capulus equilateralis* and *C. infundibulum* than in most other species, because when attached to the vaults of

[1] Variation exhibited by a Carbonic Gasteropod, Am. Geol., vol. III, June, 1889.

SYNOPTICAL TABLE OF CRINOIDS AND ASSOCIATED CAPULI.

Crinoids.	*C. chesterensis.*	*C. equilateralis.*	*C. infundibulum.*	*C. formosus.*	*C. quincyensis.*	*C. dumosus.*	*C. erectus.*	*C. parasiticus.*	*Sp. und.*
Gilbertsocrinus tuberosus.	..	*	..	..	..	..	..	..	..
Gilbertsocrinus typus.	--	*							
Actinocrinus verrucosus.	--	--	--	--	--	--	--	--	*
Physetocrinus ventricosus.	..	..	--	--	*				
Strotocrinus regalis.	--	*							
Dorycrinus immaturus.	--	--	--	*					
Agaricocrinus americanus.	--	*							
Eucladocrinus millebrachiatus.	--	--	*						
Arthroacantha punctobrachiata.	--	--	--	--	--	*	*		
Pterotocrinus acutus.	*								
Pterotocrinus depressus.	--	--	--	--	--	--	--	--	*
Pterotocrinus bifurcatus.	--	--	--	--	--	--	--	--	*
Poteriocrinus coccinus.	---	*							
Platycrinus hemisphericus.	--	*	*						
Platycrinus pileiformis.	--	--	--	--	--	--	--	--	*
Acrocrinus shumardi.	--	--	--	--	--	--	--	--	*
Cromyocrinus simplex.	--	--	--	--	--	--	--	*	
Marsupiocrinus cœlatus.	--	--	--	--	--	--	--	--	*
Melocrinus globosus.	--	--	--	--	--	--	--	--	*
Pentremites godoni.	*								

crinoids the station of each individual is definitely known. As stated already, the first of these forms generally rests on flat-vaulted crinoids; while the second commonly adheres laterally to such echinoderms as *Platycrinus hemisphericus*. *Capulus equilateralis* when occupying the same position is pendant, the apex of the shell being directed downward instead of in the opposite direction as when resting on the ventral surface of such species as *Gilbertsocrinus*. The shell thus pendant exhibits a decided tendency to straighten, or uncoil, consequently becoming longer, the apex freeing itself completely from the body whorl. In comparison, therefore, with a representative example of *C. equilateralis* those shells resting on flat crinoidal vaults are very much depressed, the aperture proportionally broader and the spire more closely coiled. Those individuals attached laterally to crinoids have a tendency to become more conical, the aperture being relatively smaller, while the spire is entirely free from the last volution and the apex often extends to a considerable distance beyond the posterior margin of the aperture.

On the other hand *Capulus infundibulum* is commonly a more or less elongate conic shell. When attached to *Platycrinus* it often assumes a very different aspect. As growth proceeds the posterior side becomes relatively shorter, the apex slightly curved backwards and not unfrequently there is a marked tendency toward a strongly arcuate form.

II. Geographic and Geologic Distribution.

General Considerations. The Calyptræidæ are widely distributed both in space and time. The earliest appearance of this group of gasteropods is in the Calciferous strata of the Lower Silurian. From this time onward its development is rather rapid, and attains a considerable expansion in the upper paleozoic, where in numerical representation, size and variety of form it is rather remarkable. There is then a gradual and general decline toward the close of the paleozoic. The ancient Capuli are confined chiefly to Europe and North America, though two forms have been described from the Carbonic rocks of Australia. During Silurian and Devonian times New York seems to have been the great center of the development of this group; while in the interior of the American continent these gasteropods did not become common until the beginning of the Carbonic.

Range of American Species. Relative to the geographic and geologic distribution of the American species of *Capulus* during

Carbonic times the results thus far reached have been merely suggestive. In other zoological groups the evidence has been much more satisfactory of a reasonable co-ordination of the vertical and horizontal ranges of the various species, especially in the Carbonic strata of the Mississippi basin. In general the question of geographical distribution during geological time has appeared to elicit but little attention, partly, perhaps, by reason of the many difficulties encountered in such investigations; and partly on account of insufficient material for intelligent comparisons. It is now known that many species, though perhaps originally described under several different names, have a much wider geographical and geological distribution than has been supposed. Several of these species have already been indicated [1]; and it is certain that an extended study of the forms belonging to the various zoological groups, from diverse horizons and from localities widely separated geographically, would be productive of many important results in the elimination of a large number of now recognized species, thereby placing paleontological science on a much firmer basis for more accurate deductions and more suggestive conclusions relative to the true status of ancient biological phenomena. The long period of comparative quietness during the deposition of the Carbonic rocks of the Mississppi basin and the concomitant more or less undisturbed conditions of environment thus imposed were particularly favorable to a wide geographic dispersion of the various species, and to their persistency through long periods of time. The majority of the species of *Capulus* appear to be more or less widely distributed in space, especially such forms as *C. acutirostris*, *C. parvus*, *C. equilateralis* and others.

The Kinderhook forms of the genus are, on the whole, extremely unsatisfactory for systematic determination, since the most of them are merely internal casts. They form, however, an important feature of the fauna inclosed in these rocks. The Burlington and Keokuk species are very closely related, and in part extend through both epochs, after which the genus is of rare occurrence in the continental interior. It is of considerable interest to note that this numerical reduction after the close of the Keokuk was accompanied by a marked depauperization of the individuals which struggled through to the end of the Paleozoic. Through all the St. Louis, and Kaskaskia Coal Measures the species without exception are diminutive. The *C. acutirostris* of the St. Louis became reduced to

[1] Keyes: Proc. Acad. Nat. Sci. Phila., July 31, 1888.

nearly one-half the size it possessed in the Keokuk, notwithstanding the fact that this species had perhaps a wider geographical range than any other congeneric form occurring within the Mississippi basin and was therefore better adapted to preserve its full vigor, at least in some parts of its distribution.

The changes in the broad mediterranean sea that once spread over the interior of North America have been referred to elsewhere[1] in connection with the striking structural features of the crinoids of the Carbonic period and will also be considered in detail in another place.

Stratigraphical Catalogue.

CARBONIC.

Lower Carbonic.

Capulus piso (Walcott).
occidens (Walcott).

Kinderhook Beds.

Capulus formosus (Keyes).
lodiensis (Meek).
paralius (White & Whitfield).
subplicatus (Meek & Worthen).
cornuformis (Winchell).
haliotoides (Meek & Worthen).

Burlington Limestone.

Capulus biserialis (Hall).
cyrtolites (McChesney).
equilateralis (Hall).
fissurella (Hall).
infundibulum (Meek & Worthen).
latus (Keyes).
obliquus (Keyes).
quinceyensis (McChesney).
tribulosus (White).

Keokuk Shales and Limestones.

Capulus acutirostris Hall.
equilateralis (Hall).
fissurella (Hall).

[1] Keyes: Genesis of the Actinocrinidae, Am. Nat., vol. XXIV, p. 243, *et seq.* 1890.

Capulus infundibulum (Meek & Worthen).
sulcatinus (Keyes).

St. Louis Limestone.

Capulus acutirostris Hall.

Kaskaskia Limestone.

Capulus chesterensis (Meek and Worthen).
ovalis (Stevens).

UPPER CARBONIC.

Lower Coal Measures.

Capulus spinigerus (Worthen).

Upper Coal Measures.

Capulus parvus Swallow.

III. DESCRIPTIONS OF SPECIES.

Generic Diagnosis. Shell depressed, subglobose, or obliquely subconic; body whorl very large. Aperture ample, expanded; labrum more or less sinuous, inner lip not anchylosed to the spire. Surface glabrate, plicate or sometimes spiniferous; lines of growth often umbricate.

The shells which have been referred to *Platyceras* present a manifold variety of forms. It is, therefore, not improbable that a fuller examination and comparison of all the known species will demand a somewhat different arrangement and subdivision of the group than that now existing. In this section the shell presents few salient characters for consideration. As already stated it is often with extreme difficulty that the forms of this group can be satisfactorily separated from certain varieties of *Platystoma* and various genera of Patelloid shells. In general, however, the test of *Capulus* is coiled, subspiral, arcuate or subconic with a relatively small spire and an immense, rapidly expanding body whorl, while the surface is usually without ornamentation. The large majority of the species of this group possesses tough, massive shells which are generally, therefore, in a much better state of preservation than most of the associated molluscan remains.

Muscular Scars. The internal scars so prominent in the shells of living *Capulus* and modern allied genera are seldom observable in paleozoic forms. Hence, having never noticed in individuals of the latter the peculiar horse-shoe shaped impressions, Hall [1] assigns this

[1] 12th Ann. Reg. Rep. 1859, p. 16.

as the only reason for regarding *Capulus* and *Platyceras* as distinct genera. Since the time that the American author first expressed this opinion, a sufficient number of fossil examples have been found to indicate clearly the real nature of these scars. A careful comparison shows that they are not very different from those of typical Capuli, though considerable variation is noticeable in the several forms and even in shells of the same species. Extended comparisons do not confirm the recent statement of M. Œhlert [1] who thus remarks: "Sur les moules internes des espéces que nous publions, nous avons egalement observé des impressions musculaires qui, tout en présentant certaines analogies avec celles des *Capulus* récents montrent néanmoins des caractères distincts, suffisants pour justifier la création du genre paléozoique que avait été prévu par Conrad, Phillips et Hall."

As exhibited in *C. infundibulum* and some other species the muscular scars consist of a transversely elliptic impression on each side connected by a narrow band traversing the posterior side of the shell. In adult examples the scars are situated about one-fourth the distance from the apertural margin to the apex. In some excellent internal casts of *Capulus protei* (Œhlert) from the lower Devonic of Mayenne the muscular impressions are somewhat different from those of congeneric species from America. The scar on the right side is comparatively large, oval and well defined; a narrow sinuous band passes around the spire posteriorly and terminates on the left side in an enlarged scar similar to, but much smaller than, that on the right. In some specimens the linear band does not appear to be perfectly continuous from one side to the other.

Capulus occidens (Walcott).

Platyceras occidens Walcott, 1884. Palæ. Eureka Dist., p. 254, pl. xxiv, figs. 9, 9a.

Capulus occidens Keyes, 1890. Am. Geol., vol. V.

Shell small, composed of about one and one-half volutions, the last rapidly expanding; spire minute; body whorl oblique, rather sharply rounded dorsally. Aperture large, irregularly triangular; labrum sharp, sinuous. Surface marked by numerous lines of growth; and apparently by a few small undefined longitudinal folds.

Horizon and locality. Lower Carbonic: Eureka District, Nevada.

This species appears to be more closely related to *C. cyrtolites* Meh., from the Burlington limestone, than to any other congeneric form of the Mississippi basin. The apex, however, is more closely

[1] Bul. Soc. géol. de France, (3), t. XI, p. 605.

coiled than in that species and the body whorl is much more expanded.

Capulus ? piso (Walcott).

Platyceras piso Walcott, 1884. Palæ. Eureka Dist., p. 254, pl. xxiv, figs. 7, 7a, 7b.

Shell below medium size, composed of about two loosely-coiled volutions, gradually expanding; body-whorl broadly rounded and, for the most part, free from the spire, which is rather small; several small obscure longitudinal folds are discernible toward the aperture. The latter is subcircular or subovate; lip sinuous. Surface exhibiting only numerous fine lines of growth.

Horizon and locality. Lower Carbonic: Eureka District, Nevada.

There is some doubt as to the correct generic reference of this species. The shell appears to differ in several important particulars from *Capulus* and it is not improbable that eventually this form will be placed elsewhere.

Capulus formosus (Keyes). [Plate II, fig. 8.]

Platyceras formosum Keyes, 1888. Proc. Am. Philosophical Soc., vol. xxv, p. 242, figs. 8 and 9. Reprint, p. 14.

Capulus formosus Keyes, 1890. Am. Geol., vol. V.

Shell arcuate, slightly oblique, enlarging rather rapidly to the ample, irregularly pentalobate aperture; posterior side rather short and concave; lateral slopes nearly straight. Apex obtuse. Surface marked by five broad well-defined longitudinal plications, each of which is composed of several smaller folds; these are crossed by sinuous lines of growth.

Horizon and locality Kinderhook beds: Marshall county, Iowa.

The two specimens of this species found are both attached to the vaults of specimens of *Dorycrinus immaturus* W. & Spr. described in the eighth volume of the Illinois Geological Survey. This species resembles, in some respects, *C. paralius* (W. & W.) but is simply arcuate instead of being coiled.

Capulus cornuformis (Winchell). [Plate II, fig. 5.]

Platyceras cornuforme A. Winchell, 1863. Proc. Acad. Nat. Sci., Phila., 1863, p. 18.

Platyceras cornuforme Keyes, 1889. Proc. Acad. Nat. Sci., Phila., 1889, p. 294.

Shell small, arcuate, forming about half a volution, rapidly expanding; young specimens often broadly and obtusely subcarinate along the dorsum. Aperture irregularly oval or subcircular; margin sinuous. Surface glabrate; lines of growth scarcely discernible.

Horizon and localities. Kinderhook beds: Burlington, Iowa; and Lodi, Ohio.

This is one of the smallest of the Lower Carbonic species of the genus; but may have attained a larger size than the type specimen indicates. A large form from Lodi, Ohio, labeled *Platyceras cornuforme* by Meek seems to be more closely related to *C. paralius* (W. & W.) than with species in question.

Capulus haliotoides (Meek & Worthen).

Platyceras haliotoides Meek & Worthen, 1866. Proc. Acad. Nat. Sci., Phila., July, 1866, p. 264.

Platyceras haliotoides Meek & Worthen, 1868. Geol. Sur. Illinois, vol. III, p. 458, pl. xiv, figs. 3a, 3b.

Shell below medium size, very obliquely ovate, forming about two very rapidly expanding volutions, which are contiguous, except near the apertural margin; whorls rather compressed, somewhat sharply rounded along the periphery. Spire slightly elevated above the level of the body whorl. Aperture ample, oval; labrum sinuous. Surface marked by undulating lines of growth and often by a few low, obscurely defined ridges.

Horizon and localities. Kinderhook beds: Richfield and Newark, Ohio.

This form is commonly found only as internal casts and the surface markings are therefore rarely preserved. The species usually does not have the labrum touching the spire, nor the latter as closely coiled as is shown in the figures of Meek & Worthen.

Capulus lodiensis (Meek).

Platyceras (*Orthonychia*) *lodiense* Meek, 1871. Proc. Acad. Nat. Sci., Phila., 1871, p. 170.

Platyceras (*Orthonychia*) *lodiense* Meek, 1875. Geol. Sur. Ohio (Palæ.), vol. II, p. 313, pl. xiii, figs. 1a, 1b.

Shell below medium size, obliquely conic, anterior slope moderately convex, lateral slopes straight, or very slightly concave, posterior slope concave; a narrow rounded ridge extends anteriorly from near the apex to the labrum. Aperture subelliptic; margin somewhat sinuous. Surface apparently marked by fine lines of growth only.

Horizon and locality. Kinderhook beds: Lodi, Ohio.

Capulus lodiensis seems to be very closely related to *C. subplicatus*, with which it should, perhaps, be regarded as synonymous; the chief difference being simply the more plicate character of the latter. It has been elsewhere shown that the plications are extremely variable and are dependent largely upon the accidental station of the mollusk. The type specimen is imbedded in a hard matrix—only the interior of the shell being exposed to view. Meek's figures were made from plaster casts of the interior, so that no surface markings are discernible.

Capulus paralius (White & Whitfield). [Plate II, figs. 1a, 1b.]

Platyceras paralium White & Whitfield, 1862. Proc. Boston Soc. Nat. History, vol. VIII, p. 302.

Platyceras paralium Keyes, 1889. Proc. Acad. Nat. Sci., Phila., 1889, p. 294.

Capulus paralius Keyes, 1890. Am. Geol., vol. V.

Shell small, forming about two rapidly expanding volutions, which are not contiguous; apical portions minute, slender, laterally compressed, subangular along the dorsum, more or less distinctly plicate. Aperture irregularly pentagonal; labrum sharp, deeply sinuous, or somewhat serrate. Surface marked by few subimbricate lines of growth.

Horizon and localities. Kinderhook beds: Des Moines and Marshall counties, Iowa; Lodi, Ohio.

The apical portion of the shell is more slender and extended than the type would indicate from a casual examination. The smaller specimen figured (Plate II, fig. 1b) shows the spire perfectly preserved. The type (Plate II, fig. 1a) has the longitudinal folds much more prominent than is apparent in a representative specimen of the species. In some examples the plications are hardly noticeable. This species is widely distributed geographically, ranging from Le Grand, in central Iowa, to the southeastern part of the State and thence to Ohio.

Capulus subplicatus (Meek & Worthen).

Platyceras (Orthonychia) subplicatum Meek & Worthen, 1866. Proc. Acad. Nat. Sci. Phila. 1866, p. 265.

Platyceras (Orthonychia) subplicatum Meek & Worthen, 1868. Geol. Sur. Illinois, vol. III, p. 457, pl. XIV, figs. 4a, 4b, 4c.

Shell small, depressed, obliquely conical; anterior slope somewhat convex; posterior and lateral slopes slightly concave or straight; several large broad undefined plications extend from the apertural margin nearly two-thirds the distance to the apex. Aperture subcircular.

Horizon and locality. Kinderhook beds: Richfield, Ohio.

This species is known only from natural casts. The specimens exhibit well the muscular scars which are described as "obliquely elongated, subovate or sublunate, and vertically striated, placed a little above the middle of each side and connected by a linear band passing around behind."

Capulus cyrtolites (McChesney). [Plate II, fig. 2.]

Platyceras cyrtolites McChesney, 1860. Desc. New Foss. Palæ. Rocks Western States, p. 71.

Platyceras cyrtolites Keyes, 1889. Proc. Acad. Nat. Sci., Phila., 1889, p. 288.

Capulus cyrtolites Keyes, 1890. Am. Geol., vol. V.

Shell small, slender, arched; composed of about one volution; dorsally subangular, with a broad flattened area on each side; posteriorly somewhat plicate. Apical portion small, incurved, sometimes enrolled or contiguous. Aperture moderately large, subquadrangular; lip sharp, sinuous. Surface marked only by strong undulating lines of growth, which are often somewhat imbricated.

Horizon and localities. Burlington limestone: Burlington, Iowa; and Calhoun county, Illinois.

This species appears to be genetically related to *C. acutirostris* (Hall) from the Keokuk and eventually the two forms may prove identical. *C. cyrtolites* is from the upper division of the Burlington limestone and differs very essentially from any known congeneric species from the same horizon.

Capulus biserialis (Hall).

Platyceras biserialis Hall, 1859. Geol. of Iowa, vol. I, pt. ii, Suppl., p. 90.

Platyceras biserialis Meek & Worthen, 1868. Geol. Sur. Illinois, vol. III, p. 509, pl. XV, figs. 3a, 3b.

Capulus biserialis Keyes, 1890. Am. Geol., vol. V.

Shell rather below medium size, somewhat ovate, subspiral, forming slightly more than one volution, regularly incurved. Aperture broadly oval; margin rather sharp, undulating, with a broad rounded sinus anteriorly. The expanded anterior portion of the shell marked on each side by a longitudinal row of long, conspicuous, hollow spines, about six in number. Surface smooth showing numerous fine, sinuous lines of growth.

Horizon and locality. Burlington limestone: Quincy, Illinois.

A marked characteristic of this form and also of *C. tribulosus* (White) is that the tubular spines are arranged in longitudinal rows, while in the few other American spine-bearing Capuli there is no regularity in the distribution of the spinous process. The spines are easily broken and hence are seldom preserved to their full length; often they are scarcely noticeable.

Capulus latus (Keyes.)

Platyceras latum Keyes, 1888. Proc. Am. Philosophical Soc., vol XXV, p. 242, figs. 10, 11. (Reprint., p. 14.)

Platyceras latum Keyes, 1889. Proc. Acad. Nat. Sci., Philadelphia, 1889, p. 290.

Capulus latus Keyes, 1890. Am. Geol., vol. V.

Shell large, depressed, forming about one and one-half volutions, very rapidly expanding from the apex to the aperture, but enlarging transversely much more than dorso-ventrally; posterior side comparatively very short. Apex small, incurved, but free from the body of the shell and nearly in the same plane as the general curvature. Aperture very large, campanulate, transversely elliptic; lip attenuate and slightly sinuous. Surface marked toward the aperture by a few small nearly obsolete folds, and by numerous sinuous lines of growth.

Horizon and locality. Burlington limestone: Burlington, Iowa.

This species is from the white compact layers of the upper division of the Burlington beds. The specimens like the majority of fossils from this stratum are usually more or less exfoliated.

Capulus obliquus (Keyes). [Plate II, fig. 3.]

Platyceras obliquum Keyes, 1888. Proc. Am. Philosophical Soc., vol. xxv, p. 241, figs. 12, 13. (Reprint., p. 13.)

Platyceras obliquum Keyes, 1889. Proc. Acad. Nat. Sci., Phila., 1889, p. 290

Capulus obliquus Keyes, 1890. Am. Geol., vol. V.

Shell of medium size, irregularly oblong, subspiral, forming one volution; regularly enlarging, slightly more rapidly transversely than in the opposite direction, to the aperture. Apex large, obtuse, far removed from the body of the shell, which is broadly arcuate; very noticeably oblique to the plane of general curvature in the body of the shell. Aperture irregularly quadrangular in outline; margin sharp and more or less sinuous. Surface marked by several undefined longitudinal plications, which sometimes form longitudinal series of obscure nodes; these are crossed by numerous sinuous, often subimbricated lines of growth.

Horizon and locality. Burlington limestone: Burlington, Iowa.

This species is a transition between the so-called "Orthonychia" and "Platyceras" groups; and is one of the few of this type occurring in the American Carbonic.

Capulus quincyensis (McChesney). [Plate II, fig. 9.]

Platyceras quincyense McChesney, 1861. Desc. New Foss. Palæ. Rocks West. States, p. 90.

Platyceras quincyense McChesney, 1867. Trans. Chicago Acad. Sci., vol. I, p. 49, pl. vi, figs. 6a, 6b.

Platyceras (*Orthonychia*) *quincyense* Meek & Worthen, 1868. Geol. Sur. Illinois, vol. III, p. 510, pl. XV, figs. 5a, 5b.

Platyceras quincyense Keyes, 1889. Proc. Acad. Nat. Sci., Phila., 1889, p. 290.

Capulus quincyensis Keyes, 1890. Am. Geol., vol. V.

Shell of medium size, broadly conical, often more or less elongated; expanding very rapidly and regularly from the central or subcentral apex to the aperture. Usually five broad, rounded ridges extend from near the apex to the aperture, which is consequently more or less prominently quinquelobate; the ridges are not unfrequently further divided into two or more smaller folds. Lip sharp, sinuous. Surface marked by subimbricating lines of growth and also by numerous small, often undefined, longitudinal costæ which do not appear in the cast.

Horizon and localities. Burlington limestone: Burlington, Iowa; and Quincy, Illinois.

The specimens described by McChesney and by Meek and Worthen were either exfoliated examples or internal casts; and this is the condition in which the species is usually found. Owing to the peculiar state of preservation the shells quickly crumble away in handling, leaving only the internal casts, but the distinctive quinquelobate character always renders them easily recognizable. In the examples figured by McChesney and also by Meek and Worthen the apices were wanting, but the individuals were not as imperfect as was supposed.

During the earlier periods of their growth many of the shells of *C. quincyensis* were very broad, but when attaining about one-third their maximum size the aperture abruptly became relatively smaller, leaving a sharp subangular ridge around the shell parallel to the apertural margin. This abrupt decrease in the expansion of the shell imparts to the natural internal casts the appearance of an apical truncation or fracture.

In its attachment to paleozoic crinoids the only forms with which *C. quincyensis* has thus far been found associated is *Physetocrinus ventricosus* (Hall), a species having a rather depressed hemispherical dome, in which the ventral opening has a subcentral location. The dome plates are small and numerous and frequently studded with small prominent tubercles or subspinous processes, which impart to the gasteropod shell series of minute corrugations extending over each of the larger folds.

Capulus tribulosus (White). [Plate II, figs. 4a, 4b.]

Platyceras tribulosum White, 1883. 12th Ann. Rep. U. S. Geol. Sur. Ter., pt. I, p. 186, pl. XLI, figs. 6a, 6b.

Platyceras tribulosum Keyes, 1889. Proc. Acad. Nat. Sci., Phila., 1889, p. 290.

Capulus tribulosus Keyes, 1890. Am. Geol., vol. V.

Shell rather below medium size, subspiral, rather slender, forming about one volution; regularly expanding to the aperture. Apex incurved, far removed from the body of the shell. Aperture irregularly oval, usually more or less broadly lobed posteriorly; lip sharp, irregular, with usually a deep sinus anteriorly. Surface glabrate, but exhibiting numerous fine, closely arranged lines of growth; also marked by three longitudinal series of long tubular spines, extending from the apertural margin about three-fourths the distance to the apex. Of these spiniferous rows two are disposed laterally, one on each side and the third centrally and dorsally.

Horizon and locality. Burlington limestone: Burlington, Iowa.

This is one of the few spiniferous species belonging to the genus *Capulus*; and only two others of similar character occur in the American Carbonic rocks. It appears to be closely allied to *C. biserialis* (Hall) and may eventually prove identical with that form, from which it apparently differs only in having three, instead of two, rows of spines. Thus far it has been noted only in the upper division of the Burlington limestone, when it occurs in the thin sandy-clay partings, associated with delicate and beautifully preserved bryozoa. The type specimen is not a characteristic representative of the species, being in several particulars quite abnormal.

Capulus acutirostris Hall.

Capulus acutirostris Hall, 1856. Trans. Albany Institute, vol. IV, p. 31.

Capulus acutirostris Hall. 1858. Geol. of Iowa, vol. I, pt. ii, p. 665, pl. xxiii, figs, 14a, 14b.

Platyceras (*Capulus*) *acutirostris* McChesney, 1860. Desc. New Palæ. Foss. West. States, p. 71.

Platyceras uncum Meek & Worthen, 1866. Proc. Acad. Nat. Sci., Phila., 1866, p 264.

Platyceras uncum Meek & Worthen. 1873. Geol. Sur. Illinois, vol. V, p. 516, pl. XVII, fig. 1.

Platyceras acutirostris Whitfield, 1882. Bul. Am. Mus. Nat. Hist., vol. I, p. 67.

Platyceras acutirostris Hall, 1883. Indiana Geol. Rept. for 1882, p. 370, pl. XXXI, figs. 13-15.

Capulus acutirostris Keyes, 1890. Am. Geol., vol. V.

Shell below medium size, rather slender, strongly arcuate, forming from one to one and one-half volutions; posterior side for some distance from the apertural margin nearly straight. Spire laterally more or less compressed; sometimes small and short, sometimes long, attenuate, simply incurved or enrolled. Aperture oval, or sub-circular; margin sharp, sinuous. Surface marked by somewhat imbricating lines of growth, and several obscurely defined longitudinal plications, the anterior one being usually larger than the others, and often forming a prominent subangular ridge.

Horizon and localities. Keokuk limestones and shales: Warsaw and Nauvoo, Illinois. St. Louis limestone: Spurgeon Hill and Bloomington, Indiana; Tuscumbia, Alabama.

This form appears to have a geographically wide distribution; and it also presents considerable variation, even within limited areas. It was originally described from Spurgeon Hill, Indiana, and like all the faunal remains of that locality is characteristically depauperate. *Platyceras uncum* M. & W. seems to be identical with this species, the imposed conditions of environment being more favorable to a normal development; and to the attainment of somewhat larger proportions.

Capulus equilateralis (Hall). [Plate II, fig. 11.]

Platyceras equilatera Hall, 1859. Geol. Iowa, vol. I, pt. ii, Supp., p. 89.

Platyceras equilatera Meek & Worthen, 1873. Geol. Sur. Illinois., vol. V, p. 518, pl. xvii, fig. 2.

Platyceras equilateralis Miller, 1877. Cat. Am. Palæ. Foss., p. 156.

Platyceras equilatera White, 1880. Indiana Geol. Rept. for 1880, p. 514, pl. vii, fig. 5.

Platyceras equilaterum Keyes, 1888. Proc. Am. Philosophical Soc., vol. xxv, p. 236, figs. 2 and 3.

Platyceras equilaterum Keyes, 1889. Am. Geologist, vol. III, p. 331.

Platyceras equilaterum Keyes, 1889. Proc. Acad. Nat. Sci., Phila., 1889, p 288.

Capulus equilateralis Keyes, 1890. Am. Geol., vol. V.

Shell medium, but often attaining a large size; extremely variable, hemispherical to oblique conical, with incurved spire, volutions one to two in number, free or contiguous, moderately enlarging for some distance from the apex and then rather abruptly and rapidly expanding. Aperture very large, broadly oval, or often nearly circular; lip thin, more or less undulating. Surface smooth, but toward the apertural margin exhibiting numerous, often strongly imbricating, sinuous lines of growth. Frequently many small obscure longitudinal folds are also present,

Horizon and localities. Keokuk limestone and shales: Keokuk and Bonaparte, Iowa; Warsaw and Niota, Illinois; Crawfordsville, Indiana. Burlington limestone: Burlington Iowa.

This species seems to be one of the most abundant gasteropods of the Keokuk beds; especially at Crawfordsville, Indiana, where the conditions of environment, during the deposition of the blue clayey shales of that locality, were uncommonly favorable to the development of this mollusk. Some of the shells from the locality mentioned have very considerable measurements: height 45 mm.; length along the dorsum, 95 mm.: breadth, 60 mm. Not only is the species under consideration variable in size but it is extremely so in form and in the configuration of the apertural margin. Perhaps no *Capulus* in all the Carbonic presents so wide a range of variation as does this species. Immature shells appear to be glabrate, but as growth proceeded they became more and more rugose and imbricate. The spire is as often contiguous as free and simply incurved; and in adult specimens it is relatively very small. The longitudinal folds are not unfrequently very pronounced and being few in number, impart a peculiar trilobate appearance to the shells; in other examples all traces of plications are wanting.

The extensive series of *C. equilateralis* from the Crawfordsville shales affords many interesting phases of the habits of these gasteropods, hitherto not elsewhere presented in such an eminently satisfactory manner. At this locality *C. equilateralis* is usually attached to the calyx of *Gilbertsocrinus tuberosus* (Lyon & Casseday) but the mollusk is not invariably associated with this particular species of crinoid, as Meek & Worthen[1] supposed. A number of typical examples of the Capulus in question have been observed adhering to *Platycrinus hemisphericus* Meek & Worthen [plate II, fig. 11] with which, however, is more commonly associated *C. infundibulum* (M. & W.). In *Gilbertsocrinus* the vault is relatively large, nearly flat, with the anal opening located midway between the center and margin. In both *G. tuberosus* (L. & C.) from the Keokuk shales and *G. typus* (Hall) from the Burlington limestone, the ventral plates are convex, or, as in many specimens very nodose. The growing margin of the gasteropod shell having adapted itself exactly to the irregularities of the surface of the crinoidal vault, necessarily was always more or less deeply sinuous, each sinus being produced by the nodosity of the vault plate in contact; while the small linguiform projection between two sinuses extended down between the nodes of two contiguous plates. The extreme nonparallelism of the lines of growth so conspicuously evident in the shells of many ancient

[1] Geol. Sur. Illinois, vol. V, p. 335.

Capuli is thus capable of being traced and especially in those examples in which the nodosity of the dome plates of the crinoid have reached a high development. This phenomenon of nonparallelism of the lines of growth is not therefore indicative of a change in station of the gasteropod as has been suggested at various times.

It has been clearly shown elsewhere[1] that shells of *C. equilateralis*, when adhering to flat surfaces are always very much depressed and have the aperture proportionately much more expanded than the average specimen, while the spire is closely incurved, even touching the body of the shell. When the gasteropod is found attached to strongly convex surfaces, or to the calyces of *Platycrinus* the shell enlarges less rapidly; and there is also a tendency in the apex to become free from the body-whorl and even to completely uncoil, often to such an extent as to approach closely some forms of the *C. infundibulum* type.

Capulus fissurella (Hall).

Platyceras fissurella Hall, 1859. Geol. Iowa, vol. I, pt. ii, Supp., p. 90.

Platyceras fissurella Meek & Worthen, 1873. Geol. Sur. Illinois, vol. V, p. 519, pl. XVII, fig. 4.

Platyceras fissurella Keyes, 1889. Proc. Acad. Nat. Sci., Phila., 1889, p. 289.

Capulus fissurella Keyes, 1890. Am. Geologist, vol. V.

Shell massive, obliquely depressed conical, enlarging rapidly to the aperture; from apex to margin straight or somewhat arcuate anteriorly, slightly concave posteriorly. Apex obtuse, situated nearly over the posterior margin of the aperture, which is ample, oval or nearly circular; lip thick, rounded, very slightly sinuous. Surface marked by numerous gently undulating, somewhat irregular and often subimbricating lines of growth. Occasionally there are obscure indications of small longitudinal folds.

Horizon and localities. Keokuk limestone: Warsaw and Nauvoo, Illinois. Burlington limestone: Burlington, Iowa.

The specific name of this form is very inappropriate, having originated in a misconception on part of the author of the species as to the true nature of the apical perforation in the type specimen. It has been clearly shown by Meek & Worthen that the aperture in the apex is not a natural opening, but an accidental fracture in the shell.

Recently typical examples of *C. fissurella* have been found in the upper Burlington limestone, thus adding another case in support of the view lately[2] advanced that the faunas of the Keokuk and Bur-

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[1] Proc. Am. Philosophical Soc., vol. XXV, p. 236.

[2] Keyes: American Journ. Sci., vol. XXXVIII, pp. 189–193.

lington limestones are much more intimately related biologically than had hitherto been generally regarded; and that many so-called Keokuk species are merely the subsequent genetic representatives of Burlington forms. The validity of their distinction simply on account of occurring in differently named geological horizons cannot be sustained. It is not to be supposed that the biologic sequence of two divisions as the Burlington and Keokuk, so closely related stratigraphically and lithologically, and deposited under identical quiet conditions should be so widely separated faunally as the described species from these limestones would indicate.

Capulus infundibulum (Meek & Worthen). [Plate II, fig. 10.]

Platyceras subrectum Hall, 1859. Geol. Iowa, vol. 1, pt. ii, Supp., p. 89 (not *P. subrectum* Hall, 1859, for a New York specimen).

Platyceras subrectum Hall, 1860. Twelfth Am. Reg. Rept. Univ. N. Y., p 18. (Not *P. subrectum* Hall, 1859.)

Platyceras infundibulum Meek & Worthen, 1866. Proc. Acad. Nat. Sci., Phila., 1866, p. 266.

Platyceras infundibulum Meek & Worthen, 1873. Geol. Sur. Illinois, vol. V, p. 517, pl. XVII, fig. 3.

Platyceras infundibulum Keyes, 1888. Proc. Am. Philosophical Soc., vol. XXV, p. 238, fig. 1.

Platyceras infundibulum Keyes, 1889. Proc. Acad. Nat. Sci., Phila., 1889, p. 289.

Capulus infundibulum Keyes, 1890. Am. Geologist, vol. V.

Shell more or less conical, often somewhat oblique, with usually many undefined longitudinal folds; apical portions slender, expanding regularly at first and then more rapidly. Apex attenuated, often slightly deflected toward the posterior side. Surface smooth, but toward the aperture marked by numerous undulating, frequently imbricating lines of growth.

Horizon and localities. Keokuk limestones and shales: Keokuk, Iowa; Warsaw, Illinois; Crawfordsville, Indiana. Burlington limestone: Burlington, Iowa.

The most closely allied form associated with this species is *C. fissurella* (Hall), from which it is distinguished in being proportionally more elongate, while the apical part of the shell is characteristically slender. Ordinarily the shell is more or less conspicuously plicate, but the folds are, for the most part, narrow, and usually irregular and broken.

For an elongated specimen Meek & Worthen[1] have indicated the name *Platyceras extinctor* "should it prove distinct," but the term

[1] Proc. Acad. Nat. Sci., Phila., p. 266, 1866.

cannot be regarded as having actually been proposed, while the form itself is manifestly only an attenuated internal cast of *C. infundibulum*. It however exhibits well the characteristic muscular impressions.

This species like *C. equilateralis* (Hall), with which it is usually associated, occurs in the Burlington limestone and ranges through the Keokuk. Its association with crinoids at Crawfordsville, Indiana, has been for the most part with *Platycrinus hemisphericus* M. & W.; while at Burlington it adheres to a structurally similar form, *Eucladocrinus millebrachiatus* W. &. Spr. The vault in the first species is very much elevated and the anal opening is situated laterally between, and slightly above, two arm bases. The dorsal cup is ornamented by numerous conspicuous rounded tubercles. As the growing shell increased in size the pliant apertural margin encountered successively the different nodes, which caused the lip at these points to deflect outward, giving rise to variously shaped prominences on the shell; when the tubercles were arranged in regular rows there appeared a series of narrow nodular plications. In many cases the gasteropod shell increased in size much faster than the echinoderm and the lip of the shell consequently often encompassed the two posterio-lateral arms and not unfrequently also the stem of the crinoid. The result was two large, deep sinuses in the anterior and one similar indentation in the posterior margin of the shell. The effect of the tubercles was to impart a similar sinuous character to the entire margin, hence the lip was always crenated during the latter part of the mollusk's existence. The continual change in the nature of the surface upon which the gasteropod shell rested also interfered with the uniform and regular growth along the apertural margin and the lines of growth are consequently often strongly imbricated.

Capulus sulcatinus sp. nov. [Plate II, figs. 12a, 12b.]

Shell of medium size, obliquely subovate, composed of two to two and one-half rather closely coiled or contiguous volutions, enlarging rapidly toward the aperture. Body whorl large and partly free from the small closely coiled spire; a broad rounded fold extends dorsally along the last whorl. Aperture broadly obovate; margin sharp, undulating, with a wide deeply rounded sinus anteriorly. Surface marked by numerous well defined, nearly parallel longitudinal ridges, with broad, rather shallow depressions between; lines of growth numerous, extremely sinuous.

Horizon and locality. Keokuk shales: Crawfordsville, Indiana.

This species occurs in the famous Crawfordsville crinoid beds, associated with *C. equilateralis* and *C. infundibulum* both of which are common species of that locality. It is one of the few regularly costate species of the genus and the only one of this character found in the Carbonic strata of America.

Capulus ovalis (Stevens).

Acroculia ovalis Stevens, 1858. Am. Jour. Sci, (2), vol. xxv, p. 261.

Platyceras laevigatum Meek & Worthen, 1866. Proc. Acad. Nat. Sci, Phila., 1866, p. 263. (Not *Acroculia laevigata* McCoy.)

Shell very small, subglobose; volutions about two an one-half in number, contiguous, rather rapidly expanding but not campanulate; spire very small. Aperture regularly subcircular or oval, but frequently somewhat flattened laterally; lip sharp, not sinuous. Surface glabrate; but under the magnifier exhibiting fine regular lines of growth.

Horizon and localities. Kaskaskia limestone: Union and Randolph counties, Illinois; St. Genevieve county, Missouri.

Capulus ovalis is one of the smallest of the lower Carbonic Capuli, having a height of only three to six millimeters and a maximum breadth of eight millimeters.

Capulus chesterensis (Meek & Worthen). [Plate II, figs. 13a, 13b, 13c, 13d.]

Platyceras (Orthonychia) chesterense Meek & Worthen, 1866. Proc. Acad. Nat. Sci., Phila., 1866, p. 265.

Platyceras chesterense Keyes, 1888. Proc. Am. Philosophical Soc., vol. XXV figs. 4 and 5.

Capulus chesterensis Keyes, 1890. Am. Geologist, vol. V.

Shell small, obliquely conical, with five nearly equidistant, longitudinal furrows, which alternate with broad flattened folds; expanding moderately to the aperture; usually more or less strongly arcuate, sometimes forming nearly half of a volution, thus bringing the apex above or even considerably beyond the posterior portion of the labrum. Apex more or less attenuated but often blunt. Aperture pentagonal, or irregularly subcircular; lip thick, rounded, with five deep, rounded sinuses. Surface marked by numerous subimbricated, broadly undulating lines of growth.

Horizon and localities. Chester division of the Lower Carbonic: Chester and Pope counties, Illinois; and Pulaski county, Kentucky.

This little species is found almost invariably attached to the vault of crinoids; and Meek & Worthen report one adhering to the side of *Pentremites godoni* DeFrance, "so as to entirely cover one of the pseudo-ambulacral fields and two intermediate areas." The specimens from Kentucky are nearly all attached to *Pterotocrinus*—*P. acutus* Wetherby, *P. bifurcatus* Weth., and *P. depressus* Weth. In the first of these species the vault is very much elevated, being nearly three times the height of the dorsal cup. The first radial dome plates are produced into monstrous, alate processes, leaving only a small summit which is perforated for the anus. The margin of the growing gasteropod shell has followed closely the surface in contact; and in the majority of examples when the summit of the crinoidal vault was not sufficiently extensive for the support of the enlarging shell, the apertural margin has been prolonged into the interradial depressions, forming prominent, rounded, linguiform extensions; while the protruding, rounded upper edges of the alate dome-plates of the crinoid have given rise to five deep, broadly rounded sinuses in the lip of the molluscan shell. The lines of growth in the shell are therefore extremely sinuous, the undulations in the direction of the aperture being concave on the broad flattened folds, and convex in the furrows. In some specimens the furrows and folds have their origin very near the apex; a fact which is suggestive that the form of the shell and the configuration of the apertural margin may not have been entirely dependent upon the immediate surface of contact; but from a long continued habit of adhering to a crinoid presenting such remarkable ventral features as *Pterotocrinus*, the gasteropod gradually acquired after many generations, a decided tendency toward the quinquelobate form, which made itself manifest at an early period of the mollusk's existence, and perhaps even in the latter part of the embryonic stage.

In order to bring the mouth over the ventral aperture of the crinoid and at the same time rest securely on the limited, flattened summit at one side of which the anal opening was situated it was necessary for the gasteropod to have the anterior portion of the shell directed toward the posterior side of the crinoid—one of the few instances of the kind that has been noted, for almost invariably the front of the gasteropod shell is directed toward the anterior side of the echinoderm.

Capulus parvus Swallow. [Plate II, figs. 14a, 14b, 14c.]

Capulus parvus Swallow, 1858. Trans. St. Louis Acad. Sci., vol. I, p. 205.

Platyceras nebrascense Meek, 1872. U. S. Geol. Sur. Nebraska, p. 227, pl. iv, fig. 15.

Platyceras nebrascense White, 1875. Expl. W. 100 Merid., Vol. IV, p. 159, pl. xii, fig. 5.

Platyceras nebrascense White, 1884. Indiana Geol. Rept. for 1883, p. 159, p. xxxii, figs. 15 and 16.

Capulus parvus Keyes, 1890. Am. Geologist, vol. V.

Shell small, broadly arcuate, or obliquely recurved, forming nearly one volution; regularly and rather rapidly expanding to the aperture. Apex rather blunt; inclined or recurved to the right. Aperture ample, subovate; lip sharp, more or less regularly sinuous. Surface nearly glabrate but under a glass showing numerous undulating lines of growth, which are clearly visible nearly to the apex. The shell is also marked sometimes by several almost obsolete longitudinal folds.

Horizon and localities. Upper Coal Measures: Indiana, Iowa, Nebraska, Kansas and New Mexico.

The small specimen figured (plate II, figs. 14a and 14b) is considered the type of Swallow's species, now in the museum of the University of Missouri. A careful comparison shows the form described from Nebraska by Meek is only a more mature individual of *C. parvus*. Since, however, Swallow's species was poorly defined and was never figured; and as Meek was the first to give a clear dignosis of this form both by a full description and by good illustrations, it is questionable whether Meek's name should not really be retained for the form, *Platyceras nebrascense* having been almost universally applied to this species as occurring throughout the west.

Capulus spinigerus (Worthen).

Platyceras spinigerus Worthen, 1873. Geol. Sur. Illinois, vol. V, p. 594, pl. xviii, fig. 4.

Capulus spinigerus Keyes, 1890. Am. Geologist, vol. V.

Shell rather small, strongly arched; composed of less than one volution; very rapidly expanding to the aperture. Apex sharp, scarcely incurved. Aperture subovate; lip sinuous. Surface marked by many undulating, often somewhat imbricated lines of growth; and also by a few scattering spines; several low broadly rounded longitudinal ridges have their origin near the apex and extend to the aperture.

Horizon and locality. Lower Coal Measures: Brighton, Illinois.

This is one of the three spiniferous species of *Capulus* occurring in the Carbonic strata of America. The other two are from the Burlington limestone and have the spines arranged in longitudinal series while in *C. spinigerus* the spines are scattered over the surface of the shell. It is very probable that this form will prove to be identical with *C. trigonalis* of Stevens.

For the loan of type specimens and material sincere thanks are tendered: Prof. G. C. Broadhead, State University of Missouri; Dr. J. S. Newberry, School of Mines, Columbia College, New York City; Mr. Charles D. Walcott, U. S. Geological Survey, Washington, D. C.; Dr. Alexander Winchell, University of Michigan, Ann Arbor; Mr. E. O. Ulrich, Newport, Ky.; and especially Messrs. Charles Wachmuth and Frank Springer.

IV. Spurious and Doubtful Species of Carbonic Capuli.

Platyceras bivolve White & Whitfield. (Proc. Boston Soc. Nat. Hist., vol. VIII, p. 302. 1862.) A careful examination of the type specimen appears to indicate that this form is a true *Platystoma* and it has accordingly been transferred[1] to that genus. Though somewhat resembling the young specimens of *Platyceras ventricosum* Conrad, as remarked by White and Whitfield, it differs very essentially from that form. The spire is much more elevated, being on a level or even above the surface of the body whorl; while the inner lip is much thickened, reflexed and anchylosed to the spire. *Platystoma bivolve* (W. & W.) has almost an exact counterpart among some forms of the upper Siluric species *Platystoma niagarense* Hall, from the Waldron (Indiana) shales.

Platyceras capax K. (Proc. Am. Phil. Soc. 1888, p. 241.) Probably synonymous with *C. equilateralis* (Hall).

Platyceras capulus Hall. (Geol. Sur. Iowa, vol. I, pt. ii, Supp., p. 91. 1859.) If recent identifications have been correct this species does not belong to the genus *Capulus*.

Platyceras extinctor Meek & Worthen. (Proc. Acad. Nat. Sci., Phila., p. 266, 1866.) Never formally proposed. It is evidently only an elongated variety of *Capulus infundibulum* (M. & W.).

Platyceras lævigatum Meek & Worthen. (Proc. Acad. Nat. Sci., Phila., 1866, p. 263.) Synonym of *Capulus ovalis* (Stevens). The name was preoccupied by McCoy.

Platyceras nebrascense Meek. (U. S. Geol. Sur. Nebraska, 1872, p. 227.) Only a more mature individual of *Capulus parvus* Swallow.

Platyceras pabulocrinus Owen. (Rept. Geol. Sur. Indiana, p. 364, 1862.) Proposed for a form similar to C. *infundibulum* (M. & W.), but without description.

Platyceras reversum Hall. (Geol. Iowa, vol. I, pt. ii, Supp., p. 91, 1859.) Manifestly is not a Capulus.

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[1] Proc. Acad. Nat. Sci., Phila., 1889, p. 293.

Platyceras subrectum Hall. (Geol. Iowa, vol. I, pt. ii, Suppl., p. 89, 1859.) Preoccupied by Hall for an Upper Helderberg form. Synonym of *C. infundibulum* (Meek & Worthen).

Platyceras tortum Meek. (Proc. Acad. Nat. Sci., Phila., 1871, p. 171.) This species does not belong to *Capulus*. The general form, the flattened character of the upper half of the body whorl, the obtuse angularity toward the sutural line and the series of distinct parallel costæ running transversely over the volutions, as well exhibited in the type specimens, all indicate that the species is actually a partially uncoiled *Naticopsis*, probably not far removed from *N. ventricosa* N. & P. A similar tendency in the whorls to become separated is admirably shown in *Naticopsis gigantea* H. & W. from the Devonic; and also in *Platystoma niagarense* Hall from the upper Siluric. The shell of *Naticopsis torta* (Meek) is extremely thin and fragile, while the lines of growth are regularly and evenly curved, both of which characters are seldom exhibited in the ancient Capuli.

Capulus triplicatus Swallow. (Trans. St. Louis Academy Sci., vol. I, p. 205, 1858.) Too imperfect for description. Apparently does not even belong to the Gasteropoda. Probably a valve of a Myalina!

Platyceras uncum Meek & Worthen. (Proc. Acad. Nat. Sci., Phila., 1866, p. 264.) Synonym of *Capulus acutirostris* Hall.

Of the five following species nothing is known except the original descriptions which are very meager and are unaccompanied by figures. They are apparently identical with species already described; but inasmuch as authentic specimens have not been examined their synonymy will not here be considered. They are: *Platyceras hertzeri* Winchell, *Platyceras vomerium* Winchell, *P. quincuxense* McChesney, *P. hickmansense* McChesney and *Acroculia trigonalis* Stevens.

Explanation of Plate II.

Fig. 1. *Capulus paralius* (W. & W.) 1a. Lateral view of type specimen [Museum of University of Michigan]. 1b. A younger individual.

Fig. 2. *Capulus cyrtolites* (McC.) Lateral aspect.

Fig. 3. *Capulus obliquus* (Keyes). Lateral view of type.

Fig. 4. *Capulus tribulosus* (White). 4a. A rather small shell, from above. 4b. Same from side.

Fig. 5. *Capulus cornuformis* (Winchell). Lateral view of a small individual. [Coll. J. S. Newberry.]

Fig. 6. Calyx of *Platycrinus pileiformis* Hall showing the impression made by a calyptraean shell on the posterior side of the crinoid.

Fig. 7. Portion of the ventral surface of *Strotocrinus regalis* (Hall) showing the impression made by a growing shell of Capulus.

Fig. 8. *Capulus formosus* Keyes. Lateral view of type specimen, attached to *Dorycrinus immaturus* W. & Sp. [Coll. Wachsmuth and Springer.]

Fig. 9. *Capulus quincyensis* (McC.) View of an exfoliated specimen.

Fig. 10. *Capulus infundibulum* (M. & W.) A shell attached to the anal surface of *Platycrinus hemisphericus* M. &. W.

Fig. 11. *Capulus equilateralis* (Hall). An example adhering to the calyx of *Platycrinus hemisphericus* M. & W. [Coll. Wachsmuth and Springer.]

Fig. 12. *Capulus sulcatinus* Keyes. 12a. View of the type specimen. 12b. Ventral view of another individual.

Fig. 13. *Capulus chesterensis* (M. & W.) 13a. View from above of a specimen resting on the ventral surface of *Pterotocrinus acutus* Weth. 13b. Another example with the alate radial dome plates of the crinoid broken away. [Both from Collection of Wachsmuth and Springer.] 13c, 13d. Lateral aspects of two other individuals.

Fig. 14. *Capulus parvus* Swallow. 14a, 14b. Views of the type specimen [Museum State University of Missouri]. 14c. A larger example generally known as *C. nebrascensis* (Meek).

[Unless otherwise stated all specimens here figured are in the collection of C. R. Keyes.]

May 6.

Dr. D. G. Brinton in the chair.

Twenty-nine persons present.

A paper entitled "New Myxomycetes in Century xxv of Ellis and Everhart's North American Fungi." By Geo. A. Rex.

The death of George S. Pepper, a member, was announced.

May 13.

Mr. Charles Morris in the chair.

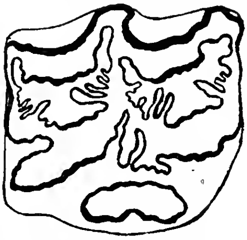
Twenty-eight persons present.

May 20.

The President, Dr. Joseph Leidy, in the chair.

Thirty-two persons present.

Hippotherium and Rhinoceros from Florida.—Prof. Leidy remarked that with other fossils, which had been the subject of former communications, collected by Joseph Willcox and Wm. M. Meigs at the phosphate bed of T. S. Morehead in Peace Creek, Florida, there were a number of Horse teeth. These were regarded as having pertained to the extinct indigenous species *Equus major* and *E. fraternus.* Among them was one, which from its general resemblance was included with the former, but since has been noticed by the quickly observant eye of Prof. Cope to belong to a *Hippotherium.* The size of the tooth indicates the species to have been as large as the ordinary domestic Horse and therefore the largest species of the genus yet discovered. The specimen also represents the third species found in Florida; the others being the *H. ingenuum* and *H. plicatile* (Proc. 1885, 33; 1887, 310). The tooth, a second or third upper molar, is three inches long in its outer curvature and the worn triturating surface, represented in the accompanying wood-cut, measures 15 lines fore and aft and 14 lines transversely. The arrangement of the enamel most nearly approximates the condition observed in *H. occidentale* from our western tertiary formation. The inner column, of uniform breadth the entire length of the crown, measures half an inch fore and aft, and in section is horizontally reniform. The species was a third larger than the *H. gracile*, the largest European form. From its size it may be distinguished with the name of Hippotherium princeps.



Hippotherium princeps.

Comparative measurements of the teeth of:

	H. ingenuum.	H. plicatile.	H. princeps.
Fore and aft diameter	19mm.	20mm.	32mm.
Transverse do	17mm.	24mm.	31mm.

The fossil bones from near Archer, Florida, which have been the subjects of former brief communications (Proc. 1884, 118; 1885, 32; 1886, 11; 1887, 309) consist in greater part of the remains of a species of Rhinoceros, distinguished as *R. proterus*. It was an animal approximating in size the living *R. indicus*, but had comparatively short, robust limbs and was probably hornless. The remains consist of teeth and bones, with fragments of others, mostly isolated, of many individuals. Thus as an indication of the latter the collection contains 28 astragali and nearly a hundred complete metapodials. The bones of the feet are remarkable for their short, robust character. Among the fossils are a few bones and teeth of a second species of Rhinoceros, a little larger than the former and with feet of the same proportions as in the recent Indian Rhinoceros. Of this species the collection contains but a single imperfect astragalus. A pair of metacarpals, the second and fourth, though of less breadth than those of *R. proterus*, approximate double the length. The comparative measurements of the specimens are as follows:

	R. longipes.	R. proterus.
Second metacarpal:		
Length, in front, at middle . .	157mm.	92mm.
Breadth of upper extremity . .	45mm.	50mm.
Breadth of lower articulation . .	39mm.	40mm.
Fourth metacarpal:		
Length, in front, at middle . .	144mm.	81mm.
Breadth of upper extremity . .	40mm.	44mm.
Breadth of lower articulation .	35mm.	41mm.

A carpal scaphoid in comparison with one of *R. proterus* presents the following measurements.

Extreme breadth	84mm.	85mm.
Extreme height	60mm.	40mm.

A pair of tusks, lower incisors, much worn, which have been about 8 inches long, are supposed to belong to *R. proterus*. They are strongly curved much compressed fore and aft, and measure 47mm. wide by 33mm. thick at the base of the crown. Another tusk, about a foot long, is supposed to have belonged to the other species of Rhinoceros. It is less curved and more cylindrical than the former, and at the base of the worn crown is 51mm. wide and 45mm. thick.

For the second species the name of RHINOCEROS LONGIPES was proposed.

MAY 27.

The President, Dr. JOSEPH LEIDY, in the chair.

Twenty-eight persons present.

Mastodon and Capybara of South Carolina.—PROFESSOR LEIDY directed attention to several fossils and made the following remarks. The exploration of the phosphate beds of the South Atlantic States promises to give us much information of the quatenary fauna of the region. Many interesting forms, both terrestrial and marine, have been brought to our notice. Recently, the fine specimen of a Mastodon tooth exhibited, looking as if carved out of ebony, as is the case with many of the fossils from the same and similar localities, was presented to the Academy by Mr. James R. McKee. It was found in the Santee Beds of Beaufort Co., S. C. It is the complete crown of a last upper molar, strikingly different from that tooth in the common American Mastodon. It is worn only on the summits of the anterior pair of lobes, which display the usual exposed dentinal areas. Notwithstanding the many species of Mastodon which have been recorded in North and South America, the present tooth seems to indicate a different one. It more nearly resembles the corresponding tooth of the *M. floridanus*, recently described, or that of the *M. angustidens* of Europe, than of the *M. americanus*. In comparison with the molars of these and other known species the tooth is remarkable for the greater proportionate length of the constituent lobes of the crown and their conspicuously wrinkled condition. The wrinkling is longitudinal and regular and apparently not the result of an abnormal state. Similar wrinkling is observed in some specimens of the same teeth in *M. americanus*, but mainly confined to the intermediate vallies of the crown, while it is well produced laterally in the present fossil. From the comparatively more prolonged condition of the lobes, the summits of the inner ones appear more tapering or narrowly pointed than in *M. floridanus;* while with the fore and aft extensions of the same lobes the summits form acute and not obtuse angles as in the latter. Regarding the specimen as indicating a previously unknown species, this may be distinguished as the MASTODON RUGOSIDENS.

Comparative measurements of the tooth are as follows:

	M. rugosidens.	M. floridanus.
Length of crown fore and aft	190mm.	190mm.
Breadth of base at fore part	92mm.	96mm.
Length of second inner lobe	90mm.	80mm.
Length of second outer lobe	80mm.	62mm.

The second fossil is a fragment of an upper incisor of a Capybara, from Ashley River, South Carolina, submitted for examination by Mr. Edwin E. Howell, of the firm of Ward and Howell. Some specimens of molar teeth from the same locality, previously described, do not differ in any respect from those of the living species, but from the conditions under which they were found were referred to a different one with the name of *Hydrochœrus œsopi* (Proc. 1856, 165).

The present fossil accords in anatomical character except size with the corresponding part in the living Capybara. Its comparative measurements are as follows:

	Fossil.	Recent.
Transverse diameter	16mm.	10mm.
Fore and aft do	11mm.	8mm.

It perhaps pertains to the same species as the fragment of a mandible from Nicaragua, referred to *Hydrochoerus robustus* (Proc. 1886, 275).

Since the description of the latter, I have seen the notice of a species, *H. magnus*, indicated by the ramus of a mandible found in Buenos Ayres, S. A. (Gervais and Ameghino, Mammif. Fossiles de l'Amerique du Sud, Paris, 1880, 45). The size of the former appears to accord with that of the latter species, and they are perhaps the same. The antero-posterior diameter of the first lower molar attributed to *H. robustus* is 25mm. Ameghino gives as the same diameter of the second lower molar of *H. magnus*, 26mm. (Bol. Acad. Nac. Ciencias, Buenos Ayres 1883, 273). In the recent Capybara, the fore and aft diameter of the first and second lower molars is nearly the same; so that the measurement of the corresponding teeth in the two fossils would indicate animals of the same size, and it may be suspected, the same species.

The following were elected members:—

Alfred G. Baker, Charles Platt, John Cadwalader, Clement A. Griscom, Charles P. Hayes, James MacAllister, Thomas Miles, John C. Garland, Annesley R. Govett, David Milne and Caleb J. Milne.

The following were ordered to be printed:—

NEW EAST INDIAN LAND SHELLS.

BY H. A. PILSBRY.

Helicina Dentoni Pilsbry.

Shell of a globose-conical form, but acutely keeled at the circumference; solid; opaque-white, with dark red inner whorls and milk-white apex. Surface slightly shining, showing under a lens numerous (about 14 on body-whorl) low, indistinct, spiral riblets. The spire is conical, nearly straight-sided; apex white; the next two or three whorls are a rich dark red color. There are 4½ whorls, very little convex, the last rather rounded but with an acute keel. Aperture half-round, dark reddish orange inside; lip expanded, light salmon-colored. The pad at the umbilical region has a glassy, faint bluish appearance.

Alt. 7, greater diam. 8¾, lesser 7½ mm.

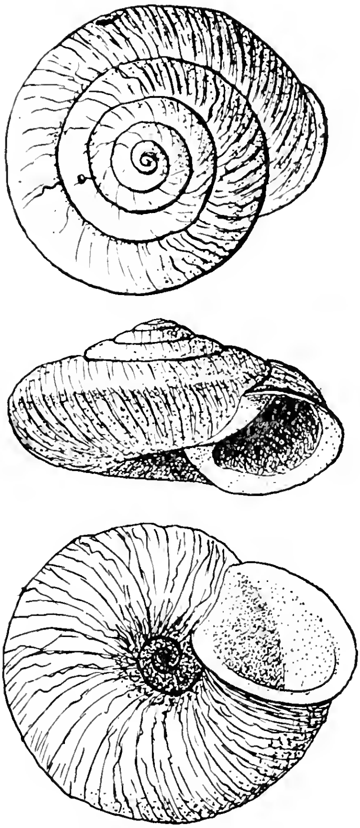
Oblique alt. of aperture 4½, greatest width 4½ mm.

One of the specimens has obscure, irregular, reddish spots on the upper surface of the last and next earlier whorls. The species does not appear in the Monographs, nor in the more recent publications of Tapparone-Canefri (Ann. Mus. Civ. Genova) and others. It is named in honor of Mr. William Denton, who collected the specimens in New Guinea.

Nanina Ruschenbergeri Pilsbry.

Shell large, depressed, thick and solid, rudely striate, deeply and perspectively umbilicated.

Solid and strong, opaque. The specimens are dead, lusterless and destitute of epidermis, of a dirty-white color with either (1) a single narrow peripheral brown girdle, the umbilicus brown inside, or (2) a broad brown girdle encircling the middle of the whorl, or (3) the upper surface of the last whorl brown except for a light girdle just above the periphery, below which there is a broad zone, its lower edge fading out on the base, the periphery itself marked by a narrow darker band; in all the forms the umbilicus is brown inside and the whorls of the spire light, the apex somewhat rufous. The surface has very coarse and uneven, irregular, oblique striæ above; they are weaker below; and under a lens, close incised



spiral lines become visible, making the surface granulate; they are nearly obsolete on the body-whorl, but usually distinct inside the umbilicus and on the earlier whorls. The spire is low, obtuse; sutures deeply impressed. Whorls 6, slowly widening, the inner three somewhat protruding above the outer; the last whorl very convex above, obsoletely angled on its earlier portion, becoming rounded, shortly but decidedly deflexed in front. Aperture very oblique, rounded-lunate; peristome expanded on its outer margin, reflexed, blunt and much thickened on the basal and columellar margins. Umbilicus deep, permitting one to see to the apex, and funnel-shaped.

Alt. 22, greater diam. 42, lesser 37 mm.; width of umbilicus 8 mm.; oblique alt. of mouth (meas. outside perist.) 21, width 21 mm.

Another specimen measures: Alt. 22, diam. 45 mm.

Habitat, Liu-Kiu Is. (Dr. Ruschenberger).

This is a very solid, heavy form, apparently belonging to the group of *H. pallasiana* Pfr. but very different from that species in its much more convex whorls, deeper suture, more broadly expanded umbilicus, and in the rounded body-whorl, the earlier part of which is very acutely carinated in *H. pallasiana*. There are four specimens before me, one of them about half grown, the others adult. The young shell is very obtusely angled at the periphery; the striæ are minutely granulated. The embryonic shell is large, about one-fifth the diam. of the adult, composed of about 2¾ whorls, of which the outer 1½ are finely, distinctly granulate, the inner ones having low, curved, radiating little folds. The termination of the embryonic shell is marked by a distinct line.

DESCRIPTION OF A NEW SPECIES OF HELIX.

BY JOHN FORD.

Helix (Planispira) Deaniana Ford.

Shell umbilicated, discoidal, flattened above and below; thin but solid; white, with a broad chestnut-brown zone encircling the last whorl just above the periphery, and continued on the next whorl immediately above the suture.

Surface comparatively smooth, the growth striæ being very faint. Whorls 4½, convex, the inner ones sunken a trifle below the level of the penultimate whorl, which projects slightly above the last whorl. The latter is large, rounded above, below and at the periphery, slowly descending in front to about the middle of the preceding whorl; narrowly constricted behind the basal lip, much inflated just behind the constriction and obliquely excavated in the umbilicus behind the columellar lip. Aperture very oblique, rotund, lunar, white, showing the brown bands inside. Lip broadly expanded on upper and outer margins, very narrowly reflexed on the basal and columellar. The outer and basal portions are of a beautiful pink rose-color. The parietal wall has a thin wash of callus. Umbilicus funnel-shaped and slightly impinged upon by the columellar lip.

Alt. 11½, greater diam. 26, lesser 20 mill.

Aperture, oblique alt. 16, breadth 14½ mm. including peristome. Width of umbilicus 2½ mm. Hab. New Guinea. Though resembling somewhat the figure of *H. tortilabia* in Reeve's Monograph (Pl. 92, fig. 498), it has a far more broadly expanded superior lip, narrower baso-columellar lip, and the body-whorl is much less gibbous behind the lip than in Reeve's figure.

This beautiful species was collected in the interior of New Guinea by the late Mr. Wm. Denton and presented to the Academy by his son, Mr. Shelley Denton, of Wellesley, Mass.

It has been named in honor of Mr. Geo. W. Dean of Kent, Ohio, a dear friend of both gentlemen, and a most worthy student of conchological science.

JUNE 3.

Mr. THEO. D. RAND in the chair.

Twenty persons present.

JUNE 10.

Mr. J. H. REDFIELD in the chair.

Fifteen persons present.

The death of Richard K. Betts, a member, May 29th, was announced.

JUNE 17.

Mr. THOMAS MEEHAN, Vice-President, in the chair.

Twenty-seven persons present.

The death of Isaac J. Williams, a member, June 10, was announced.

Marine and Fresh Water Diatoms and Sponge-Spicules from the Delaware River Clays of Philadelphia.—Mr. LEWIS WOOLMAN exhibited under the microscope, in connection with the Microscopical and Biological Section, specimens of sponge spicules and diatoms from the Philadelphia clays and stated respecting them that about a year ago Mr. C. Henry Kain remarked to him that a pupil in a public school of the city had handed him, in 1884, a lump of blue clay with the broad but rather indefinite information that it was obtained from a cellar near 8th and Vine streets, and that it contained diatoms, which on further examination proved to be salt water forms.

Mr. Kain at that time catalogued the forms but did not publish the discovery because unable to exactly locate and positively identify the bed from which the clay had been obtained and also because some question had been raised as to the probability of marine species occurring in Philadelphia clays.

The tearing down of the houses at the south-west corner of 9th and Market streets, formerly occupied by Messrs. Cooper & Conard, preparatory to the erection of a new building to be used by their successors, Messrs. Granville B. Haines & Co., recently presented an opportunity to investigate the subject referred to by Mr. Kain.

In deepening the cellar and digging still lower for the foundations, a bed of clay was encountered varying from whitish and yellowish to bluish in color. In the northwest corner of the basement this bed was found ten feet below the pavement; from this point it has a slight but irregular dip toward the southeast. It has a thickness of about six feet and rests upon gravel which varies in different places from a sharp sand to a coarse gravel containing some extra large pebbles. Enclosed within the clay on the 9th street side are some thin lenticular-shaped deposits of sand.

A careful examination of all portions of the clay which was here exposed over an area of 120 feet by 132 feet revealed the presence of sponge spicules in considerable numbers, but more numerous at the bottom than at the top of the bed. Many were of the pin-head forms characteristic of salt water. A very few marine diatoms were also observed.

Within a week after the preceding investigations some bluish clay belonging to the same bed was obtained from an excavation at 9th & Race streets. The clay is here a few feet nearer the street level. At this point sponge spicules and diatoms occur, both in abundance. The diatoms show a mixture of salt water and fresh water forms. About fifty species have been observed, two-thirds being marine and one-third fresh water. Numerically, however, probably seven-eighths of the individual forms are marine. Among the sponge spicules the characteristic marine forms with pin head termination at one end were here again observed. Here also the life forms were more plentiful in the lower part of the bed.

What is probably the same clay bed and likewise containing marine spicules and diatoms has been met with at 11th and Cherry streets, about two feet below the pavement in an excavation for an underground telegraph conduit.

Clay with marine spicules has also been obtained from a depth of two and a half feet at 15th and Summer streets and also from beneath the basement floor of the City Hall.

The inference to be drawn from these facts is that the former and wider ocean estuary of Delaware Bay covered the site of Philadelphia with its saline waters and that its life forms were mainly marine, but that it was subject to considerable invasion of fresh water from the river and neighboring streams, and thus fresh water forms were brought into association with marine species.

Mixtures of salt and fresh-water diatoms have also been found in deposits near the present borders of the Delaware and Schuylkill rivers. They occur at lower levels than that of the clay bed at 9th and Market streets and probably belong to a lower flood plain of the rivers and would therefore be more recent in date. The Delaware Bay had by this time considerably diminished in width but the presence of marine diatoms would indicate the continuance of ocean water influences up to the latitude of Philadelphia until quite recently. The assemblage of salt and fresh water diatoms now referred to were found in borings preliminary to work done or to be done for the foundations of the eastern abutments of the Chestnut and Walnut street bridges over the Schuylkill also in a boring made below the bottom of the Schuylkill in searching for a suitable foundation for the central pier of the pivot bridge at Penrose Ferry. These borings were furnished by S. L. Smedley, City Surveyor. Marine and fresh water diatoms were also met with in abundance near Reed street wharf on the Delaware river in clay from an excavation twenty feet or more in depth made for the construction of a water tank for the use of Spreckels' Sugar Refinery.

Dr. F. W. Lewis in the Proceedings for 1861 evidently refers to this same deposit when on page 62 he says: "The old estuary bed of the Delaware (blue clay) was very rich in these forms" (*i. e.* brackish and marine) "and by digging down a short distance at any part of the meadowland bordering the river the blue clay which contains them may be exposed."

In connection with these remarks, and as completing the record of discoveries relating to diatoms in Philadelphia clays, it may be well to refer to an exclusive fresh water deposit brought to the notice of the Academy by Prof. G. A. Koenig, in November, 1885, and by Aubrey H. Smith in May, 1886. This was found in the bottom of the cut of the Baltimore and Ohio R. R. south of Gray's Ferry road. The same bed has since been seen by the speaker in the bottom of an excavation made for Reed street sewer near where it passes under the Baltimore and Ohio R. R. and about three blocks from the former locality.

This fresh water bed occupies a higher level than the marine deposits bordering the rivers. It underlies the clays used for brick making in the vicinity, and is separated therefrom by a few feet of gravel and must itself lie very close to or upon the micaceous rocks underlying and surrounding the city, and which outcrop between the points where the deposit has been observed and the Schuylkill River. From information obtained from workmen at the locality the bed is believed to be about ten feet thick. Its exact relation to the marine and mixed deposits previously described in this communication has not yet been determined.

JUNE 24.

Mr. CHARLES MORRIS in the chair.

Seventy-six persons present.

Mexican Explorations.—PROF. ANGELO HEILPRIN made a preliminary report on the work accomplished by the exploring party which went to Mexico in February last. It was announced that detailed reports of the expedition were being prepared and would be presented for publication later in the year.

Mr. J. Dundas Lippincott was elected a member.

The following was ordered to be printed:—

DESCRIPTIONS OF THREE NEW SPECIES OF MYXOMYCETES, WITH NOTES ON OTHER FORMS IN CENTURY XXV, OF ELLIS AND EVERHART'S NORTH AMERICAN FUNGI.

BY GEO. A. REX.

The Myxomycetes recently issued in Century XXV of N. A. Fungi, E. and E., include an unusual number of representative American species. The following specific diagnoses and descriptions apply to three of these, which have hitherto been undescribed.

Physarum tenerum n. sp., No. 2489.

Sporangia stipitate, erect or nodding, exactly spherical in shape, about $\frac{1}{3}$ mm. in diameter; wall of sporangium single, membranaceous, but thickly studded with circular, flattened, yellow granules of lime, rupturing when mature in a more or less regularly laciniate manner. Stipes from 1 to $1\frac{1}{2}$ mm. in height, subulate, opaque, slender, of a light yellow color above, shading into a light brown below, longitudinally striate at the base or sometimes the entire length; columella wanting. Capillitium white, delicate, forming a loosely but regularly meshed network, with numerous small round or rounded yellow lime granules at the intersections. Spores dark brown, 7.5 to 8 μ. in diameter, with a delicately warted epispore which, however, is apparently smooth under a less amplification than about 700 diameters.

Fairmount Park, Philadelphia; Ohio, (Morgan.)

This is a delicate graceful Physarum, very fragile and evanescent, and seems to be distinct, by reason of its characteristic rounded lime granules, from any similar stipitate species. It might be mistaken for a globose form of *Tilmadoche mutabilis* but the capillitium is sufficiently distinctive.

The species varies somewhat according to locality, the Ohio specimens being a little larger, and having thicker and more calcareous stipes than is usual in the specimens found in the vicinity of Philadelphia. The walls of the sporangia when fully matured, generally rupture into several petal-like segments which finally become reflexed.

Trichia subfusca n. sp., No. 2495.

Sporangia stipitate, simple, very rarely double or triple, generally exactly spherical, exceptionally globose-turbinate, about $\frac{1}{2}$ to $\frac{2}{3}$ of a mm. in diameter. Color of sporangia, a dull tawny brown above, shading to a dark brown at the base. Stipes uniform in diameter, and equal in height to the diameter of the sporangium, brown or brownish-black in color, longitudinally rugose and separated from the cavity of the sporangia by the internal layer of the sporangium wall. Spores and capillitium concolorous, of a bright yellow color in mass.

Elaters cylindrical 3.5 to 4 μ. in diameter, terminating generally in a smooth elongated end 10–12 μ. long, which is either sharp or blunt, straight or curved to one side. Spirals four in number, non-spinulose, winding more or less unevenly, with interspaces as wide or wider than the thickness of the spirals. Spores 11.5 to 12.5 μ. in diameter delicately but distinctly warted.

Adirondack Mts., New York.

This Trichia is more nearly allied to some of the forms of *Tr. fragilis* than to any other species. There seem, however, to be sufficiently well-marked specific differences. In addition to the different external characters, the elaters are undoubtedly cylindrical in a majority of the specimens. Occasionally individual sporangia are found in which the elaters are a little thicker in the center, narrowing slightly toward the ends, but even these exceptions terminate abruptly in the same form of ends as the true cylindrical elaters. Occasionally also, as with all Trichias, sporangia will be found in which the elaters are branched or distorted, or have a tendency to bulbous expansions near the ends or in their course, but these are abnormal and exceptional. The specimens distributed under this number (2495) were collected in August, 1889, with a few exceptions. The unusually wet season had the effect of rendering many of them much darker in color than is indicated in the foregoing specific diagnosis, which was drawn from types developed and collected under the most favorable conditions.

Trichia erecta n. sp., No. 2496.

Sporangia stipitate, usually simple, occasionally double or triple and very rarely fasciculate, with a cluster of 6 to 8 on a single stipe. Single sporangia globose or globose-turbinate ½ to ⅔ of a mm. in the transverse diameter.

Color of sporangia a dark nut brown, which is uniform below, but checkered or broken above into irregular patches with broad septa of a bright yellow color.

Stipes about 1 mm. in height, rough or granular on the surface, quite thick and equal throughout their length, and dark brown in color. Spores and capillitium concolorous, being a bright yellow color in mass.

Elaters cylindrical, 3.75 to 4 μ. in diameter terminating in short, sharp, smooth ends 4 to 6 μ. long. Elater spirals 4 in number, spinulose with numerous irregular spines, coarse, winding irregularly. Adjoining spirals often united with each other by interspiral branches which run either longitudinally or obliquely in the direction of the spirals.

Spores 12–13 μ in diameter, delicately warted when examined under a high power lens.

Shawangunk and Adirondack Mts., N. Y.

This Trichia is conspicuous for the checkering or areolation of the upper surface in the perfectly mature sporangia, showing a sharp contrast between the adjoining nut brown and bright yellow colors. In this respect it resembles *Tr. fragilis* which sometimes exhibits in its var. *lateritia* and also in one of its simple forms, a dull mottling of the color of the upper surface of the sporangia.

The following species of Myxomycetes, also among those issued in the same Century, present special points worthy of record :—

Didymium eximium Pk., No. 2493.

The specimens distributed under this number correspond with the type of the species in the Herbarium of the N. Y. State Museum of Nat. History in Albany.

The thick yellow papyraceous or crustaceous walls of this interesting Didymium are generally permanent at the base, forming a sort of receptacle or cup. The white surface crystals of lime characteristic of the genus are scanty and occasionally wanting. The columellas are yellow in color, discoid, exceedingly rough on the upper surface and sometimes spinulose even to the extent of long spicules (in exceptional cases) penetrating to one-third the height of the sporangia.

The specimens under No. 2089, N. A. Fungi E. and E., which were also distributed as *D. eximium* Pk. differ in many respects from those just described, the sporangium walls being thin, membranaceous and translucent, when divested of the abundant, snow-white crystals of lime by which they are covered. The stipes are longer, darker and more slender, and the columellas, also discoid, are less roughened above and either pure white or yellowish-white in color. The spores in both forms are delicately warted when seen under a high power lens.

Having collected and examined the specimens issued under both of these numbers, I believe them to be referable legitimately to the same species.

They apparently form the extreme limits of what must be considered an extremely variable species, the intermediate and connecting links of which exist, and can be demonstrated by the examination of a sufficient number of specimens developed in different localities under varying conditions of growth.

Badhamia lilacina Fr., No. 2494.

It is difficult for a student of the American Myxomycetes to determine with certainty the species distributed under this number, from the published descriptions. The proverbial inadequacy of descriptions alone, in many cases, to create an intelligent conception of the objects described, is in this instance abundantly illustrated. The specimens distributed were all collected in the mountain districts of New York, and may be considered as representing the American form of this species. In some of its characters, this form differs so much from the original description of Fries and the later one of Rostafinski (as given in the Myxomycetes of Great Britain—Cooke), that an enlarged description is necessary to cover the points of difference. The most notable of these are the occasional development of stipes, and the existence of a crustaceous layer of lime on the outside walls of the sporangia, which crumbles and falls away in flakes at maturity, as in some of the double-walled Chondriodermas.

In the form in which it is found in New York and Pennsylvania the species may therefore be described as follows:

Sporangia closely aggregated, globose or obovate, usually sessile or substipitate, and occasionally stipitate. If stipitate, the stipe is short, varying in size from a mere point to $\frac{1}{6}$ of a mm. in height, light chestnut-brown in color and longitudinally striate.

Color of sporangia generally dull white above, becoming dusky about the middle of the sporangia and shading into a bright brown at the base. Capillitium white, composed of coarse irregular tubes filled with snow-white granules of lime, radiating from the center, which in most sporangia is occupied by a columella-like mass of lime to the wall of the sporangia, and communicating with each other by lateral branches.

Walls of sporangia thick, composed of a membranaceous internal layer, coated externally with a thick, easily separable layer of lime, which ultimately breaks and falls away. Spores dark violet 11.5 to

12.5 μ. in diameter, with thick epispores studded irregularly with peculiar, blunt, elongated projections, each of which by the use of a high power lens can be resolved into from 2 to 8 or more minute, irregularly cylindrical processes standing side by side, apparently joined by their bases, in rank or in irregular angular clusters.

The spore sculpturing is absolutely characteristic, and is the same in both European and American specimens. It does not resemble that of any known spore of the Myxomycetes and is well shown by the illustration in Rostafinski's Monografia Sluzowce.

The color of the sporangia is often modified, as is the case with some of the specimens distributed under No. 2494, by the readiness with which the external limy layer is stained by rain water, tinged with coloring matter from the decaying leaves on which the sporangia may be developed.

As the result of immaturity or imperfect development, a few individuals of a cluster of sporangia, may occasionally be found lacking the external layer of lime, either wholly or in part, in which case the membranaceous wall is beautifully iridescent.

The stipitate sporangia are solitary, not gregarious in habit of growth. They are ellipsoidal or obovate in shape and probably represent the highest stage of development of the species.

JULY 1.

Mr. CHARLES MORRIS in the chair.

Thirteen persons present.

Papers under the following titles were presented for publication :—

"The Spider Fauna of the Upper Cayuga Basin." By Nathan Banks.

"On a new Genus of Colubridae from Florida." By Arthur Erwin Brown.

JULY 8.

Mr. CHARLES MORRIS in the chair.

Ten persons present.

JULY 15.

Mr. THOMAS MEEHAN, Vice-President, in the chair.

Sixteen persons present.

A paper entitled "On Birds collected in Yucatan and Southern Mexico," by Witmer Stone, was presented for publication.

JULY 22.

Mr. CHARLES MORRIS in the chair.

Twelve persons present.

Papers under the following titles were presented for publication :—

"Contributions to the Life-Histories of Plants. No. 5." By Thomas Meehan.

"An Account of the Vincelonian Volcano." By Benjamin Sharp, M. D.

The death of James W. Queen, a member, on the 12th inst., was announced.

The Publication Committee reported in favor of publishing a paper entitled "The Spider Fauna of the Upper Cayuga Basin," by Nathan Banks, in the Journal of the Academy.

JULY 29.

Mr. Thomas Meehan, Vice-President, in the chair.

Twelve persons present.

A paper entitled "Barometric Observations on the Heights of Mexican Volcanoes with a Consideration of the Culminating Point of the North American Continent," by Prof. Angelo Heilprin, was presented for publication.

Mr. George Frederick Kunz of New York was elected a Correspondent.

The following were ordered to be printed:—

ON A NEW GENUS OF COLUBRIDÆ FROM FLORIDA.

BY ARTHUR ERWIN BROWN.

The snake described below was captured at Lake Kerr, Florida, and was lately received at the Zoological Garden from Mr. N. P. Fry, of that place. As I am unable to refer it to any heretofore described genus of *Colubridæ*, the genus *Stilosoma* is established to receive it.

STILOSOMA genus nov.

Generic Characters.—Body very slender, cylindrical and rigid; tail short; head rounded on frontal outline, not distinct from body. Rostral prominent but not recurved; no prefrontals, anteorbitals or loreal. One nasal. Postfrontals and occipitals in contact with labials. Scales smooth. No scale pits. Anal entire. Teeth smooth. Palatal teeth present.

S. extenuata, species nov.

Eye moderately small. One nasal with nostril in the center. Postfrontals large, in contact with the second and third labials and forming, with the latter, the anterior border of the orbit. Vertical hexagonal, the anterior angle obtuse. Superciliaries short and broad. Occipitals large, bounding the postorbitals behind and touching the fifth labial. Two small postorbitals, the lower one resting on a notch between the fourth and fifth labials. Three temporals in a horizontal series; the first lying between the fifth and sixth labials and ten occipitals. Six superior labials; third and fourth in orbit; fifth largest. Five lower labials; fourth very large. Three pairs of thin shields. Nineteen rows of dorsal scales, lozenge shaped and perfectly smooth.

Abdominal scutellæ 235. Subcaudals small in 44 pairs.

Ground color silvery-gray, with sixty-one dorsal spots of dark brown with blackish border, from head to anus and eleven on the tail. Anteriorly, the spots are from two to four scales long and from five to seven wide; posteriorly becoming smaller. The interspaces are about equal in length to two spots and have the three median rows of scales mottled with pale red. Under surface of body silvery gray, much blotched with black, which runs up on the three exterior rows of scales, opposite the intervals between the dorsal spots. On the sides, each light scale is finely punctuated with black. An elongated, triangular dark patch on the occipitals, pointing backward and a small dark blotch just below it on each side of the neck. A dark bar running back from the eye on the upper margin of the labials. The forepart of the head and the chin and throat much maculated with black.

Total length of specimen 532 mm. (21 in.). Length of tail 50 mm. (2 in.).

The general coloring of the specimen is much like that of *Rhinochilis lecontii,* but the generic and other characters render it impossible to confuse it with that or any other North American species. The fact that but one specimen has yet been collected in a region so comparatively well known as northern Florida renders it probable that the species is of extreme rarity.

The specimen is herewith presented to the Academy.

ON BIRDS COLLECTED IN YUCATAN AND SOUTHERN MEXICO.

BY WITMER STONE.

The collections here described were made by Mr. F. C. Baker and myself on the recent expedition from the Academy of Natural Sciences of Philadelphia under the charge of Prof. Angelo Heilprin. The principal districts where collections were made were in north western Yucatan and on the Mexican highlands in the immediate vicinity of the peak of Orizaba. For convenience, I will treat of the two regions separately.

YUCATAN.

The country throughout the north-western part of the peninsula is flat and dry. There are no surface streams whatever, the water being obtained from deep wells. On the western side, fifty miles south from the north coast, is a range of hills running northwest and southeast. The following is a brief description of the most important points where specimens were collected :—

At Progreso, on the north coast, the shore is lined with extensive sand hills covered by a low growth of Palmetto, Cactus and various thorny bushes. These sand hills extend back from the beach for about half a mile and are characterized by such birds as the Cardinal, Cactus Wren, Lawrence's Gnatcatcher and Mocking bird. Farther inland are low mud flats bordering the Mangrove swamps and lagoons which separate the strip of land on which Progreso is situated from the mainland. On the mud flats and along the edge of the mangroves, are found Bryant's Warbler, Myrtle Warbler, Red-wing Blackbird and Vermilion Flycatcher, while about the lagoons various water-birds abound, especially the Louisiana Heron and American Egret.

Farther inland, the country is very stony and covered with a scrubby growth six to ten feet high, composed mainly of various thorny leguminous bushes. At Tekanto, about fifty miles to the southeast, situated in the midst of this scrubby forest, a number of species were collected. The most characteristic birds found here were the Cardinal, Mockingbird, Blue-Gray Gnatcatcher, Parula Warbler, Oriole, Groove-billed Crotophaga, Motmot and Chaparral Cock, while about the haciendas or ranchos were found the Great-tailed Grackle, Ground Doves and Uxmal Woodpecker. Birds were also collected along the Valladolid road from Tekanto to Tunkas especially near Izamal, Sitilpech and Shkolak. At the first of these localities the forest is about the same as at Tekanto but after passing Sitilpech it becomes much denser and is not so dry, the trees are much larger and are covered with orchids and bromelias. Here we began to encounter birds of a more tropical character such as the Yucatan Blue Jay, Aztec Paroquet, Guatemalan Ivory-billed Woodpecker, Booted Trogon and Euphonia.

The vegetation is densest about half way between Sitilpech and Tunkas where there are two large pools of water or aguadas, at Shkolak and Skashek, which probably communicate with underground water courses. These are surrounded on all sides by a luxuriant forest growth, and birds of all sorts abound. Several species of water birds were seen here, most prominent among which was the Mexican Jacana. Among the smaller birds the Tyrant Flycatchers probably outnumbered all the others together—the Giraud's Flycatcher being the most abundant.

Along the range of hills to the west, collections were made at the hacienda of Calcehtok near the western end of the range and at Ticul, Uxmal and Labna. At Ticul the vegetation was much the same as at Tekanto but on the southern side of the hills in the vicinity of Labna it was denser and more tropical and the character of the birds seen at the two places varied accordingly.

Our visit to Yucatan (Feb. 22nd to March 26th) occurred during the dry season and was probably not the best time for collecting birds, as we were told that a little later there was a migration of birds to the northern part of the peninsula and that the more tropical species were then much more abundant.

The following is a list of all the species observed by us with such notes as we were able to gather in regard to their habits, etc.:

1. **Podilymbus podiceps** (L.)? Pied-billed Grebe.

Several birds supposed to belong to this species were seen swimming in the aguada at Schkolak, but no specimens were obtained.

2. **Larus argentatus smithsonianus** Coues. Herring Gull.

One seen flying about the vessel while at anchor off Progreso, March 22nd.

3. **Larus atricilla** Linn. Laughing Gull.

Common off Progreso, March 22nd.

4. **Anhinga anhinga** Linn. Snake bird.

Several seen on the lagoon back of Progreso; said to be common.

5. **Pelecanus fuscus** Linn. Brown Pelican.

Several of these birds were always to be seen fishing close to the beach at Progreso. They appeared to be very tame, coming close up to the pier where boats were being unloaded.

6. **Fregata aquila** (Linn.). Man-o'-War Bird.

Very common off the coast. Both old and young were seen, though the former appeared the more numerous. Sometimes as many as one hundred could be seen in one flock.

7. **Anas discors** Linn. Blue-winged Teal.

Several were observed on the lagoon back of Progreso, March 19th, and one specimen was shot.

8. **Anser ?**

On the night of March 19th great numbers of geese were seen and heard flying overhead, following the coast line in a northeasterly direction. Unfortunately no specimens were procured.

9. **Phoenicopterus ruber** Linn. Flamingo.

Said to be common along the coast but not seen during our stay.

10. **Ardea herodias** Linn. Great Blue Heron.

Found in the swamps back of Progreso.

11. **Ardea egretta** Gmelin. American Egret.

Very common flying about over the lagoons and mangrove swamps along the coast. We secured no specimens.

12. **Ardea caerulea** Linn. Little Blue Heron.

One seen on the aguada at Shkolak.

13. **Ardea tricolor ruficollis** (Gosse). Louisiana Heron.

Very common in the mangrove swamps at Progreso.

14. **Ardea virescens** Linn. Green Heron.

One seen near Progreso.

15. **Gallinula galeata** (Licht.) ? Florida Gallinule.

One bird seen swimming on the aguada at Shkolak supposed to be this species.

16. **Aegialitis vocifera** (Linn.). Killdeer.

One shot on the mud flats back of Progreso, March 20th.

17. **Jacana gymnostoma** (Wagl.). Mexican Jacana.

These birds were very common about the aguadas at Shkolak but were exceedingly shy and kept hidden in the dense growth of sedge, only occasionally venturing out on to the large water-lily leaves which cover the surface of the water, in search of food. When roused by a shot they flew across the water uttering a plaintive cry and with their long feet stretched out behind. When on the wing the yellow markings are very prominent.

18. **Colinus nigrogularis** (Gould). Yucatan Bob White.

Common in the forest along the road south of Izamal in flocks of twelve to twenty. Several specimens were shot.

19. **Meleagris ocellata,** Temm. Ocellated Turkey.

Several seen in the woods near Tekanto, Feb. 28th. Unfortunately none were secured.

20. **Columba flavirostris** Wagl.? Red-billed Pigeon.

Several large pigeons were seen near Tunkas which probably belonged to this species.

21. **Melopelia leucoptera** (Linn.). White-winged Dove.

This species was rather common throughout the interior and was generally seen in pairs.

22. **Columbigallina passerina pallescens** (Baird). Mexican Ground Dove.

Very common everywhere about the haciendas and along the roads. Specimens were shot at Tekanto and Ticul.

23. **Columbigallina rufipennis** (Bonap.). Rufous Ground Dove.

Not so common as the preceding. Specimen procured at Tekanto, Feb. 28th.

24. **Cathartes aura** (Linn.). Turkey Vulture.

Occasionally seen at Tekanto and Tunkas, and more frequently between Ticul and Uxmal along the base of the hills. Nowhere common.

25. **Catharista atrata** (Bart.). Black Vulture.

Everywhere abundant and extremely tame. A " nest " containing eggs was found near Tekanto about February 15th.

26. **Geranospizias caerulescens** (Vieill.).

A fine specimen was shot at the aguada at Shkolak.

27. **Rupornis ruficauda** (Scl. & Salv.).

This appeared to be the most common hawk along the road south of Izamal. Several specimens were shot. One, a young male

(Izamal, Mar. 6), has the breast buffy-white longitudinally striped with brown, while the whole upper surface is of a browner hue than in the adult. All the specimens have the ground color of the tail ashy-gray.

28. **Asturina plagiata** (Licht.). Mexican Goshawk.

A fine specimen of this hawk was shot near Tunkas, March 3rd. It has the bands on the tail nearly pure white.

29. **Spiziastur melanoleucus** (Vieill.).?

A large hawk supposed to be this species was frequently seen in the vicinity of Tekanto and Sitilpech.

30. **Falco sparverius** (Linn.). Sparrow Hawk.

Common on the hills at Calcehtok. A few were also seen at Izamal and at Progreso.

31. **Glaucidium phalænoides** (Daud.). Ferruginous Pigmy Owl.

One seen in the woods near Tunkas. Mar. 3rd. It was in the rufous phase of plumage.

32. **Chrysotis albifrons** (Sparrm.). White-fronted Parrot.

This parrot was first met with in the forest west of Tunkas, only one flock of about half a dozen were seen and one specimen was procured. Several were afterwards seen at Citilpech. They were very noisy.

33. **Conurus aztec** Souancé. Aztec Paroquet.

The Paroquet was common in the forest between Sitilpech and Tunkas usually associating in large flocks. Whenever one was shot the rest rose on the wing and flew over the trees filling the air with their harsh cries. A few small flocks were seen at Tekanto, Ticul and Labna.

34. **Crotophaga sulcirostris** (Sw.). Groove-billed Ani.

This bird was common everywhere in the interior being most abundant in the open portions of the forest and, unlike the other "Blackbirds" of the country, was seldom seen about the Indian huts, towns, or haciendas. A few were seen in the scrubby growth on the sandhills at Progreso.

35. **Geococcyx affinis** Hartl. Mexican Road-runner.

This bird was only met with in the scrubby woods about Tekanto. It does not seem to be common as only three individuals were seen. Two were shot while running rapidly through the brush, the other was seen early in the morning perched on top of a small bush ; when alarmed it jumped to the ground and made off through the under-brush. When running through the brush these birds bear a striking resemblance to the Iguanos which abound in the region.

36. Piaya cayana (Linn.).

Only seen on the hills near Ticul. This species did not seem to be common and no specimens were procured.

37. Trogon caligatus Gould. Booted Trogon.

Only one specimen of this beautiful bird was seen. This was shot in the forest west of Tunkas.

38. Eumomota superciliaris (Sw.).

Rather common, seen at Tekanto, Tunkas and Ticul. Frequent about towns and haciendas.

39. Ceryle alcyon (Linn.). Belted Kingfisher.

A Kingfisher was seen at the aguada at Shkolak and again at Progreso. It appeared to be identical with our common northern bird but as no specimens were procured the identification remains in doubt.

40. Campephilus guatemalensis (Hartl.) Guatemalan Woodpecker.

Two were seen in the deep forest west of Tunkas, March 4th, and others near Labna. One specimen was procured.

41. Dryobates scalaris parvus (Cabot). Cabot's Woodpecker.

Rather common through the interior, specimens were procured at Tunkas and Tekanto.

42. Centurus dubius (Cabot). Uxmal Woodpecker.

Very common everywhere in the interior. Specimens from Tunkas, Shkolak, Tekanto and Labna.

43. Nyctidromus albicollis (Gmel.). Parauque.

Common after dark all along the roads near Tunkas and Shkolak; also seen at Ticul. One female specimen has the wing bars entirely buff.

44. Chaetura gaumeri Lawr. ? Gaumer's Swift.

A swift was quite common at Tunkas and Ticul, which was supposed to be this species but no specimens were procured.

45. Chlorostilbon caniveti (Less.). Canivet's Hummingbird.

A male shot near the aguada at Shkolak, March 2nd.

46. **Trochilus colubris** Linn. Ruby-throated Hummingbird.

Common at Shkolak, March 5th, at Labna, March 15th and at Progreso on the sand hills, March 19th.

47. **Lampornis prevosti** (Less.). Prevost's Hummingbird.

A fine male shot on the road from Ticul to Uxmal at the eastern base of the hills, March 13th. Also seen at Labna.

48. **Amazilia cinnamonea** (Less.). Cinnamon Hummingbird.

Rather common, seen at Tekanto, Sitilpech and Ticul.

49. **Amazilia yucatanensis** (Cabot). Cabot's Hummingbird.

A few males shot at Labna, March 14th.

50. **Tyrannus melancholicus** Vieill. Mexican Kingbird.

This is probably the commonest of all the flycatchers found in northern Yucatan. It was seen throughout the interior especially about the haciendas. In the scrubby growth on the sandhills at Progreso we found a Tyrannus which at first sight seemed different but is probably identical with this species. It seemed to differ considerably in its habits from the bird of the interior, being much more quiet. Only one specimen was collected in the interior and it is hardly right to take this as typical of all the inland birds, but comparing the three Progreso specimens with this, I find them much lighter yellow beneath, with a wider and more prominent grayish-olive band across the breast. The back is nearly uniform gray while it is very strongly tinged with olive in the inland bird. The crest of the coast bird contains much less red than the inland specimen and the under tail coverts are spotted with brown.

51. **Pitangus derbianus** (Kaup). Derby Flycatcher.

One specimen shot at Tunkas, March 3rd. No others seen.

52. **Megarhynchus pitangua** (Linn.).

Specimens procured in the forest near Shkolak and also near Tekanto.

53. **Myiozetetes texensis** (Giraud). Giraud's Flycatcher.

Very common throughout the interior, especially about the haciendas and at the aguadas at Shkolak. These birds have a shrill cry and keep up a continuous noise.

54. **Oncostoma cinereigulare** Scl.

Apparently rare; only one specimen was seen which was shot near Tekanto, February 26th.

55. Myiarchus yucatanensis Lawr. Yucatan Crested Flycatcher.

Quite common about the haciendas. Two specimens were shot near Tekanto.

56. Contopus albicollis Lawr. White-throated Wood Pewee.

Specimens were shot near Tekanto and also near Shkolak.

57. Empidonax minimus Baird. Least Flycatcher.

Seen at Ticul, Tunkas and Tekanto. Rather common.

58. Pyrocephalus rubineus mexicanus (Scl.). Vermilion Flycatcher.

This bird was common on the mud flats bordering the mangrove swamps at Progreso and seems to be restricted to the coast region as none were seen inland. The specimens collected are of a more rosy red than those from Orizaba, Mexico.

59. Cissolopha yuca ta (DuBois). Yucatan Blue Jay.

The Jay is common throughout the interior but seems to be more abundant in the dense forest surrounding the aguadas at Shkolak, where large flocks were frequently seen.

60. Xanthoura luxuosa cyanocapilla (Cab.). Yellow-bellied Green Jay.

Seen at Tekanto, Izamal and Ticul, always close to the towns.

61. Callothrus robustus (Cab.). Red-eyed Cowbird.

Abundant in the cow yards of the haciendas, continually flying about the cattle, in company with *Dives*.

62. Agelaius phoeniceus (Wagl.). Red-winged Blackbird.

Several pairs seen on the edge of the Mangrove swamps at Progreso, March 20.

63. Icterus auratus Bp.

One male shot and several others seen near Tekanto, always in company with the following.

64. Icterus gularis Wagl.

This bird was abundant throughout the interior and, with the exception of the one above mentioned, all the orioles shot belonged to this species. It is strange that this species which we found so common is not mentioned in Mr. Boucard's list of the birds collected in Yucatan by Dr. Gaumer, and that the species described by him as abundant were not seen at all by us.

Perhaps the breeding districts of the various species are different and one species may predominate in Northern Yucatan at one time and be succeeded by another. We saw no females of this species though from their difference in coloration they ought to have been easily recognized if they were present.

65. **Icterus cucullatus igneus** Rdgw.? Fiery Oriole.

A smaller oriole observed at Progreso was probably this species though as no specimens were procured I can not be certain. Both males and females were seen here but the species was not observed elsewhere.

66. **Dives dives** (Bonap.).

Abundant throughout the interior but always found about the towns or haciendas. Not seen at Progreso.

67. **Quiscalus macrourus** Sw. Great tailed Grackle.

Common in all the towns and about the haciendas but never found far away from them.

68. **Embernagra rufivirgata verticalis** Rdgw. Striped-crowned Sparrow.

Tolerably common about Tekanto, but very hard to shoot as it keeps continually concealed in the thickest bushes. Its note resembles that of the Field Sparrow (*Spizella pusilla*) but is louder. It was also met with on the hills near Ticul.

69. **Cardinalis cardinalis yucatanicus** Rdgw. Yucatan Cardinal.

Everywhere common in the dry scrubby growth about Tekanto, and Ticul also on the sand hills at Progreso, but not found where the vegetation is denser, as at the aguadas. At Ticul it occurred abundantly on both slopes of the mountains.

70. **Habia ludoviciana** (Linn.). Rose-breasted Grosbeak.

Single birds seen at Tekanto and Tunkas.

71. **Guiraca caerulea** (Linn.). Blue Grosbeak.

A few seen about haciendas at Tekanto and Tunkas.

72. **Passerina parellina** Bp. Blue Bunting.

One bird supposed to belong to this species was seen near Sitilpech but was not secured.

73. **Passerina ciris** (Linn.). Painted Bunting.

A number of cage birds seen which were said to have been taken in the vicinity of Merida; none were observed, however, by any of our party. They probably occur later in the season.

74. **Saltator grandis** Lafr.

One specimen was shot at Tunkas and others were seen at Sitilpech and Ticul.

75. **Euphonia affinis** (Less.).

Two were seen between Tunkas and Shkolak, one of which was shot.

76. **Progne chalybea** Gmel. Gray-breasted Martin.

A flock of these birds were seen flying over the aguada at Shkolak, March 5th, and one specimen was secured.

77. **Petrochelidon fulva** (Vieill.)? Cuban Cliff Swallow.

Large flocks of cliff swallows were seen about the cave on the hills near Calcehtok, but none were shot, so the identification is in doubt.

78. **Tachycineta albilinea** Lawr. White-rumped Swallow.

Very common at Progreso especially about the lagoons and mangrove swamps.

79. **Stelgidopteryx serripennis** (Aud.). Rough-winged Swallow.

Common about the hills at Calcehtok.

80. **Cyclorhis flaviventris** Lafr.

Not common; one was shot at Tekanto, March 9th, and another at Calcehtok, March 11th.

81. **Vireo noveboracensis** (Gm.). White-eyed Vireo.

One shot at Tekanto, February 28th. Very common on the mountains near Ticul, March 17th, in company with *Dendroica virens*, *Geothlypis trichas* and *Compsothlypis americana*.

82. **Compsothlypis americana** (Linn.). Parula Warbler.

Common throughout, especially about Tekanto and at Ticul, March 17th.

83. **Dendroica bryanti** Rdgw. Bryant's Warbler.

Very common among the mangroves at Progreso, March 19th and 20th. Song very much like that of *D. aestiva*. The female specimens were in very worn plumage.

84. **Dendroica coronata** (Linn.). Myrtle Warbler.

Common among the Mangroves, March 20th, in company with the preceding.

85. **Dendroica dominica albilora** Baird. Sycamore Warbler.

Several seen at Tunkas and quite common at Ticul on the Palmetto trees.

86. **Dendroica virens** (Gm.). Black-throated Green Warbler.

One shot near Shkolak, March 5th; very common on the mountains near Ticul, March 17th.

87. **Dendroica palmarum** (Gm.). Palm Warbler.

One shot among the mangroves at Progreso, March 19th.

88. **Seiurus noveboracensis** (Gm.). Water Thrush.

Common among the mangroves at Progreso.

89. **Geothlypis trichas** (Linn.). Maryland Yellow-throat.

Tolerably common at Merida and Tekanto and abundant on the mountains at Ticul, March 17th.

90. **Setophaga ruticilla** (Linn.). Red-start.

Several males seen near Tekanto, March 7th.

91. **Mimus gracilis** Cab. Yucatan Mockingbird.

Common throughout though most abundant in dry scrubby localities. Observed at Progreso and all over the mountains near Ticul. The four specimens collected vary somewhat in the amount of white on the tail and in the color of the back.

92. **Campylorhynchus guttatus** (Gould). Yucatan Cactus Wren.

Common in the scrubby growth which covers the sand hills at Progreso. A nest was found nearly completed March 19th.

These birds keep well covered in the bushes and are very hard to shoot.

93. **Troglodytes brachyurus** Lawr.

Tolerably common about Tekanto and other places where the vegetation is low and scrubby.

94. **Polioptila caerulea** (Linn.). Blue-Gray Gnatcatcher.

Common throughout the interior but most abundant in the drier and more open districts.

95. **Polioptila albiventris** Lawr. Lawrence's Gnatcatcher.

One male shot at Progreso, March 19th. Not seen elsewhere.

96. **Merula grayi** Bonap. Gray's Thrush.

One shot near Labna, March 15th, and several others seen at Ticul.

Mexico.

At the town of Orizaba a few specimens were collected but we had not time to procure anything like a full series of the avifauna of the region. The town lies in a narrow winding valley at an altitude of about 4,000 feet and is surrounded on all sides by hills and mountains; the vegetation is very luxuriant and the Rio Blanco, a mountain stream, runs through the valley. The following species were observed during our stay in the town:

1. **Columbigallina passerina pallescens** (Baird). Mexican Ground Dove.

Common.

2. **Cathartes aura** (Linn.). Turkey Vulture.

Common, almost entirely replacing the Black Vulture which abounds in the lower country, especially at Vera Cruz.

3. **Catharista atrata** (Bart.). Black Vulture.

Only a few seen.

4. **Falco sparverius** Linn. Sparrow Hawk.

Common.

5. **Ceryle cabanisi** (Tschudi). Texan Kingfisher.

Several seen along the stream.

6. **Empidonax bairdii** Scl. Baird's Flycatcher.

Two shot, March 31st.

7. **Pyrocephalus rubineus mexicanus** (Scl.). Vermilion Flycatcher.

Common.

8. **Callothrus robustus** (Cab.). Red-eyed Cowbird.

Common about the haciendas.

9. **Quiscalus macrourus** Swains. Great-tailed Grackle.

Very common.

10. **Aimophila rufescens** Swains

Several seen in low thickets bordering swamps, one was shot.

11. **Melospiza lincolni** (Aud.). Lincoln's Sparrow.

Very common, in company with the following.

12. **Ammodramus sandwichensis alaudinus** (Bon.). Western Savanna Sparrow.

Common.

13. **Sporophila morelleti** (Bonap.). Morellet's Seed-eater.

Common in flocks.

14. **Piranga hepatica** Swains.? Hepatic Tanager.

One bird seen supposed to belong to this species.

15. **Stelgidopteryx serripennis** (Aud.). Rough-winged Swallow.

Common.

16. **Dendroica coronata** (Linn.). Myrtle Warbler.

I think this is about the limit of this bird's distribution inland, as higher up the mountains and farther west we found it replaced by *D. auduboni* (Towns.). One specimen was shot March 31st, several others seen at the same time.

17. **Cinclus mexicanus** Sw. American Dipper.

Seen along the Rio Blanco. No specimens secured.

18. **Troglodytes aëdon aztecus** Baird. Western House Wren.

Rather common.

At the town of Chalchicomula or San Andres a number of specimens were collected and a good idea of the avifauna of the region was obtained.

Chalchicomula is situated on a level plain covered with loose sand or volcanic ash and is surrounded by numerous small cones of volcanic origin while the great peak of Orizaba lies in full view a few miles to the east. The plain is exceedingly dry and the vegetation is restricted to a few scattered bushes and scrubby trees, while on the peak of Orizaba are the regular mountain forests of pine and spruce. The altitude of the town is about 8,200 while the peak towers up some 10,000 feet above the plain, reaching a height of over 18,000 ft. above the sea level.

The difference between the birds of this vicinity and of the town of Orizaba, 4,000 ft. below, was at once apparent. Only three species were seen at both places, the Turkey Vulture, Lincoln's Sparrow and Sparrow Hawk, and only the last of these was at all abundant at Chalchicomula. Nearly all the species seen belonged to more northern genera, and the absence of such birds as the Great-tailed Grackle, Black Vulture and Red-eyed Cowbird was especially noticeable.

In the town itself the only birds observed were the House Finch, Barn Swallow and Blue Grosbeak, while in the sandy country stretching toward the mountain the most characteristic species were Baird's Wren, Black-eared Bush Tit, Curve-billed Thrasher, Western Chipping Sparrow, and the two species of Towhee. On the edge of the pine forest of the mountain a fine finch, *Aimophila superciliosa*, was abundant. In the forest were found the Robin, Western Blue bird, Slender-billed Nuthatch, Mexican Creeper, Mexican Chickadee, Audubon's Warbler, Mexican Snow bird, Sieber's and Sumichrast's Jays. The spruce belt of the mountain was not well defined and did not seem to offer any peculiarities in its avifauna.

While several of the mountain species, such as Sumichrast's Jay and the Mexican Snow-bird, were found on the plain some distance from the edge of the forest, none of the characteristic birds of the open country were met with in the wooded districts.

The following is a list of the species seen in the vicinity of Chalchicomula and on the Orizaba mountain, together with notes on the species found on the peaks of Popocatepetl, Ixtaccihuatl and Toluca, the latter furnished by my associate, Mr. Frank C. Baker.

1. **Cathartes aura** (Linn.). Turkey Vulture.

A few seen; also found about Toluca, Popocatepetl and Ixtaccihuatl, usually to an altitude of 8,000–10,000 ft., though on the last two mountains Mr. Baker says they were observed all the way up to the summit.

2. **Falco sparverius** (Linn.). Sparrow Hawk.

Seen about Chalchicomula and up to the summit of Orizaba, also at the summit of Popocatepetl and up to 10,000 ft. on Ixtaccihuatl.

3. **Dryobates stricklandi** (Mall.). Strickland's Woodpecker.

One shot near the base of Orizaba at 8,700 ft., April 4th.

4. **Colaptes cafer** (Gmel.). Red-shafted Flicker.

A flock of about a dozen seen at the base of Orizaba, April 4th. Also at 11000–12000 ft. on Ixtaccihuatl and Popocatepetl.

5. **Trochilus platycercus** Sw. Broad-tailed Hummingbird.

Several were observed in the vicinity of Chalchicomula; one female specimen was secured.

6. **Milvulus forficatus** (Gm.). Scissor-tailed Flycatcher.

One of these birds was seen near Chalchicomula but was not secured.

7. **Aphelocoma sumichrasti** (Ridgw.). Sumichrast's Jay.

Very common in the lower part of the pine forest of Orizaba up to 900–1000 ft., also found on Popocatepetl and Ixtaccihuatl up to about 11,000 ft.

8. **Aphelocoma sieberii** (Wagl.). Sieber's Jay.

One specimen shot on Orizaba Mt. at 10,000 ft.

9. **Corvus corax sinuatus** (Wagl.). Mexican Raven.

Several observed near Chalchicomula and on the mountain to the extreme summit, where two were observed flying over the snow fields. They also occurred up to the tops of the other mountains.

10. **Icterus spurius** (Linn.). Orchard Oriole.

A male and female observed near Chalchicomula were very small. The female which was shot measures (skin) 5·50 in. in length, wing 2·70 in., tail 2·62 in.

11. Loxia curvirostra stricklandi (Rdgw.). Mexican Crossbill.

One male shot at the lower edge of the pine forest, at about 9,000 ft., April 4th.

12. Carpodacus mexicanus (Müll.). Mexican House Finch.

Very common about the houses in the town and along the roadsides nearly to the base of the mountain.

13. Aimophila superciliosa Sw.

This bird was abundant just below the pines at the base of the mountains and was very easy to shoot as it remained perfectly still, perched on the top of a bush intent only on its song. Sumichrast's statement (see Biologia Cent. Am., Aves I, p. 396) that this species replaces *A. rufescens* in the higher altitudes is undoubtedly correct; the latter species was found at the town of Orizaba 4,000 ft. below.

14. Spizella socialis arizonae (Coues). Western Chipping Sparrow.

Very common throughout the open sandy country nearly to the edge of the pines.

15. Junco cinereus (Sw.). Mexican Snowbird.

Very common through the pine forest to 11,000 ft. It was also found some distance below the pines on the plain. Seen on Popocatepetl at 11,000 ft. and on Toluca at 8,000 ft.

16. Melospiza lincolnii (Aud.). Lincoln's Sparrow.

One shot near Chalchicomula, April 5th.

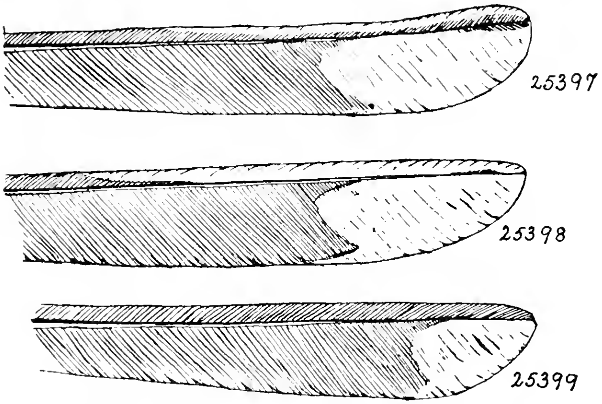
17. Pipilo fuscus Swains. Brown Towhee.

Common about Chalchicomula nearly to the base of Orizaba.

18. Pipilo maculatus Sw. Mexican Towhee.

Common, associating with the last. Three males were collected which differ somewhat from one another but are all referred to this species by Mr. Ridgway who kindly examined them. All have a more or less prominent white spot on the throat. In No. 25,399, which is the brightest colored individual, the white streaks above are restricted entirely to the sides of the back, and are faintly tinged with yellow, as is also the case with the spots on the wing coverts, some of the latter being also narrowly edged with black. This specimen has a distinct white line from the bill to the eye. No. 25,397 has the white streaks on the back strongly suffused with rufous and some of the black feathers of the breast edged with the same.

The amount of white on the tail feathers seems to vary considerably as can be seen from the accompanying cut, which represents an external tail feather from each of the specimens. No. 25,397 in addition to the spot of white on the inner web of the third tail feather has a small spot on the outer web also, while No. 25,399 has no spot at all on the outer web and only a small one at the extremity of the inner web.



19. Guiraca caerulea eurhyncha Coues. Western Blue Grosbeak.

Several flocks observed in the town.

20. Tachycineta albilinea Lawr. ? White-rumped Swallow.

A species of swallow was very common in the deep crevices or ravines near the town. It seemed to belong to this species though as no specimens were obtained the identification must remain in doubt.

21. Lanius ludovicianus excubitorides (Sw.). White-rumped Shrike.

Rather common about clumps of bushes on the sandy country between the town and the mountain.

22. Helminthophila celata (Say). Orange-crowned Warbler.

One shot on the lower edge of the pine forest, April 4th.

23. Dendroica auduboni (Towns.). Audubon's Warbler.

Common in the pine forest of Orizaba at an elevation of 10,000–12,000 ft.; also on Popocatepetl and Ixtaccihuatl at about the same altitude.

24. Harporhynchus curvirostris (Sw.). Curve-billed Thrasher.

Common throughout the open sandy country; especially about the Indian huts and along the roadside.

25. **Thryothorus bewickii bairdi** Salv. & Godm. Baird's Wren.

Common all over the plain, but not found in the town or on the mountain.

26. **Troglodytes brunneicollis** Scl. Tawny-throated Wren.

In the pine forest of Orizaba at 10,000–13,000 ft.; also found on Popocatepetl at 10,000 ft.

27. **Certhia familiaris mexicana** (Glog.). Mexican Creeper.

In the pine forest of Orizaba from the lower border to an altitude of 11,000 ft. It also occurred on all the other mountains.

28. **Sitta carolinensis aculeata** (Cass.). Slender-billed Nuthatch.

From the lower edge of the forest to 10,000 ft. above. Seen also on Ixtaccihuatl at 10,000 ft. elevation.

29. **Parus meridionalis** Scl. Mexican Chickadee.

Common in the pine and spruce forests from about 11,000 ft. to the limit of tree growth.

30. **Psaltriparus melanotis** (Hartl.). Black-eared Bush-Tit.

Common on the sandy plain between Chalchicomula and the Peak of Orizaba.

31. **Regulus calendula** (Linn.). Ruby-crowned Kinglet.

Rather common on the lower edge of the pine forest. Seen also on Ixtaccihuatl at 9,000 ft. elevation.

32. **Merula migratoria** (Linn.). Robin.

This species occurred in the pines of Orizaba at 9,000 ft., and on all the other mountains at an altitude of 9,000–11,000 ft.

33. **Sialia mexicana** Sw. Western Bluebird.

Common on Orizaba from the lower edge of the forest to about 11,000 ft. Also seen on Popocatepetl and Toluca at about the same altitude.

In addition to the collections above described Mr. Baker procured a few other specimens at several localities in the western part of Mexico.

At Lake Pátzcuaro on May 1st he collected :—

Aythya collaris (Donov.). Ring necked Duck.

Plegades guarauna (Linn.). White-faced Glossy Ibis.

Botaurus exilis (Gmel.). Least Bittern.

Fulica americana (Gmel.). American Coot.

Tyrannus vociferus Sw. Cassin's Kingbird.

Sayornis nigricans (Sw.). Black Phoebe.

Agelaius gubernator (Wagl.). Bicolored Blackbird.

Carpodacus mexicanus frontalis (Say). House Finch.

Ammodramus sandwichensis alaudinus (Bp.). Western Savanna Sparrow.

About fifteen miles south of Pátzcuaro he collected a male and female of that interesting bird, *Chamaeospiza torquata* (DuBus). The resemblance of this bird to the tanager, *Buarremon brunneinucha* (Lafr.), has frequently been remarked, and it was actually described as a *Buarremon* by Mr. Lawrence (An. Lyc. N. Y. viii, 126). The structure of the feet and bill, however, bring it very close to *Pipilo* and its nearest relative seems to be *P. chlorurus.* Salvin and Godman in the Biologia Cent. Americ. seem inclined to transfer *Chamaeospiza* to the Tanagridae while they place *Pipilo chlorurus* in the genus *Embernagra.*

As regards the habits of *Chamæospiza* Mr. Baker says they resembled those of *Pipilo.*

At La Playa, near the base of the volcano of Jorullo, May 3rd the following species were collected :

Centurus elegans (Sw.). Elegant Woodpecker.

Cassiculus melanicterus (Bp.). Crested Cassic.

Chondestes grammacus strigatus (Sw.). Western Lark Sparrow.

NEW NORTH AMERICAN FUNGI.

BY J. B. ELLIS AND BENJAMIN M. EVERHART.

Typhula subfasciculata.

On bark of dead elm, London, Canada, Dec., 1889. J. Dearness, 1245. Subfasciculate, 2–3 together or single, cylindrical, curved, 1–2 mm. high, white-farinose, contracted above into a pointed, rather darker colored apex. Basidia 15–25 μ. long with a rounded obtuse head 6–8 μ. diam. and a cylindrical base 5–6 μ. diam. Spores not satisfactorily made out, apparently small, 3 x 2 μ.

Stereum atrorubrum.

On old logs, British Columbia, May, 1889. Macoun, No. 86. Fan-shaped or reniform, 1–3 cm. broad and long, coriaceous, thin, narrowed behind into a sessile base, yellow at first (about the same color as *S. complicatum*) and tomentose pubescent with a few narrow faint zones, but when mature of a dull dark red (about the color of the pileus of *Pol. lucidus*) with the surface glabrous and densely radiate-rugose, margin lobed and crisped and in some specimens, proliferous, young hymenium yellow, becoming when old nearly brick color when moist, paler when dry. In the mature state the 3–5 concentric zones are more distinct and slightly elevated. The specimens roll up in drying and become hard and brittle.

Hymenochaete rugispora.

On charred wood of *Abies Douglasii*, British Columbia, May, 1889. Macoun, No. 94. Subpeltate, umber color throughout, margin divided into numerous small (½ cm. broad) pilei which are partly reflexed and tomentose, thick (2–3 mm.), firm, uneven (colliculose), often two or more confluent, forming a patch 5 cm. or more across. Hymenium of vertically-fibrous structure, bristles subcylindrical, 100–150 x 7–8 μ. slightly thickened, roughish and obtuse above. Spores oblong with an oblique apiculus subhyaline at first, becoming rusty-brown, wrinkled, 6–8 x 3 μ.

Asterina rubicola.

On living leaves of *Rubus occidentalis*, London, Canada, Sept., 1889. J. Dearness 712. Spots rusty yellow-brown, indefinite, paler below, confluent over large areas of the leaf. Perithecia epiphyllous, solitary or 2–4 connate, depressed-hemispherical, pierced above, black, 75–80 μ. diam. Asci oblong, sessile 35–45 x 12–15 μ. with abundant obscure paraphyses. Sporidia biseriate, ovate-elliptical yellowish-brown, 12–15 x 6–8 μ. rounded at the ends, 1–septate and constricted.

Asterina bignoniae.

On living leaves of *Bignonia capreolata*, St. Martinsville, La., Feb., 1889. Langlois, 2225. Hypophyllous, perithecia gregarious or scattered, depressed-globose, 115–125 μ. diam. roughish, black; ostiolum papilliform. Mycelium very scarce or wanting. Asci obovate, 20 x 15 μ. finally elongated-pyriform 30 x 15 μ. Sporidia crowded, oblong, 1–septate, 12 x 4 μ. hyaline, obtuse, slightly constricted (becoming brown)? On account of the subglobose perithecia and the absence of any radiate-fibrous structure this might be placed in *Dimerosporium*.

Chætomium pusillum. N. A. F. 2350.

On basswood bottom of a barrel standing in a cellar at Newfield, N. J., July, 1889. Found also at Manhattan, Kansas, on an old churn in a cellar, March, 1889. (Kellerman 1437.) Perithecia gregarious, black membranaceous, about 150 μ. diam. and 200 μ. high, the lower part clothed with fine loosely-entangled, pale slate-colored, branching hairs; upper part of the perithecia clothed more sparingly with longer, darker, mostly simple, spreading hairs which are partially transparent and continuous or very faintly septate, about 3 μ. thick at base, tapering nearly to a point. Asci narrow-cylindrical, 30 x 3½ μ. (p. sp.), without paraphyses. Sporidia uniseriate, elliptical, brown, 3½–4½ x 2½–3 μ. The asci soon disappear and the spores are expelled in a cylindrical mass ½–¾ mm. long, carrying along with it the ruptured upper half of the perithecium clothed with its spreading hairs.

C. sphærospermum, C. & E. has this same habit, and otherwise much resembles this, but has the terminal hairs more or less branched and coarser (5–6 μ. thick below) and the sporidia globose, 6–7 μ. with brown subglobose 3–3½ μ. conidia. We have not seen the asci in *C. sphærospermum* but from the form of the spore-clusters they appear to be obovate.

Myriococcum consimile.

On the basswood bottom and elm hoops of a barrel standing in the cellar, Newfield, N. J., July, 1889. Perithecia gregarious, globose, 80–100 μ. diam. carbonaceo-membranaceous, black, collapsing, pierced with a small, round opening above, filled with olivaceous, oblong 4–4½ x 1½ μ. sporules without any evident basidia. The upper half finely radiate-striate, texture close, fine radiate-cellular. The perithecia are enveloped in a loose, glauco-cinereous mycelium of the same color and character as that in *M. Everhartii* from which this differs in its smaller sporules and smaller striate perithecia with an apical opening.

Calosphaeria alnicola.

On dead alder, Newfield, N. J., March, 1889. Subcuticular, Perithecia scattered, subglobose, ½ mm. diam., roughish, seated on the surface of the inner bark, at length slightly collapsed above. Ostiola short-cylindrical, slightly raising and barely perforating the epidermis. Asci racemose-fasciculate, clavate-oblong, 20–22 x 3½–4 μ., 8–spored, the upper end of the spore-mass truncate and surmounted by the empty transparent, dome-shaped apex of the asci. Spores crowded-biseriate, allantoid, curved, 5–6 x 1 μ.

When the epidermis is peeled off the perithecia either adhere to it or remain attached to the inner surface of the bark, in which respect this differs from *Sphaeria secreta*, C. & E. in which the perithecia always adhere to the epidermis. This latter species also has longer distinctly clavate asci with a long, slender base and longer sporidia and is we believe specifically distinct from the species on alder though much resembling it.

Calosphaeria microsperma E. & E.

On *Carpinus Americana*, London, Canada, Apr., 1890. Dearness, 1587. Perithecia subcuticular, circinate, 6–18 together, about ½ mm. diam., their cylindrical necks converging and erumpent in a small compact fascicle of short ostiola projecting but slightly and mostly 4–sulcate. Asci clavate 22–25 x 4 μ. gradually attenuated to a slender base, paraphyses much longer than the asci. Sporidia minute, 3½ x ¾ μ. curved into a semicircle.

Coelosphaeria corticata.

On bark of dead *Maclura aurantiaca*, Emma, Mo., Nov., 1889. Rev. C. H. Demetrio, 272. Perithecia scattered, globose, about ½ mm. diam. closely enveloped except the papilliform ostiolum and the apex by the adherent epidermis, and clothed with a thin coat of brown, branching, sparingly septate hairs about 3 μ. thick. Asci (p. sp.) about 35 x 7 μ. 8-spored. Sporidia crowded biseriate, 2-nucleate, hyaline, moderately curved, obtuse, 10–14 x 3 μ. The perithecia soon collapse down to or a little beyond the part embraced by the epidermis and become strongly concave.

Diaporthe nivosa, Ell. & Holw.

On dead alders. Isle Royale, Lake Superior, July, 1889. E. W. D. Holway. Perithecia mostly 8–12, about ¾ mm. diam. subcircinate, buried in the unaltered substance of the bark which is raised in a pustulate manner over them, contracted above into short necks with black subhemispherical papilliform ostiola erumpent around the margin of a snow-white disk rather less than 1mm. in diam. having the same general appearance as *V. nivea* Fr. Asci (p. sp.) about 60 x 12 μ. Sporidia subbiseriate, oblong, 4–nucleate, 1–septate, constricted, 12–16 x 3–4 μ. straight or very slightly curved. There is no black circumscribing line around the stroma.

Valsa floriformis.

On dead limbs of *Populus monilifera*, near Concordia, Mo., Oct. 1887. Rev. C. H. Demetrio, No. 13. Stroma conic-hemispherical, about 2 mm. broad and 1½ mm. high seated on the inner bark and covered by the epidermis which is either simply pierced or sublaciniately ruptured by the thick fascicle of cylindrical (1 mm. or more long) somewhat spreading, rather obtusely pointed ostiola, swollen just below the tip and erumpent through a yellowish disk which is soon obliterated. Perithecia numerous (25–50) packed in a single layer in the lower part of the stroma, 1 x ¾ mm. diam. ovate or irregular from compression, contracted above into slender necks which rise through the cinereous contents of the stroma and terminate above in the cylindrical ostiola. Asci (p. sp.) 35–40 x 5 μ. Sporidia biseriate, cylindrical, hyaline, slightly curved 6–7 x 1½ μ. eight in an ascus. Differs from *V. verrucula*, Nits. in its long ostiola and smaller asci and sporidia. Has much the same general appearance as *V. scoparia*, Schw. but ostiola not sulcate and asci and sporidia larger.

Valsa glandulosa, Cke.

According to the description of this species in Grev. VII, p. 52, the ostiola are not sulcate. The specimens distributed in N. A. F. 2343 on bark of *Ailanthus* from Kentucky have the ostiola distinctly 4–5 sulcate, so also the specimens sent from Ohio by Mr. Morgan and from Staten Island, N. Y., by Mrs. E. G. Britton. An examination of the specimen in Rav. F. Am. 661 shows that they also have the ostiola sulcate. This species must then be placed in the subgenus *Eutypella*. The minute ($3\frac{1}{2}$–$4\frac{1}{2}$ x 1 μ.) sporidia distinguish it from *V. ventriosa* C. & E. In Grevillea 18, p. 86. Cooke has published the Staten Island specimens as a new species "*Valsa clavulata* Cke.," but at most this is only a robust form of *V. glandulosa* Cke. which, as distributed in Rav. F. Am., certainly has the ostiola sulcate as stated above.

Valsa (Eutypella) canodisca, Ell. & Holway.

On dead branches of *Salix*, Decorah, Iowa, May, 1886. E. W. D. Holway. Stroma depressed-hemispheric, $1\frac{1}{2}$–2 mm. diam. flattened above and covered by a circular blackish-gray definitely limited disk 1–$1\frac{1}{2}$ mm. diam. and pierced in the center by the fascicle of deeply 4–sulcate ostiola. Perithecia 6–15 in a stroma, seated on the surface of the subjacent wood, ovoid or subangular from mutual pressure, $\frac{1}{4}$–$\frac{1}{3}$ mm. diam. with thick black walls and contracted above into short converging necks with quadrisulcate ostiola collected in a slightly erumpent fascicle in the center of the disk. The upper part of the stroma around and between the necks of the perithecia is filled with whitish, grumous matter. Asci about 100 μ. long including the slender base (p. sp. 50 x 10–12 μ.). Paraphyses filiform, abundant. Sporidia eight in an ascus, allantoid, yellowish, moderately curved 12–18 x $3\frac{1}{2}$–4 μ. The stromata are often confluent. The wood beneath is marked by a distinct black circumscribing line. The circular, flat, grayish-black disk is a distinguishing character.

Pseudovalsa stylospora, E. & E.

On bark of dead *Acer spicatum*, London, Canada, March, 1889. J. Dearness, 1506 (B.). Stroma cortical, convex 2–3 mm. diam. covered by the epidermis. Perithecia circinate 4–8 in a stroma, globose, $\frac{3}{4}$ mm. diam. collapsing when dry, contracted above into short necks, terminated by small, globose ostiola, subseriately arranged and erumpent through a small crack in the bark. Asci (p. sp.) 80–85 x 15 μ. Sporidia biseriate, oblong-elliptical, hyaline and granular at first, becoming brown and 2–septate and slightly constricted at the septa, 25–30 x 10–14 μ. Pycnidia central bearing cylindrical 3–septate, hyaline stylospores 40–55 x 10–12 μ. on short basidia.

Thyridaria fraxini E. & E.

On bark of dead *Fraxinus*, London, Canada, Jan. and March, 1890. Dearness, 1371 and 1496. Perithecia thickly scattered, buried in and almost filling the bark which is uniformly blackened on the inner surface, globose $\frac{1}{2}$–$\frac{3}{4}$ mm. diam. coriaceous with thick walls, black and shining inside, contracted above into a short neck terminated by an erumpent subhemispheric-tuberculiform ostiolum more or less distinctly radiate-sulcate. Asci with a slender base, 90–100 x 15–20 μ. polysporous. Paraphyses obscure. Sporidia biseriate, vermiform, brown, 3–6 septate, 20–26 x 4 μ. The central septum is distinct, the others fainter. Spermogonia (*Cytisporina Fraxini*) central. Sporules filiform, curved, 40 μ. long. Near *T incrustans*, Sacc.

Cryptovalsa sparsa, E. & E.

On dead oak limbs, St. Martinsville, La., Feb., 1890. Langlois, 2207. Perithecia mostly only 1–4 in a stroma ½ mm. diam. buried in the inner bark with only a faint circumscribing line which does not penetrate the wood, with thick coriaceous walls, black and shining inside, attenuated above into short necks terminating in more or less distinctly quadrisulcate ostiola erumpent in a small pustuliform disk but scarcely projecting above it. Asci (p. sp.) 70–75 x 8–10 μ. polysporous, with a slender base and accompanied by paraphyses. Sporidia allantoid, yellowish, moderately curved, with a nucleus in each end, 6–7 x 1½ μ.

Diatrype macounii.

On maple bark (*Acer rubrum*)? Agassiz, British Columbia, May, 1889. Macoun, No. 127. Stroma discoid, gray, 3–4, mm. across and about one mm. thick, suborbicular or subelliptical, seated on the surface of the inner bark and loosely embraced by the upturned ruptured epidermis, circumscribed by a distinct black line which penetrates the bark and stains the surface of the subjacent wood but does not penetrate it. Perithecia numerous, 30–50, in a single layer, ovate-globose, ¼–⅓ mm. diam. contracted above into a short neck terminating in a small, indistinctly radiate-cleft black ostiolum which is in a slight depression of the stroma. Asci (p. sp. 20–30 x 3 μ.) or including the thread-like base, 50–60 μ. long. Sporidia biseriate above, allantoid, yellowish, slightly curved 4–6 x ¾–1 μ. Substance of the stroma dirty white inside.

Diatrype hochelagæ.

On decorticated elm wood, London, Canada, March, 1890. J. Dearness. Stroma orbicular or elongated, 2–3 mm. long and 1–2 mm. wide, often more or less confluent, pulvinate-verrucose with the margin abrupt or slanting off at the ends, with a faint circumscribing black line which does not penetrate deeply into the wood, dull black outside, dirty white within. Peritheecia crowded in the stroma, subglobose, about ½ mm. diam. with thick, black coriaceous walls. Ostiola conic-hemispherical, deeply 4–5-sulcate cleft. Asci (p. sp.) 40–45 x 7–8 μ. with stout paraphyses and allantoid yellowish, moderately curved 8–12 x 2½ μ. sporidia. Resembles outwardly *Diatrypella quercina*, var. *lignicola*, C. & E. Specific name from Hochelaga, an Indian name for the St. Lawrence River.

Diatrypella vitis.

On dead vines of *Vitis bipinnata*, Bayou Chene, La., Oct., 1888. Rev. A. B. Langlois, 1508. Stromata, tuberculiform-hemispherical, about 1 mm. diam. erumpent-superficial, black inside. Perithecia 1–4 in a stroma, globose ½ mm. diam. black and shining within, contracted above into a short neck. Ostiola scarcely prominent, quadrisulcate. Asci polysporus, 75–80 x 10–12 μ. clavate-cylindrical, rather abruptly contracted below into a stipitate base and surrounded by obscure paraphyses. Sporidia allantoid, yellowish-hyaline, 6–7 x 1½ μ. not strongly curved. The surface of the wood beneath the stromata as well as the inner surface of the bark is marked with a black circumscribing line.

Diatrypella demetrionis.

On dead limbs of *Salix chlorophylla* in a wet mountain valley, Colorado, July, 1888. Rev. C. H. Demetrio, No. 205. Stroma pulvinate, depressed-hemispheric, orbicular, slate-black, 1½–2 mm. diam. penetrating to the wood which is marked with a black circumscribing line, closely embraced by the superficial layer of the bark which forms a narrow adnate margin; inner substance whitish. Ostiola only slightly prominent, distinctly but not deeply radiate cleft. Perithecia of medium size, globose or angular from mutual pressure. Asci slender-clavate 75–80 μ. long (p. sp. 35 x 6 μ.). Sporidia crowded, pale yellowish in the mass, nearly hyaline when separated, minute, allantoid, slightly curved, about 4–5 x 1–1¼ μ.

This comes near *D. exigua*, Winter, which is also on willow limbs but that species is said to have the stroma very small ("minutissimis") and the sporidia 8 x 1½ μ. In the Colorado specimens we found no sporidia over 5 μ. long and mostly only about 4 μ. The general appearance is almost exactly that of *Diatrype disciformis*.

Ceratostomella mali.

On inner surface of loose hanging bark of partly dead apple trees, Newfield, N. J., Dec., 1889. Perithecia scattered, membranaceous, globose, 400 μ. diam. barely covered by the bark which is slightly raised above them and pierced by the short-cylindrical, obtuse 150 x 75 μ. ostiolum with a rather large round opening at its apex. Asci clavate, subtruncate above and narrowed gradually to the acute base, about 40 x 5 μ. 8–spored. Paraphyses none. Sporidia biseriate oblong-cylindrical, scarcely curved, faintly 2–nucleate, 6–8 x 1½ μ. Differs from *C. dispersa*, Karst. in its rather smaller straight bald ostiolum.

Ceratostoma juniperinum.

On a wounded dead place on a limb of *Juniperus Virginiana.* Flatbush, Long Island. Rev. J. L. Zabriskie. Perithecia gregarious, awl-shaped, black, 700–800 μ. high, slightly enlarged at the tip, swollen and about 150 μ. thick below. Asci included in the ovate-swollen base, oblong-elliptical, about 12 x 6 μ. with a slender base 12–15 μ. long. Sporidia crowded-biseriate, ovate-globose, brown, 4 x 3½ μ. or a little less. The sporidia exude and form a little brown head at the apex of the perithecia thus giving the appearance of a *Calicium.*

Ceratostoma parasiticum.

On old *Fomes applanatus*, West Chester, Pa., June 28th, 1889. Gregarious, membranaceous, subhemispherical, ⅓ mm. diam. reddish-brown becoming slaty-black, prolonged above into a stout beak 2–2½ mm. long, 150 μ. thick below, narrowing to about 75 μ. at the paler, subfimbriate tip. Asci oblong-ovate, (p. sp.) about 20–25 x 7–8 μ. Sporidia crowded, acutely elliptical, hyaline becoming dark, 7–8 x 4½–5 μ. The asci and sporidia often ooze out at the tip of the long beak or ostiolum and form a dark colored globule which inclines to flatten out and thus gives the appearance of an enlarged truncate tip.

Specimens of *Periconia sphærophila* Pk. found by Mr. Meschutt in Northern New Jersey and by Miss Minns in New Hampshire are ascigerous and much resemble this.

Ceratostoma conicum.

On rotten pine logs, Newfield, N. J., July, 1889. Perithecia immersed or subsuperficial by the falling away of the surrounding wood, gregarious, subovate, about ½ mm. diam., rough, prolonged above into a conical rough ostiolum projecting above the surface of the wood and finally elongated to about 1 mm. in length. Asci 75–80 x 8 μ. (p. sp.) with stout lance pointed paraphyses much longer than the asci. Sporidia biseriate, oblong-fusoid, yellowish-hyaline, about 5–nucleate, straight, 18–20 x 3 μ.

Rosellinia albolanata.

On old rails, Emma, Mo., Nov. 1889. Rev. C. H. Demetrio, 269. Perithecia subseriate, erumpent, the lower part remaining sunk in the wood, about 1 mm. diam. clothed except the black papilliform ostiolum with a thin, white, farinose coating which finally disappears, bicorticate, outer wall carbonaceous, inner submembranaceous. Asci cylindrical, about 100 x 10 μ. Sporidia uniseriate, elliptical, 12–16 x 7–10 μ. Found also bursting through the bark on dead Salix limbs, at Mill Creek, near Sheridan, Montana, Nov., 1889, by Mr. and Mrs. H. M. Fitch (com. F. W. Anderson).

Rosellinia glandiformis.

On decaying wood of an old live oak stump, St. Martinsville, La., Feb., 1889. Langlois, No. 1768. Perithecia scattered, conic-hemispheric, black and roughish (granular), 1–1½ mm. diam. about ½ part sunk in the wood, mostly with a slight reinforcement around the lower half of the projecting part like the cup of an acorn, but this is sometimes wanting. Ostiolum minute and inconspicuous. Asci cylindrical 100–114 x 8–10 μ. with numerous paraphyses. Sporidia 1–seriate, acutely elliptical, opaque (subhyaline at first), 14–15x 7–8 μ. Closely allied to *R. subiculata*, Schw. but perithecia more scattered and rather larger and the yellow subiculum wanting.

Rosellinia parasitica.

On dead limbs of *Symphoricarpus occidentalis*, Helena, Montana. Rev. F. D. Kelsey, No. 7. Perithecia gregarious, seated on the wood in transverse cracks of the bark or often on or among the collapsed perithecia of a sterile *Valsa* on the same limbs, ovate-globose, covered with short black spreading bristles at first but these soon disappear leaving the perithecia rough, ¼–⅓ mm. diam., smoother above with a broad papilliform, obtuse ostiolum. Asci cylindrical, 60–70 x 6 μ. (p. sp.) with abundant paraphyses. Sporidia uniseriate, oblong-elliptical, subobtuse, dark brown, 7–10 x 4–5 μ. This is certainly very near *R. detonsa* (Cke.) which Sacc. in Sylloge considers a var. of *R. ligniaria* (Grev.) but it differs in its perithecia more flattened above and in its constantly smaller spores.

Rosellinia kellermanni.

On rotten wood of *Negundo aceroides*, Manhattan, Kansas, March, 1889. Gregarious, superficial, perithecia subglobose about

⅕ mm. diam., clothed with short (15–22 μ.) straight, spreading bristles, except the papilliform ostiolum, finally nearly bare. (Asci long and slender, 5–spored sec. Kellerman and Swingle.) Sporidia elliptical or subglobose, 3–4 x 4–6 μ. Distinguished by its small sporidia.

Rosellinia langloisii.

On very rotten stem of *Vitis*, St. Martinsville, La., March, 1889. Langlois 1779 (p. p.). Perithecia scattered, erumpent, the base sunk in the wood, conic-hemispheric, ⅓ mm. diam. smooth and shiny black. Ostiolum papilliform. Asci about 100 μ. long and 5–6 μ. thick with abundant paraphyses. Sporidia acutely elliptical, dark-brown, 2–nucleate, 1–seriate, 6–7 x 4 μ. Resembles *R. albolanata* but perithecia and sporidia smaller and the white farinose coat wanting.

Anthostoma ontariensis.

On dead limbs of *Salix*, London, Canada, Feb., 1890. J. Dearness 1390. Stroma convex ¼–½ mm. diam. more or less subseriately confluent often for several cm., formed of the unaltered substance of the bark and surrounded by a black circumscribing line which penetrates the wood. Perithecia crowded in the stroma, subglobose ½–¾ mm. diam. with thick coriaceous walls, contracted above into a narrow neck terminated by the subglobose, deeply quadrisulcate, erumpent, ostiola. Asci slender 8–spored, 90–110 μ. long (p. sp 75–80 x 8–10 μ.) with abundant paraphyses. Sporidia subbiseriate, cylindrical moderately curved, brown, 20–26 x 4–4½ μ. Has much the same general appearance as some compact forms of *Valsa stellulata*, Fr.

Anthostomella ludoviciana, Ell. & Lang.

On dead stems of *Smilax*, St. Martinsville, La., Jan., 1889. Perithecia gregarious, covered by the blackened cuticle which is pierced by the papilliform, minutely perforated ostiolum, 140–170 μ. diam. Asci 50–55 x 3–3½ μ. cylindrical, paraphysate. Sporidia oblong-elliptical, brown, mostly 2–nucleate, 4–6 (mostly 4–5) x 2–2½ μ. uniseriate. The perithecia are often in subseriate patches, lying so near as to touch each other but hardly confluent and are buried in the substance of the bark or even in the denuded wood which is then continuously and uniformly blackened on the surface but not within. Distinguished from other allied species by its small sporidia.

Hypoxylon albocinctum.

On bark of dead *Cratægus*, Preston, Hamilton Co., Ohio, Jan., 1890. A. P. Morgan, No. 884. Stroma thin (1mm.), flat, carbonaceous, mostly orbicular, $\frac{1}{4}$–1 cm. diam., light cinereous at first soon purplish-black except the margin which remains light colored for some time, surface uneven from the projecting vertices of the perithecia which are ovate-globose, small ($\frac{1}{3}$–$\frac{1}{2}$ mm.), monostichous, moderately crowded, sunk nearly to the base of the stroma, contracted above into a short neck terminating in the minute papilliform ostiolum. Asci cylindrical, 80–100 x 5–6 μ. (p. sp. about 60 μ. long), with abundant paraphyses. Sporidia uniseriate narrowly elliptical, brown, 1–2 nucleate, subacute, 7–8 x 3$\frac{1}{2}$–4 μ. The bark beneath the stroma is whitened and surrounded by a black circumscribing line. The general appearance is like that of orbicular forms of *H. serpens*, from which it differs in its purplish stroma and smaller perithecia and sporidia.

Poronia leporina.

On rabbit dung, Emma, Mo., Sept., 1889. Rev. C. H. Demetrio, 250. Stipitate, flesh colored, small, stipe 1–2 mm. long, $\frac{1}{2}$ mm. thick expanding above into a discoid stroma 1–2 mm. diam. and mamillose from the slightly prominent perithecia which are ovate-globose, about $\frac{1}{3}$ mm. diam. 6–20 in a stroma. Ostiola large, black, convex. Asci clavate-cylindrical, 80–100 (p. sp. 75–80) x 10–12 μ. with obscure paraphyses. Sporidia at first greenish-hyaline 1–2 nucleate, becoming opaque, subinequilaterally elliptical mostly uniseriate, 12–15 x 6–7 μ.

Physalospora zeicola, E. & E.

On dead stalks of *Zea mays* exposed to the weather through the winter, Newfield, N. J., Apr., 1890. Perithecia gregarious minute ($\frac{1}{4}$–$\frac{1}{3}$ mm.) covered by the cuticle which is slightly raised and pierced by the obtusely conical, black and shining ostiolum. Asci clavate-cylindrical, 75–80 x 12–15 μ. nearly sessile, with abundant paraphyses. Sporidia crowded-biseriate, elliptical or almond shaped, hyaline, granular. 18–20 x 8–10.

Physalospora conica.

On old canes of *Arundinaria*, St. Martinsville, La., Oct., 1888. Rev. A. B. Langlois, No. 1567. Perithecia gregarious, erumpent and superficial, conical, about $\frac{1}{2}$ mm. broad and high. Asci oblong about 75 x 20 μ. with abundant paraphyses. Sporidia biseriate, elliptical, hyaline, granular, often bulging on one side, 20–22 x 10–12 μ. The asci and sporidia are the same as in *Botryosphaeria fuliginosa* (in N. A. F. 475–481) but its scattered conical perithecia are quite different from any of the forms included under that name.

Physalospora pandani.

On leaf of *Pandanus*, in a greenhouse, Knoxville, Tenn., Jan., 1890. Prof. F. L. Scribner. Perithecia amphigenous, on large dull white spots with a purplish-red border, covered by the epidermis, subglobose, 150–200 μ. diam. membranaceous, of coarse cellular structure, the apex and papilliform ostiolum erumpent. Asci cylindrical, about 100 x 10 μ. with faint rudimentary paraphyses. Sporidia uniseriate or biseriate, hyaline, granular, oblong-elliptical, 18–20 x 7–8 μ.

Laestadia orientalis.

On dead leaves of "Japan Chestnut" *Castanea japonica* (cult.), LaFayette, La., March, 1889. Langlois, 1664. Perithecia amphigenous, depressed-hemispherical, 180–200 μ. diam. scattered, erumpent. Asci clavate-cylindrical, p. sp. 45–50 x 12 μ. or including the slender base 70–75 μ. long. Paraphyses none. Sporidia crowded-biseriate, inequilaterally-elliptical, hyaline, granular and nucleolate, 12–14 x 5–6 μ. There is also on the same leaves a *Septoria* with gregarious, subglobose 80–100 μ. perithecia and hyaline, nucleate subundulate, 12–25 x 1–1½ μ. sporules—agreeing with the description of *S. gilletiana* Sacc. in all but its smaller continuous sporules.

Laestadia apocyni, E. & E.

On dead stems of *Apocynum*, London, Canada, June, 1890. Dearness, 1734. Perithecia gregarious, depressed-spherical, 150–200 μ. diam. perforated above, covered by the cuticle through which they are visible by translucence. Asci clavate-cylindrical, 40–45 x 10–12 μ. Sporidia crowded-biseriate, oblong, 2–nucleate, obtuse, mostly a little curved, 10–15 x 5–6 μ.

Sphaerella conigena.

On scales of dead cones of *Abies douglasii*, Belt Mts., Montana, Sept., 1889. F. W. Anderson, 612. Perithecia gregarious on the back of the exposed tip of the scale, minute (74 μ.) buried except the black smooth conic-papilliform apex. Asci narrow clavate-cylindrical, gradually attenuated below, 75–80 x 5 μ. paraphyses none. Sporidia uniseriate, ovate, 1–septate and constricted at the septum hyaline, 6–7 x 3–3½ μ. Differs from the usual type of *Sphaerella* in its narrow elongated asci.

Sphaerella spinicola.

On spines of *Rosa rubiginosa*, West Chester, Pa., July, 1889. Perithecia scattered or 3–4 together, minute 110–120 μ. collapsing, visible through the translucent epidermis as minute black specks, fringed around the base with scanty mycelium. Ostiolum papilliform. Asci oblong, sessile, about 45 x 12 μ. (p. sp.). Sporidia biseriate, oblong-elliptical, continuous, granular, rounded at the ends, 12–15 x 5–6 μ.

Sphaerella ciliata.

On dead stems of *Steironema ciliatum*, London, Canada, May, 1890. Dearness, 1650. Thickly gregarious. Perithecia subglobose, 150 μ. diam. covered by the cuticle but not sunk in the matrix, ostiolum papilliform. Asci clavate-cylindrical 40 x 7 μ. Sporidia, biseriate, clavate-oblong, hyaline, 1–septate and constricted 10–12 x 3 μ.

Sphaerella angelicae.

On dead stems of *Angelica atropurpurea*, London, Canada, June, 1890. Dearness, 1715. Perithecia scattered, growing under the bark and attached to it so that when the bark is peeled, off they come with it, globose, ¼ mm. diam., collapsing below, ostiola papilliform, barely piercing the cuticle and only slightly raising it. Asci clavate-cylindrical, with abundant paraphyses, 65–70 x 7–9 μ. Sporidia biseriate, oblong-elliptical, 2–nucleate, 12–15 x 3½ μ., becoming ovate-oblong and 1–septate.

Judging from the specimens in F. Eur. and F. G., this is different from *S. rubella*, Niessl.

Sphaerella maclurae.

On leaves of *Maclura aurantiaca*, Emma, Saline Co., Mo., Aug., 1889. Rev. C. H. Demetrio, 251. Spots red-brown with a definite, darker border 3–10 cm. diam. or by confluence more, very brittle, the central part paler and soon falling out. Perithecia innate with their vertices erumpent, small (75 μ.). Asci oblong-cylindrical 50 x 8–10 μ. without paraphyses. Sporidia biseriate, oblong-pyriform, constricted, slightly curved, 12–14 x 5 μ., ends subacute.

Sphaerella polifolia.

On living or partly dead leaves of *Andromeda polifolia*, London, Canada, Aug., 1889. J. Dearness. Perithecia epiphyllous on grayish-black, indefinite spots 2 mm. or more in diam., erumpent, rough, minute, broadly pierced above. Asci oblong, 35–40 x 6–8 μ. without paraphyses. Sporidia biseriate, clavate oblong, 1–septate, 10–12 x 2½–3 μ.

Didymella canadensis.

On dead limbs of *Salix*, London, Canada, Jan., 1890. J. Dearness, No. 1378. Perithecia irregularly but thickly scattered, buried in the bark, which is slightly raised above them and pierced by the small, black, papilliform ostiola, white inside, globose, about ⅓ mm. diam. Asci clavate-cylindrical, 75–90 x 12–15 μ. with abundant paraphyses. Sporidia crowded-biseriate, cylindrical, obtuse, hyaline, 4–nucleate, constricted in the middle and slightly so near each end, 25–34 x 6–7 μ.

Didymella cornuta, E. & E.

On dead stems of *Asclepias cornuti*, London, Canada, Apr., 1890. Dearness, 1635. Perithecia scattered, minute 175–200 μ. diam. attached to the blackened surface of the stem just beneath the thin epidermis which is barely pierced by the prominent ostiolum. Asci cylindrical, nearly sessile, 65–70 x 7 μ. Paraphyses present. Sporidia, biseriate, fusiform, yellowish, very slightly curved, 1–septate and constricted, becoming 3–septate, 20–25 x 3–3½ μ. ends subobtuse.

Didymella andropogonis, E. & E.

On dead leaves of *Andropogon muricatus*, St. Martinsville, La., Apr., 1889. Langlois, 2209. Perithecia hypophyllous, subgregarious, about ½ mm. diam. buried in the substance of the leaf with the apex and short conic-cylindrical ostiolum projecting. Asci cylindrical, narrow, 80–90 x 5 μ. with filiform paraphyses. Sporidia overlapping uniseriate, fusoid-oblong, 3–nucleate, becoming 1–2 septate and constricted, acute at first but finally obtuse, hyaline or yellowish-hyaline, 12–15 x 3 μ. some of them very slightly curved. Near *D. subgemina* B. & C.

Didymella mali.

On the inner surface of loose hanging bark of living apple trees, Newfield, N. J., Dec. 8, 1889. Perithecia scattered about ¼ mm. diam. buried in the substance of the bark except the emergent rather acutely conic ostiolum. Asci clavate-cylindrical, about 70 x 7 μ. with abundant paraphyses. Sporidia biseriate, fusoid, slightly curved, about 4–nucleate not constricted 20–22 x 3 μ. ends acute.

Venturia parasitica.

Parasitic on old *Hypoxylon (perforatum)* ? On bark of *Magnolia* near St. Martinsville, La., Jan., 1889. Langlois, 1781. Perithecia densely gregarious, globose, 90–100 μ. diam. collapsing above, sparingly clothed with spreading straight rigid continuous spines or bristles about 30 x 5 μ. Asci clavate-cylindrical about 25 x 5 μ. without any paraphyses. Sporidia oblique or (biseriate) oblong, 3–4–nucleate, hyaline, 6–8 x 2 μ.

Venturia sabalicola.

On dead leaves of *Sabal palmetto*, Bayou Chene, La., Oct., 1888. Langlois, 1546. Scattered or subgregarious. Perithecia globose, 125–135 μ. diam. pierced above, beset with stout straight black bristles 50–80 x 6–8 μ. Asci oblong-clavate 50–60 x 7–8 μ. without paraphyses. Sporidia fusoid-oblong, hyaline, 4–nucleate (becoming 1–septate) ? 10–13 x 2½–3 μ. crowded biseriate.

Diaporthe columbiensis.

On dead limbs of some undetermined tree, British Columbia, April, 1889. Macoun, 32. Perithecia in subcircinate clusters of 3–6 (occasionally only one) buried in the inner bark, their bases penetrating to the subjacent wood, large (¾–1 mm.) collapsing below, abruptly contracted above into a short neck terminating in a subtubercular, quadrisulcate-cleft ostiolum erumpent (but not strongly prominent) through the thin, black, superficial convex crust that covers the stroma. The substance of the stroma consists entirely (except the black circumscribing layer) of the bleached substance of the bark. Stroma elliptical, 2–5 mm. diam. with a distinct black circumscribing line which does not penetrate deeply into the wood. Asci oblong-lanceolate, about 100 x 12 μ. Sporidia biseriate, hyaline, oblong 20–22 x 7–8 μ., 1–septate and constricted, each cell with a large nucleus.

Diaporthe (Euporthe) leucosarca.

On dead limbs of *Carpinus Americana*, London, Canada, May, 1890. Dearness, 1696. Perithecia thickly scattered, buried in the unchanged substance of the inner bark and covered by the gray epidermis which is raised in a pustuliform manner and pierced by the minute papilliform ostiola. Asci oblong-cylindrical, 80–110 x 20–22 μ. (without paraphyses) ? Sporidia biseriate, broad-fusoid, hyaline, 1–septate and constricted, each cell with a large nucleus, 22

–30 x 8–10 μ. Perithecia about ½ mm. diam., white inside, stroma not limited by any dark circumscribing line.

Diaporthe crinigera.

On dead oak limbs, London, Canada, March, 1890. J. Dearness, 1347 B. Stroma cortical. Perithecia buried in the substance of the inner bark, subcircinate, 6–20 together, ovate-globose ⅓–½ mm. diam. contracted above into short, slender, convergent necks with the ostiola smooth and rounded or distinctly quadrisulcate and erumpent in a small compact fascicle. In well developed specimens the ostiola are cylindrical 1–2mm. long but quite as often they project only slightly above the epidermis. There is not a separate circumscribing line around each cluster of perithecia but one continuous thin black layer extends along just under the surface of the inner bark over the entire space occupied by the fungus. In the early stage of growth and where there are only a few perithecia in a cluster, the surface of the inner bark is smooth and even, but where the perithecia are more numerous and well developed they raise the bark into little flat pustules about 2 mm. diam. Asci 45 x 7–8 μ. (p. sp.) with paraphyses. Sporidia biseriate, oblong-fusoid, 4–nucleate, slightly constricted in the middle, ends subobtuse, 10–13 x 3–4 μ. This was at first referred to *Diaporthe woolworthii*, Pk. but having compared it with a specimen of that species from Mr. Peck we find it to differ in its larger and more numerous perithecia with long cylindrical ostiola and its broader sporidia ; nor is there any seriate arrangement in the clusters of perithecia or any circumscribing line or layer. Mr. Commons sends the same from Delaware (No. 1266) differing only in the clusters of perithecia being more or less longitudinally confluent.

Diaporthe comptoniae.

On *Comptonia asplenifolia*, Newfield, N. J., June, 1889. Perithecia subcircinate, buried in the inner bark, small (⅓ mm.), 10–20 in a group, globose, contracted above into a short neck ending in a short cylindrical, obtuse ostiolum with a round, entire opening, generally not projecting above the surface of the bark and scarcely visible. The ascigerous nucleus is whitish at first, becoming nearly black. The bark is raised into little pustules above the perithecia and these pustules soon become irregularly ruptured above. Asci oblong 35–40 x 7 μ. Sporidia biseriate, oblong, subinequilateral, 1–septate and slightly constricted at the septum, 10–12 x 3–3½ μ. yellowish-hyaline. Accompanied by spermogonia with minute allantoid spores in a multilocular grayish-black stroma in pustules similar to those containing asci and sporidia. The ascigerous perithecia finally fall out (or are eaten out by insects)?

Diaporthe americana, Speg.

On dead shoots of *Magnolia glauca*, Newfield, N. J., Jan., 1889. Perithecia buried in the inner bark and partly sunk in the wood about ½ mm. diam. whitish or horn-color inside, the thin cylindrical ostiola either singly or oftener converging and bursting through the ruptured epidermis but scarcely projecting above it, their tubercular-cylindrical tips rounded and obtuse and more or less distinctly quadrisulcate-cleft. The stroma is formed of the unchanged substance of the wood which it penetrates deeply and is limited by a black circumscribing line. The perithecia are either irregularly scattered or in groups of 4–8. Asci 40–50 x 6–7 μ. without any distinct paraphyses. Sporidia oblong-fusoid, hyaline, 2–3–nucleate, finally 1–septate and slightly constricted, 10–12 x 3 μ. This agrees fairly well with the description of Spegazzini's species.

Diaporthe megalospora.

On dead wood of *Sambucus Canadensis*, Manchester, Mass., July, 1889. Wm. C. Sturgis. Perithecia globose, ½–¾ mm. diam. scattered, buried in the wood which is blackened on the surface but remains white within, abruptly contracted above and prolonged into a long (2–3 mm.) rough, subflexuous ostiolum. Asci (p. sp.) 70–90 x 10–12 μ. Sporidia biseriate, oblong-fusoid, slightly curved, 1–septate and constricted at the septum, each cell with 1 or 2 large nuclei, acute at the ends, 25–35 x 4½–5½ μ. Narrower than in *D. leucosarca.*

Didymosphaeria andropogonis, Ell. & Lang.

On dead culm of *Andropogon muricatus*, St. Martinsville, La., July, 1889. Langlois, 1814. Stroma consisting of the nearly unchanged substance of the culm which is a little whiter than the surrounding parts, 3–4 cm. long, 1 cm. broad, surrounded by a greenish-black line which penetrates deeply, the surface also being of a uniform slaty-black. Perithecia scattered, subglobose ½–¾ mm. diam., entirely buried except the convex-discoid, erumpent ostiolum. Asci cylindrical about 110 x 8–10 μ. with stout but evanescent paraphyses. Sporidia uniseriate, oblong-cylindrical, rounded at the ends, slightly curved, 1–septate, hyaline at first, becoming brown, 18–22 x 4½–5½ μ.

Melanconis salicina.

On dead limbs of *Salix*, London, Canada, Jan., 1890. Stroma flat, thin, orbicular, about 2 mm. in diam. composed of the slightly altered substance of the bark which is not perceptibly elevated above it, surrounded by a black circumscribing line which does not penetrate below the surface of the wood. Perithecia 3–6 (exceptionally only one) in a stroma, large (¾ mm.), globose, membranaceous with a light colored nucleus, contracted above into short necks which terminate in a rather broad, round, concave ostiolum piercing the epidermis but scarcely rising above it. Asci broad lanceolate, 90–110 x 12–16 μ. (p. sp.) with abundant paraphyses. Sporidia crowded-biseriate, oblong–fusoid, 1–septate and slightly constricted, a little bent or curved, 40–60 x 8–10 μ. yellowish-hyaline with a short obtuse apiculus at each end. Spermogonia in a central perithecium in the middle of the stroma. The base of the perithecia is sunk in the surface of the subjacent wood.

Valsaria salicina.

On dead limbs of *Salix*, London, Canada, Jan., 1890. J. Dearness, No. 1312. Stroma subovate, 2–2½ mm. diam. buried in the bark, the upper part light colored within and projecting so as to form a brownish-black subhemispherical tubercle, 1–2 mm. across and less than 1 mm. high, minutely papillose above from the slightly projecting ostiola. The upper projecting part of the stroma is of a light horn-color inside. Perithecia 10–20 irregularly crowded in the bottom of the stroma, ovate globose, with thick coriaceous walls, contracted above into slender necks 1 mm. or more long, terminating above in the papilliform ostiola. Asci slender 70–80 x 5–6 μ. (p. sp.). Paraphyses abundant, longer than the asci. Sporidia obliquely 1–seriate, oblong, crowded, cylindrical, 2–nucleate, brown, 1–septate, 10–12 x 3½ μ. Allied to *V. anthostomoides*, Sacc.

Leptosphaeria maclurae.

On leaves of *Maclura aurantiaca*, Emma, Saline Co., Mo., Aug., 1889. Rev. C. H. Demetrio. Spots as in *Sphaerella Maclurae*, E. & E. (which occurs on the same leaves) suborbicular reddish-brown, 4–10 mm. diam. with a darker margin and deciduous center. Perithecia mostly hypophyllous, innate-erumpent, small (75 μ.), black. Asci oblong-cylindrical, 50–60 x 8–10 μ. Paraphyses? Sporidia biseriate, fusoid, about 6–nucleate becoming 5–septate, slightly curved, nearly hyaline, 20–22 x 3 μ.

Leptosphaeria steironematis.

On dead stems of *Steironema ciliatum*, London, Canada, May, 1890. J. Dearness. Perithecia gregarious around the nodes of the stem, subepidermal, conic-hemispherical, ½ mm. diam. raising the epidermis which is pierced by the obtusely conic ostiolum.

Asci clavate-cylindrical, 75–100 x 15–20 μ., with abundant filiform paraphyses. Sporidia biseriate, oblong, 3–septate, sometimes slightly constricted at the septa, brown, obtuse at the ends, mostly a little curved, 15–22 x 7–8 μ.

Leptosphaeria brunellae.

On dead stems of *Brunella vulgaris*, London, Canada, May, 1890. Dearness, 1712. Perithecia scattered, minute (⅓–¼ mm.) covered by the epidermis which is only slightly raised and barely pierced by the papilliform ostiolum. Asci clavate-cylindrical, 75–80 x 10–12 μ. subsessile with filiform paraphyses. Sporidia biseriate, fusoid, slightly curved, pale yellowish-brown, 3–septate, the next to the upper cell swollen, 22–30 x 4 μ. Differs from *L. pyrenopezizoides*, Sacc., in its perithecia not collapsing and from *L. parietariae*, Sacc., in its paler spores.

Accompanied by perithecia containing fasciculate acicular stylospores (Rhabdospora), 40–55 x 2–2½ μ. These perithecia are white inside and rather larger. Other smaller perithecia contain spores 4 x 1½ μ. (*Phoma*).

Leptosphaeria folliculata.

On leaves of *Carex folliculata*. On pale white elliptical spots 2–4 x 1–1½ mm. Perithecia buried in the substance of the leaf with their apices slightly prominent, few on a spot (1–6), small 60–75 μ. diam. Asci clavate-cylindrical, 50 x 10–12 μ. Spor. biseriate, oblong or clavate-oblong 2–septate and slightly constricted at the septa, 12–15 x 3 μ. yellowish-brown, ends obtuse. Differs from the other species on *Carex* in its distinct spots and smaller sporidia.

Metasphaeria rubida.

On a decaying log of *Platanus occidentalis*, Flatbush, Long Island, N. Y., Dec. 31, 1889. Rev. J. L. Zabriskie, 384. Perithecia gregarious, globose, minute (¼ mm.), sunk in the surface of the wood with their apices and obtusely-conic ostiola projecting. On carefully shaving off the ostiola the upper part of the perithecium is seen to be filled with carnose bright flesh-red material which is also often visible through the broadly perforated ostiola. The lower part of the perithecia is white inside. Asci clavate-cylindrical, 75–80 μ. long (p. sp. about 40 x 12 μ.). Paraphyses abundant, longer than the asci. Sporidia crowded-biseriate, oblong-fusoid, slightly curved 3–septate, the next to the upper cell swollen, hyaline, 20–22 x 3½–4½ μ. The upper part of the perithecia seems to be covered (as in *Clypeosphaeria*) with a more or less distinct cap of black carbonaceous matter which is irregularly ruptured by the emergent ostiolum.

Pleospora diaportheoides.

On old stems of parsley (*Petroselinum*), Newfield, N. J., May, 1890. Perithecia scattered, depressed-hemispherical, about 200 μ. diam. erumpent-superficial, with a short, stout, cylindrical ostiolum. Asci clavate-cylindrical, 75–85 x 12–15 μ. with stout, jointed paraphyses. Sporidia subbiseriate, oblong-elliptical, yellow-brown, 3–septate with one or more of the cells divided by a longitudinal septum, not constricted at the septa, about 15 μ. long (14–18 x 7–8 μ.).

Pleospora hyalospora.

On leaves of *Lathyrus sativus* (1348) and *Pisum sativum* (1370). Starkville, Miss., May and June, 1890. S. M. Tracy. Perithecia scattered, depressed-hemispherical, 75–90 μ., of coarse cellular structure, at first sunk in the parenchyma of the leaf, finally more or less erumpent-superficial, with a papilliform ostiolum. Asci oblong, 75–85 x 35–40 μ., 8–spored. Sporidia oblong or slightly ovate-oblong, 3–6–septate (mostly 5–septate), with one or more longitudinal septa more or less distinct, nearly hyaline, ends obtusely pointed or rounded slightly constricted at the septa, especially at the middle one, 25–40 (mostly 25–30) x 12–15 μ. Differs from *P. Pisi* (Sow.) in its obovate asci, nearly hyaline sporidia and more delicate smaller perithecia.

Pyrenophora zabriskieana.

On bark of *Ulmus Americana*, New Baltimore, N. Y., Apr., 1872. Rev. J. L. Zabriskie, No. 108. Perithecia loosely gregarious, erumpent-superficial, ovate-globose, 175–200 μ. diam. densely clothed with straight, erect, sparingly-septate, yellowish-brown hairs 100–125 μ. long and about 5 μ. thick at the base tapering gradually to the subacute tip, of membranaceous texture and dark yellowish-brown color (under the microscope). Asci clavate-oblong, 100–112 x 22–25 μ. rounded above, with a short, abrupt, stipitate base.

Paraphyses slender and numerous but inconspicuous. Sporidia crowded-biseriate, ovate-elliptical, densely muriform, rounded at the ends, yellowish-brown 22–30 x 12–14 μ. constricted across the middle. The sporidia are so closely and densely muriform as to appear granular, the granular contents being arranged in transverse lines across the sporidia so that they appear 12 or more septate. Differs from *P. polyphragmia*, Sacc. to which it comes nearest in its smaller perithecia and shorter sporidia.

Fenestella amorpha.

On dead hickory limbs, Lyndonville, N. Y., Apr., 1888. Dr. C. E. Fairman. Stroma tuberculiform, seated on the wood, variable in size from 1mm. inclosing a single perithecium to 3 or 4 mm. with 4–6 perithecia, or sometimes confluent in a seriate manner for 1 cm. or more, black outside, whitish within, mostly depressed-hemispherical with the stout, cylindrical ostiola rising from the apex or bursting out through cracks in the bark but scarcely projecting. Asci cylindrical 150 x 15 μ. (p. sp. 100–110 x 15) with abundant paraphyses. Sporidia uniseriate, elliptical, 5–6–septate and muriform, becoming almost opaque, so that the septa are hardly visible. 20–22 x 12–14 μ. When the bark falls away the stroma becomes superficial.

Ophiobolus trichisporus.

On dead culms of grass, London, Canada, June, 1890. Dearness, 1734. Erumpent-superficial. Perithecia ovate-conic, ¼ mm. or less in diam. attenuated above into the acute short-beaked ostiolum. Asci, 170–200 x 3 μ. Sporidia filiform multinucleate, nearly as long as the asci. Differs from *O. stictisporus* E. & E. principally in its acutely beaked perithecia.

Ophiobolus medusæ, E. & E. J. M. I., p. 150. var. **minor** E. & E.

In leaves of *Andropogon muricatus*, St. Martinsville, La., Feb., 1889. Langlois, No. 1771. Differs from the specimens on *Spartina* in its erumpent larger ostiolum and smaller asci and sporidia which are 110–120 x 7–8 μ. and 90–110 x 2½ μ. respectively. The perithecia, mode of growth, etc., are the same as in the original specimen.

Melanomma commonsii.

Parasitic on *Hypoxylon sassafras*, Wilmington, Del., Jan., 1890. Commons, 1258. Perithecia gregarious, ovate-globose, rough, black, minutely tomentose-pubescent when young, 110–125 μ. diam. Ostiolum papilliform. Asci clavate-cylindrical 50–55 x 7–8 μ. with abundant filiform paraphyses. Sporidia biseriate, fusoid-oblong, 3-septate, slightly constricted at the septa, olive-brown 12–14 x 3–3½ μ.

Melanomma tetonensis.

On bark of *Artemisia cana*, Valley of the Teton river in northern Montana, July, 1889. Anderson, 551. Perithecia scattered, erumpent-superficial, ovate-globose, nearly smooth, ½–¾ mm. diam. collapsing above. Ostiolum narrow and only slightly prominent. Asci clavate-oblong, 75–80 x 18–20 μ. with abundant paraphyses. Sporidia crowded, subbiseriate, fusoid-cylindrical, slightly curved, yellow, 5-septate, 22–27 x 6–7 μ. ends acute while lying in the asci, obtuse when free. This differs from *M. occidentalis* (Ell.) in its scattered mode of growth and larger perithecia and sporidia, the latter being constantly 5-septate and not constricted at any of the septa. It might be considered a var. of that species.

Melanomma parasiticum.

On old *Diatrype stigma*, Newfield, N. J., April, 1889. Perithecia scattered or gregarious, superficial, ovate-hemispherical, 110–130 μ. diam. roughish, black. Ostiolum papilliform soon perforated. Asci oblong cylindrical 40–50 x 8–10 μ. sessile, without paraphyses. Sporidia crowded-biseriate, oblong-fusoid, 3-septate, and finally slightly constricted at the septa, 10–12 x 3–4 μ. pale olivaceous. *Sphaeria nigerrima*, Blox. (Cke. Hndbk. No. 2612) which is also parasitic "on various species of *Diatrype*" has sporidia 12½–20 μ. long and at length multiseptate and perithecia "sprinkled with short stiff bristles." Our specimens of *M. vile* Fckl. have the perithecia larger and differ otherwise. *Melanomma subsparsum* Fckl. which we have not seen is said to have yellow sporidia.

Winteria tuberculifera.

On bark of wild plum (*Prunus*) London, Canada, 1890. Dearness, 1533. Perithecia gregarious, superficial, ½ mm. diam. depressed-globose, narrowed below, tubercular roughened, collapsed and cup-shaped when dry, black. Asci 35–40 x 5–6 μ. Sporidia crowded-biseriate, fusoid-oblong, hyaline 2–4 nucleate 6–8 x 2–2½ μ. (becoming 1–3 septate) ?

Cucurbitaria kelseyi.

Perithecia large (¾–1 mm.) rough, subglobose, regularly rounded above with a papilliform ostiolum, bursting through cracks in the bark in elongated tufts, crowded and subconfluent, connected below by a scanty grayish-black stroma. Asci cylindrical 170–190 x 15–20 μ. contracted below into a short stipe-like base. Paraphyses filiform, abundant. Sporidia uniseriate oblong-elliptical straw-yellow, becoming dark brown, contracted in the middle with three principal septa and several fainter ones (7–9 in all), muriform, 25–30 x 14–16 μ. ends at first obtusely pointed, finally rounded. Three main transverse septa are the only distinct and decided ones, the others both transverse and longitudinal being more or less indistinct and interrupted. On *Philadelphus lewisii?* Helena, Montana, March, 1889. Rev. F. D. Kelsey, No. 38. This is with difficulty distinguished from *C. berberidis*, Gray and might perhaps better be considered a var. of that species from which it seems to differ in its broader sporidia. The ascigerous perithecia were accompanied by others inclining more to ovate, with a short conic-cylindrical ostiolum and filled with very minute ($1\frac{1}{2}$–2 x $\frac{1}{2}$ μ.) spores.

Cucurbitaria fraxini.

On bark of dead *Fraxinus*, London, Canada, Feb., 1890. J. Dearness, 1461. Perithecia globose, rough, black (white inside), $\frac{1}{2}$ mm. diam. flattened above, with a papilliform ostiolum, seated on the surface of the inner bark in compact clusters of about 8–12 and surrounded by the ruptured epidermis. Asci cylindrical, p. sp. about 150 x 12–15 μ. with a short, stipe-like base and surrounded by numerous paraphyses. Sporidia uniseriate or subbiseriate, ovate-oblong, constricted in the middle, 5–6 septate and muriform, yellowish-brown, 25–30 x 10–14 μ.

Cucurbitaria setosa, E. & E.

Parasitic? on the tubercular, erumpent stroma of some *Diatrype*, on dead limbs of Wild Plum (*Prunus*), London, Canada, March, 1890. Dearness, 1493. Stroma black, carnose, 2–3 mm. across, its convex surface thickly covered with the minute parasitic? perithecia which are subglobose about $\frac{1}{6}$ mm. diam., clothed laterally with stout black, spreading spines, 25–40 x 7 μ. Ostiolum either smooth and subpapilliform or more or less distinctly radiate-sulcate. Asci oblong clavate 45–55 x 12 μ. (p. sp.), contracted below into a narrow, stipe-like base. Paraphyses longer than the asci, evanescent. Sporidia biseriate, subrhomboidal-oblong, hyaline and multinucleate at first, becoming yellowish, 3–5–septate and submuriform, 12–15 x 4–5 μ. Accompanied by *Cornularia Persicae*, (Schw.) The crowded perithecia bear a general resemblance to those of *Plowrightia mor-*

bosa, Schw. from which, however, this is quite distinct. The stroma is carnose and black inside and out, and in the bark beneath it are buried the numerous small abortive perithecia of a *Diatrype* or *Valsa*.

Teichospora mammoides.

On dead stems of *Sarcobatus vermiculatus* near Great Falls, Montana, July, 1889. F. W. Anderson, 542. Perithecia erumpent-superficial, gregarious, depressed-hemispherical, brownish-black, ¾ mm. diam. with a prominent nipple-like black ostiolum. Asci clavate-cylindrical, subsessile, 100–110 x 12–15 μ. with abundant filiform paraphyses. Sporidia uniseriate, ovate-oblong 5–7 septate and muriform, scarcely constricted, yellow becoming brown, 20–22 x 9–11 μ.

Teichospora mycogena.

Parasitic on old *Diatrype stigma*, Newfield, N. J., Apr., 1889. Scattered immersed except the partially erumpent apex which slightly raises the surface of the Diatrype stroma rupturing it in a subradiate manner. Perithecia of medium size with an indistinct ostiolum. Asci subcylindrical about 100 x 12 μ. abruptly contracted below into a short stipe. Sporidia biseriate, ovate-oblong, with three distinct transverse septa and a longitudinal septum across one or more of the cells, yellowish becoming dark brown, distinctly constricted at the middle septum and when mature 5–6–septate, 12–15 x 6–8 μ. This might be mistaken for *Lophiostoma floridanum* E. & E. but that has the perithecia more superficial and quite different sporidia.

Teichospora umbonata.

On dead branches of *Symphoricarpus occidentalis*, Helena, Montana, March, 1889. Rev. F. D. Kelsey, No. 7. (in part). Perithecia gregarious, discoid, about ⅓ mm. diam. seated on the surface of the inner bark exposed by the falling away of the epidermis, ostiolum tuberculiform. Asci cylindrical 75–80 x 7–8 μ. with paraphyses. Sporidia uniseriate, ovate, 3–septate, constricted at the middle septum, straw-yellow, 12–15 x 6–8 μ. Most of the sporidia show only the three transverse septa but in some of them one or both the inner cells are divided by a longitudinal septum. It is not improbable that the sporidia may finally become brown and acquire additional septa.

Teichospora papillosa.

On weather beaten dead decorticated limbs of *Salix*, Helena, Montana, Feb., 1889. Rev. F. D. Kelsey, No. 4. Gregarious, subsuperficial, depressed-globose, ⅓ mm. diam. strongly papillose-roughened with a few short weak glandular hairs when young, finally collapsing above, ostiolum papilliform, not conspicuous. Asci oblong, 75–85 x 20–24 μ. nearly sessile, paraphyses evanescent. Sporidia crowded-biseriate, 8 in an ascus oblong or slightly clavate-oblong, a little curved, obtuse at the ends. Mostly 5-septate with one or two of the cells divided by a longitudinal septum, hyaline becoming yellow-brown, 22–30 x 10–11 μ.

Teichospora megastega.

On bark of old weather-beaten willow limbs and also on the wood. Helena, Montana, Feb., 1889. Kelsey, No. 4 (pr. p.) and on *Acer glabrum*, Kelsey No. 49. Perithecia gregarious, subsuperficial, the base sunk in the wood or bark with about two-thirds of the upper part projecting, hemispheric-globose, ¾–1 mm. diam. rough, ostiolum inconspicuous, subpapilliform. Asci cylindrical 175–200 x 15 μ. with a short stipe-like base and abundant paraphyses. Sporidia 1-seriate, about 7-septate and muriform, mostly constricted in the middle more or less distinctly, ends rounded or obtusely pointed, 25–36 x 12–15 μ. Closely allied to *T. obducens*, but perithecia less crowded, more depressed, larger and rougher and sporidia rather larger.

Teichospora helenae.

On decorticated weather-beaten limbs of *Salix*, Helena, Montana, Feb., 1889. Rev. F. D. Kelsey, No. 4 (in part) also on wood of *Prunus Virginiana*, F. W. Anderson. Perithecia gregarious, semi-erumpent, ½–¾ mm. diam. granular-roughened, collapsing above, ostiolum minute. Asci clavate-cylindrical, 112–120 x 10–12 μ. rather abruptly contracted below into a short stipe-like base and surrounded with abundant paraphyses. Sporidia uniseriate, ovate-oblong, brown, constricted in the middle, 5–7-septate and with one or two of the intermediate cells divided by a longitudinal septum 15–25 x 8–12 μ. Quite often asci are seen in which the sporidia are smaller, black and shriveled as if struck with blight before maturity. Closely allied to *T. patellarioides*, Sacc. but differs in its larger globose-hemispherical perithecia without any fringe of hyphae at the base and in its 5–7septate sporidia uniseriate in narrower asci.

Teichospora kansensis.

On outer bark of cottonwood trees, Kansas, Coll. Dr. G. Egeling Com. Dr. J. W. Eckfeldt. Perithecia scattered, minute (120–

175 μ.), conic-hemispheric, base slightly sunk in the bark, ostiolum papilliform. Asci oblong 75–80 x 12 μ. sometimes shorter and broader (45–50 x 15 μ.). Sporidia biseriate, ovate oblong, pale brown, 3–septate, finally 6–septate and slightly constricted across the middle, lower end subacute, about 20 x 8–9 μ. *Teichospora pruniformis* (Nyl.) which is also found on bark of poplar and willow is much larger (½ mm. diam.).

Nectria diplocarpa.

On thallus of some foliaceous lichen (*Parmelia*)? on trunk of a tree, Farmington, N. Y., Dec., 1888, Edgar Brown, No. 17. Perithecia gregarious or subcespitose (2–3–connate) superficial, ovate, about ¼ mm. diam. clothed with white septate, sparingly branched, substrigose hairs, collapsing more or less distinctly above, deep flesh color, ostiolum papilliform, large and distinct, smooth. Asci clavate, 40–50 x 8–12 μ. filled with reddish granular matter at first, then containing 4 oblong elliptical, hyaline spores, 8–12 x 4–5 μ., 1–septate and more or less constricted at the septum, ends rounded and obtuse, lying irregularly in the asci. Paraphyses apparently present but very obscure as are also the asci which are soon dissolved. Together with the sporidia already described are others much larger, 30–45 x 18–25 μ. granular, hyaline, 1–septate and strongly constricted at the septum, oblong-elliptical in shape with the ends obtuse and rounded. It is not easy to see just how these large spores originate but there is good reason to believe them true ascospores as in several instances asci were seen containing, in addition to the smaller sporidia, a single sporidium intermediate in size between the smaller and the larger ones. Only one of the larger intermediate sized spores was seen in the same ascus and as far as we could judge only one of these large sized spores was produced in an ascus, though when the spore had reached the largest size mentioned the ascus which contained it had disappeared. If this is the correct view the large spores are normal and mature and the smaller ones undeveloped and immature. In examining our Exsiccati we find that specimens collected in Missouri by Demetrio on thallus of *Parmelia* and issued by Dr. Winter in his Rabenhorst-Winter Fungi, No. 3252, as *Nectria lecanodes* Rabh. are the same as this. The description, however, of *N. lecanodes* does not apply to this, that species having sporidia only 9–11 x 3–4 μ. and in fact the specimen of *N. lecanodes* in DeThumen's Mycotheca, 1746 and Fungi Gallici, 665 (both collected by Madame Libert) as well as those in Rehm's Ascomycetes, No. 38 and Plowright's Fungi Britannici 212, have the sporidia 8–12 x 3–4 μ. The New York and Missouri specimens also differ from those just cited in their brighter red color and distinctly hairy perithecia and come nearer to *N. erythrinella*, Nyl. which again has the perithecia only partially emergent and sporidia 18–25 x 6–8 μ. much larger than in *N. lecanodes* it is true but still far too small. Possibly this variability in the size of the sporidia is only accidental but from its occurrence in specimens from such widely separated localities there is reason to consider it normal and if so, characteristic of a species not heretofore described.

Hypocrea pallida.

Specimens of this species found by Dr. John Macoun in Prince Edwards Island, parasitic on *Polyporus chioneus* Fr. agree perfectly with the Newfield specimen (J. M. II, p. 65) only there is an orange colored mycelium which stains the Polyporus within, of a fine light yellow.

Hypocrea melaleuca.

On decaying oak limbs, Newfield, N. J., Jan., 1889. Subiculum, membranaceous, thin, white, covered except the margin with a single layer of minute (112–130 μ.) slate-colored perithecia filled with globose 2½–3 μ. sporidia? (or perhaps stylospores) as no asci were seen. This seems to be a distinct species but requires further observation with more perfectly developed specimens.

Calonectria dearnessii.

On decaying branches, London, Canada, Jan., 1890. J. Dearness, No. 1346. Cespitose on the ostiola of some *Massaria* on ash and elm. Perithecia 3–12 in a cluster, ovate, narrowed above and below, light orange-yellow, about ⅙ mm. diam. and a little more than that in height, seated on a white, radiate-fibrous, silky mycelium which at first partially envelops and clothes the perithecia but finally disappears. Ostiola broad papilliform not distinctly prominent, at length slightly collapsing. Asci 75–80 x 10–12 μ. with paraphyses. Sporidia oblong-cylindrical, obtuse, yellowish-hyaline, biseriate, 3–5–septate, more or less constricted at the septa, 25–35 x 6–7 μ. ends obtuse, slightly curved. This differs from *N. fulvida* E. & E. in several particulars.

Thyronectria chrysogramma.

On bark of *Ulmus Americana*, Manhattan, Kansas, March, 1889. Kellerman and Swingle, No. 1421. Also on elm limbs

Potsdam, N. Y., 1857. Perithecia cespitose, ovate, $\frac{1}{3}$–$\frac{1}{2}$ mm. diam. seated on the surface of the inner bark without any evident stroma and bursting through the epidermis in compact groups of 3–6, densely clothed with a greenish-yellow farinaceous coat, only the prominent ostiolum becoming bare and black. Asci clavate-cylindrical, 150–175 x 14–18 μ. with abundant paraphyses. Sporidia biseriate, oblong-elliptical, mostly a little curved, 7–10–septate with very faint interrupted longitudinal septa, hyaline at first, finally quite dark brown, 20–30 x 10–12 μ. The sporidia are certainly muriform though the longitudinal septa are very faint. We at first supposed this to be the mature state of *Nectria aurigera* B. & Rav. but a careful examination of the specimens of that species in N. A. F. and Rav. F. Am. failed to reveal any longitudinal septa in the sporidia which as well as the perithecia are also smaller than in this though apparently mature. Near *Th. virens*, Hark.

Chilonectria crinigera.

On bark of dead *Fraxinus viridis*, Lincoln, Nebraska, Nov., 1888. H. J. Webber, No. 18. Perithecia cespitose 3–12 on a tubercular stroma in compact clusters 1–2 mm. across, the single perithecia subglobose and about $\frac{1}{2}$ mm. in diam. covered at first with a brownish farinaceous coat, becoming nearly black, rounded and obtuse above with a papilliform ostiolum which is slightly collapsed when dry. Asci clavate-cylindrical, 65–75 x 12–15 μ. rounded and obtuse above, contracted below into a stipitate base and overtopped by the abundant paraphyses. The asci are at first filled with innumerable minute (3 x $\frac{1}{2}$ μ.) allantoid hyaline sporidia but in what we take to be the mature state these minute sporidia appear to be transformed into eight biseriate, globose yellowish-hyaline, 5–7 μ. diam. sporidia which while lying in the asci are faintly marked with radiating lines and when free are surrounded with about a dozen radiating hyaline filaments 8–10 μ. long and extending out from all sides of the sporidium like rays from a star.

Nectria sambuci.

On *Sambucus Canadensis*, Lincoln, Nebraska, Aug., 1888. H. J. Webber. Cespitose on a tubercular base (*Tubercularia Sambuci*, Cda.). Perithecia 4–12 on a stroma, ovate-globose, pruinose pale red, about $\frac{1}{3}$ mm. diam. Strongly collapsed above when dry. Ostiolum papilliform, finely fimbriate. Asci oblong clavate 50–60 x 6–7 μ. (p. sp.) without paraphyses. Sporidia biseriate oblong, uniseptate, straight or slightly curved, hyaline 12–20 x $3\frac{1}{2}$–$4\frac{1}{2}$ μ. The

Tubercularia has allantoid hyaline conidia 6–8 x 1½–2 μ. on basidia 35–40 μ. long, branched above. This is according to the specimens in DeThumen's Mycotheca and in Fungi Gallici the *T. sambuci* Cda. We are not aware that its ascigerous state has ever been observed before.

Nectria athroa.

On decaying sycamore log, Manhattan, Kansas, Feb., 1889. Kellerman and Swingle, No. 1325. Densely gregarious. Perithecia ovate, 150–200 x 110–120 μ. dark red, smooth or nearly so, not collapsing. Asci (p. sp.) about 35 μ. long cylindrical, evanescent. Sporidia uniseriate, oblong-elliptical, hyaline, obtuse at the ends 1–septate and slightly constricted, 5–6 x 2½ μ. This has the general appearance of *N. ditissima*, Tul. but besides the more regularly shaped perithecia the sporidia are much smaller. The asci are with difficulty seen so that this might be taken for a stylosporous fungus only from the fact that here and there series of eight spores lying end to end indicate the presence of asci.

Nectria mammoidea, Phill. & Plow.

This species was found at Newfield some years ago on outer bark of living apple trees and again Dec., 1888 on outer bark of living Quince trees. The Newfield specimens agree with authentic specimens from Plowright in all respects only the sporidia are a little smaller (15 x 5–6 μ.). In Plowright's specimens they are 18–22 x 6–7 μ. and subinequalateral. The Newfield specimens were immature, the asci being mostly filled with granular matter.

Nectria pithoides.

On dead alders, British Columbia, May, 1889. Macoun, 122. Densely cespitose forming suborbicular tufts, 1½–2½ mm. diam. Perithecia ovate, dark red, about ⅕ mm. diam. muriculate-roughened, collapsing above so as to appear truncate, but only slightly concave, appearing in profile like small jars. Ostiolum papilliform only slightly prominent. Asci cylindrical, 75–80 x 5 μ. Paraphyses not seen. Sporidia 1–seriate, oblong-elliptical 2–nucleate, becoming 1–septate 6–10 x 3–3½ μ., smoky hyaline. The perithecia are seated on a convex yellow stroma 50–100 together and when young are clothed with a few short white glandular hairs. Nearly allied to *N. microspora*, C. & E. which has less numerous paler red, smoother, more irregularly collapsed perithecia. The specific name from Grk. *pithos* a barrel.

Nectria sulphurata.

On dead wood of *Populus tremuloides*, Sand Coulee, Montana. May, 1889. F. W. Anderson, No. 496. Perithecia gregarious, minute ($\frac{1}{5}$ mm.) subglobose with a slightly contracted base, covered with a sulphur-yellow granulose-pruinose coat which finally disappears and leaves the perithecia black; collapsed above when dry and more or less distinctly radiate-sulcate. Asci subcylindrical, 65–70 x 6–7 μ. Sporidia subbiseriate, allantoid, hyaline, with a small nucleus near each end, slightly curved, 9–12 x 2 μ. Differs from *N. aurea* S. & S. in its smaller sporidia.

Homostegia kelseyi.

On dead stems of *Ribes rotundifolia*? Helena, Montana, Jan., 1889. Rev. F. D. Kelsey, No. 3. Sent also by Mr. F. W. Anderson, apparently on a different species of *Ribes* (No. 398). Perithecia gregarious or cespitose or united 3–6 together in an imperfect stroma, often transversely seriate through cracks in the bark, ovate $\frac{1}{2}$–$\frac{3}{4}$ mm. diam. with a conic or cylindric-conic, stout ostiolum which is sometimes imperfectly radiate-sulcate. Asci cylindrical, 150–190 x 8–9 μ. with paraphyses. Sporidia uniseriate, hyaline, oblong-cylindrical 3–septate, straight, obtuse, 15–20 x 7–9 μ.

Dothidea bigeloviae.

On dead stems of *Bigelovia*, Helena, Montana, Nov., 1888. Rev. F. D. Kelsey, No. 141. Stromata depressed-tubercular, suborbicular, about 1 mm. diam smooth and black, gregarious, partly sunk in the bark of the dead stems. Ascigerous cavities peripheric, minute, numerous. Asci oblong 40–50 x 12 μ. soon disappearing. Sporidia subbiseriate, 1—septate, constricted at the septum, 15–20 x 7–10 μ.

Plowrightia staphylina, E. & E.

On bark of *Staphylea trifolia*, London, Canada, March, 1890. Dearness, 1560. Cespitose, clusters of perithecia about 1 mm. diam. mostly seriately confluent for several centimeters in length, erumpent through cracks in the bark and only slightly prominent. Perithecia black, small, 150–200 μ. diam. ovate or obovate, narrowed below into a substipitate base. Ostiolum conic-papilliform, soon broadly and somewhat irregularly perforated. Asci clavate-cylindrical, subsessile, paraphysate, 60–65 x 8 μ. Sporidia mostly biseriate, oblong or clavate-oblong, hyaline, 1–septate and slightly constricted, 12–15 x 4–5 μ., ends obtuse.

Plowrightia symphoricarpi.

On dead branches of *Symphoricarpus occidentalis*, Sand Coulee, Cascade Co., Montana, Dec., 1888. Anderson, No. 210. Stroma convex, penetrating to the wood but not limited by any black circumscribing line, brownish-black, whitish within, 1½–2 mm. diam. Perithecia 10–15 in a stroma, ⅓ mm. diam. the upper part mostly prominent and free. Sometimes the stroma is wanting, the perithecia being then simply cespitose or subsolitary. Ostiola obtusely conic, nearly smooth or indistinctly radiate-sulcate. Asci clavate-cylindrical, subsessile, 75–80 x 12 μ. with paraphyses. Sporidia uniseriate or subbiseriate above, ovate-elliptical, 1–septate and constricted, hyaline and granular at first, becoming yellow-brown, 15–18 x 8–10 μ.

Curreya shepherdiae.

On dead limbs of *Shepherdia argentea*, Valley of the Teton, Northern Montana, July, '89. Anderson, 539. Perithecia 4–6 together in a loose imperfect brown stroma, ovate, white inside, their short, obtuse ostiola, rupturing and slightly raising the epidermis and forming little black pustules scattered irregularly over the branch. Asci clavate-cylindrical, 100–110 x 15 μ. with obscure paraphyses. Sporidia 1–seriate, obovate 3–5–septate and muriform, slightly constricted in the middle, yellow, 18–22 x 10–12 μ.

August 5.

Mr. Charles Morris in the chair.

Ten persons present.

August 12.

Mr. Thomas Meehan, Vice-President, in the chair.

Thirteen persons present.

A paper entitled "Notes on a Collection of Shells from Southern Mexico," by Frank C. Baker was presented for publication.

August 19.

Mr. Thomas Meehan, Vice-President, in the chair.

Thirteen persons present.

August 26.

Mr. Thomas Meehan, Vice-President, in the chair.

Nineteen persons present.

Papers under the following titles were presented for publication:—

"Spiders of the Family Lycosidæ from Pennsylvania and New Jersey." By Witmer Stone.

"Remarks on the Family Muricidæ with descriptions of New Species." By Frank C. Baker.

"New and little-known American Mollusca, No. 3." By H. A. Pilsbry.

The death of Mr. Rathmell Wilson, a member, was announced.

The following were ordered to be printed:—

BAROMETRIC OBSERVATIONS AMONG THE HIGH VOLCANOES OF MEXICO, WITH A CONSIDERATION OF THE CULMINATING POINT OF THE NORTH AMERICAN CONTINENT.

BY PROFESSOR ANGELO HEILPRIN.

Among the objects for which the Expedition, recently organized under the auspices of the Academy of Natural Sciences of Philadelphia, was dispatched to Mexico was the determination of the physical features of the giant volcanoes of the south, with special reference to a study of the vertical distribution of animal and vegetable forms. While prosecuting our observations in this direction, I took the opportunity, in company with one or more of my associates, of scaling the four loftiest summits of the land, namely: the peak of Orizaba, Popocatepetl, Ixtaccihuatl, and the Nevado de Toluca. This gave me the advantage of making personal comparisons between the life that existed in different regions of "cloud-land," at the same time that it offered me the opportunity of more closely investigating the geological features of some of the most gigantic volcanic mountains known to us. Numerous measurements of altitude were made during the ascents, and, in the higher regions, always with the same instrument. This was a registered aneroid, tested and corrected at Philadelphia—immediately before the starting, and shortly after the return of the Expedition—at the sea-level of Vera Cruz, and in the Central Meteorological Observatory of the City of Mexico, at an elevation of 7403 feet. To the officers of the latter institution I am indebted for the privilege of making comparisons with the standard mercurial column.

The results of our measurements show a striking accord in some instances with those obtained from earlier measurements, while in other cases they exhibit marked divergence. The fact that all the summits were ascended within a period of three weeks, were measured with the same instrument, and during a period of atmospheric equability and stability which is offered to an unusual degree by a tropical dry season, renders the possibility of errors of any magnitude almost nil; at any rate, such errors as may have crept in will probably not affect a general comparative result. The points of important difference are: 1, The highest summit of Mexico is not, as is commonly supposed, Popocatepetl, but the peak of Orizaba (Citlaltepetl, the "Star Mountain"), which rises 700 feet higher (18,200 feet); 2, Ixtaccihuatl, the familiar "White Woman" of the plain of Anahuac, is but a few hundred feet (about 550) lower than Popocatepetl.

In the following summary of our results I have taken up the history of each volcano individually. The peak of Orizaba was ascended on the 6th and 7th of April, Popocatepetl on the 16th and 17th of the same month, the Nevado de Toluca on the 21st, and Ixtaccihuatl on the 26th and 27th.

The Peak of Orizaba.

The ascent of this mountain was made from the side of San Andres Chalchicomula, which lies not far from the west foot of the volcano, at an elevation of some 8,200 feet above the level of the sea. The attacking party consisted of myself, three of my scientific associates, Messrs. Roberts Le Boutillier, J. E. Ives, and Witmer Stone, and eleven guides and carriers. The two last-named gentlemen desisted from the attempt when not further than 300 feet below the summit, while the strength of the first gave out already at an altitude of about 14,000 feet. My measurements were made at a point on the rim of the crater which I estimated to be approximatelu 40 yards below the actual apex of the mountain; the result obtained is 18,205 feet. I append herewith the data for the determination:

Reading of the barometer at the summit, with the correction for error (.26) kindly given to me by the authorities of the Mexican Central Observatory, 15,56 inches (395.4 mm.).

Barometer at the same hour (5 p. m.) at the Mexican Observatory, 23.02 inches (584.87 mm.).

Temperature of the air on the summit, 35° F.

Temperature of the air, City of Mexico, 78°5 F.

During the ascent of the second day, and continued through the greater part of the following day, the barometer indicated a drop of .1 inch; this I determined by a re-measurement of my positions on the down slope, and through a subsequent examination of the barometric reading made at the sea-level of Vera Cruz.[1]

The calculation is based upon the tables prepared by Delcros and Guyot, published in the Smithsonian Miscellaneous Collections, I.

The elements of the calculation are as follows:

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[1] For the use of the daily and hourly barometric readings made at this point I am indebted to the courtesy of Captain Powell, constructing engineer of docks of the Mexican Railway.

Tables of Delcros:

Difference of barometric values . . .	3117.7 metres.	
Addition for temperature	173.6 "	
Correction for latitude (decr. grav.) . .	7.4 "	
Correction for gravity (vertical) . .	10.0 "	
Correction for elevation of lower station .	2.5 "	
	3311.2	
	10,863.3 English feet.	
Elevation of the Mexican Observatory	7403.0 " "	
Elevation above point of observation	120.0 " "	
	18,386.3	
Allowance for drop of .1 barometer	180.4	
		18,206

Tables of Guyot:

Difference of barometric values . .	10,232.9 feet.	
Addition for temperature . . .	563.0 "	
Correction for latitude (decr. grav.) .	22.5 "	
Correction for gravity (vertical) . .	34.0 "	
Correction for lower station . . .	7.5 "	
Elevation of Mexican Observatory . .	7403.0 "	
Elevation above point of observation .	120.0 "	
	18,382.9	
Allowance for drop of .1 barom. . .	178.4	
		18,204

This determination of the height of Orizaba is considerably above the values which have heretofore been given for the mountain. Ferrer, in 1796, by means of angle measurements taken from the Encero, determined its height to be 17,879 feet.[1] Humboldt, a few years later, measured the mountain from a plain near the town of Jalapa, and obtained only 17,375 feet,[2] but he observes with char-

[1] Humboldt, Cosmos, V, p. 252, Bohn's Edition. I have not been able to find the orginal account of this measurement, but there is a brief note, entitled "Height of some Mountains in New Spain," and published by Ferrer in the 6th volume of the Transactions of the American Philosophical Society (p. 164), in which the height here stated (or its equivalent, 2795 toises) is given.

[2] *Op. cit.*, V, p. 252.

acteristic caution that his "angles of elevation were very small, and the base-line difficult to level." He in fact, rejects his measurement in favor of the one by Ferrer, remarking that he was "still uncertain which of the two volcanoes, Popocatepetl or the peak of Orizaba, is the highest." No carefully conducted measurement appears to have been made between this time and 1877, when a Mexican scientific commission, composed of MM. Plowes, Rodriguez, and Vigil, made the ascent of the volcano from the side of San Andres Chalchicomula. A barometer registering to 14,000 feet was used for approximate determinations up to that height, but the actual measurement of the summit was made trigonometrically from the plain of Chalchicomula. The results obtained [1] give an elevation above the town of Chalchicomula of 9211 feet (2807.84 metres), or, computed by the same observers for the sea-level of Vera Cruz, 17,664 feet. It must be observed here, however, that the elevation of Chalchicomula, which served as the base for the trigonometrical measurement, and which is given by these authors as 2576.3 metres or 8452.6 feet, is placed approximately 250 feet too high. The leveling of the Mexican Railway places the station of San Andres at 7974 feet. I measured barometrically the rise of the tramway which connects San Andres with Chalchicomula (or more properly, San Andres Chalchicomula), a few miles distant, and found only 230 feet. The town can therefore be elevated only about 8200 feet. Deducting the excess from the figures of the Mexican commission we have 17,415 feet, a result strikingly close to that obtained by Humboldt, but which that investigator felt obliged to question and to reject.

I am not aware of the reasons which have prevented the acceptance of the results of the Commission by Mexican geographers, unless it be that an implicit confidence in the researches of Humboldt has given marked preference to the earlier measurement. Thus Garcia Cubas, in the 1885 edition of his magnificent "*Cuadro geográfico, estadistico, descriptivo, é historico de los Estados Unidos Mexicanos,*" still retains the figures of the illustrious German savant. This preference for Humboldt's measurement is in the present instance the more suprising in view of the doubt which Humboldt himself expresses regarding its accuracy. German geographers have, on the other hand, very generally accepted Ferrer's figures (17,879 feet), or

[1] Annales del Ministerio de Fomento, III, 1877, pp. 99 and 113.

the late determination by Dr. Kaska, by means of a mercurial barometer, which gave 5500 metres (18,045 feet.) [1]

Popocatepetl.

The ascent of this mountain was made by Mr. Baker and myself, with the assistance of five guides and carriers, from the side of Ameca, just nine days after our descent from the peak of Orizaba. As compared with the ascent of the latter volcano, that of Popocatepetl is easy, although even here a good constitution and a goodly amount of endurance are required. But neither the ascent of Popocatepetl nor that of Orizaba is dangerous in the sense that Alpine climbing really is, although trouble might arise from the difficult respiration of the rarefied atmosphere. The Orizaba Commission, indeed, lost two of its assisting members, (guides or porters) as a direct consequence of this rarefied atmosphere.

We reached the northern rim of the crater, the *ultima thule* of most ascensionists, at 11 o'clock in the morning of the second day, and the culminating point, which lies toward the southwest, overlooking the State of Morelos from a still greater elevation of 700 feet, at 1.40 p. m. Barometric observations made at this point indicate an absolute elevation, as computed from the readings of Mexico City, of 17,513 feet, and from Vera Cruz of 17,533 feet, or an average of 17,523 feet. The data for the measurement are:

Barometer on the summit, with determined correction, 16.04 inches	(407.5 mm.)
Barometer in City of Mexico	585.55 mm.
Barometer at Vera Cruz	29.91 inches.
Temperature of the air on summit	45° F.
Temperature City of Mexico	23.5° C. (74°3 F.)
Temperature City of Vera Cruz approx.	83° F.

The elements of the calculation are as follows:

Tables of Delcros (calculated from the readings at the City of Mexico):

Difference of barometric values	2886.3 metres.
Addition for temperature	177.3 "

[1] Meyer's Konversations-Lexikon, article Orizaba.—Grisebach, in his Vegetation der Erde, (2d Ed., II, p. 563, 1884), quotes Müller as having obtained a trigonometrical measurement of the volcano of 17,000 French feet (18,112 English feet.) Unfortunately I have been unable to obtain access to Müller's Reisen, and, therefore, do not know the details of this measurement.

Correction for latitude (decr. grav.) . .	6.9 metres.
Correction for gravity (vertical) . . .	9.0 "
Correction for elevation of lower station .	2.2 "
	3081.7
	10,110.4 English feet.
Elevation of Mexican Observatory	7403.0 " "
	17.513 feet.

Tables of Guyot:

Difference of barometric values	9472.9 feet.
Addition for temperature	582.0 "
Correction for latitude	20.0 "
Correction for gravity	29.9 "
Correction for lower station	6.0 "
	10110.8
Elevation of Mexican Observatory . .	7403.0
	17.513.8 feet.

Computed from the readings at Vera Cruz:

Tables of Guyot:

Difference of barometric values	16,279.6 feet.
Addition for temperature	1157.6 "
Correction for latitude	35.0 "
Correction for gravity	58.4 "
Correction for lower station	3.0 "
	17,533.6 feet.

It is not necessary in this place to recite all the previous measurements of Popocatepetl that have been made, which in a general way agree in giving the mountain an elevation of from 17,400 to 18,000 feet. The brothers Glennie reached the highest point of the crater-wall on the 20th of April, 1827, and by barometrical observations deduced its height to be 17,884 feet.[1] The opposite to the extreme

[1] Humboldt (Cosmos, V, p. 458 Bohn's Edition) states that this measurement had been corrected by Burkart into 18,017 feet. I find no reference to this correction in Burkart's original communication (translation of Glennie's narrative) published in Schweigger's Jahrbuch der Chemie und Physik, XX, pp. 385 et seq., 1827. Glennie, however, gives the pressure of the barometer as 15,63 inches. which, if taken under conditions similiar to those which marked our own measurements, would indicate a value of upward of 18,000 feet. But no statement is made as to the testing of the barometer for accuracy.

high measurement given by Glennie is that of Truqui and Craveri, who ascended the mountain in September, 1855, and found, at a point estimated to be about 50 metres below the virtual summit, a barometric value (as computed by them) of 5230 metres (= 17,159 feet.)[1] Their barometric reading (409 mm.), made a short distance beneath the summit, would, if reduced to the summit, coincide almost exactly with our own; and I fail to see, in view of the common datum accepted for Vera Cruz, how our calculated results should differ to the extent that they do (380 feet). The difference should not exceed some 50–75 feet, but since Truqui and Craveri give no formula of their computation, it is impossible to determine whence the divergence arises.

The most extensive series of measurements made to determine the height of Popocatepetl are those of August Sonntag (1857), published in the Smithsonian Contributions to Knowledge (XI), and incorporated in an article entitled "Observations on Terrestrial Magnetism in Mexico." The average of three series of measurements (barometric and trigonometric, and varying from one another in very narrow limits) gives 17,785 feet for the height of the mountain, or almost exactly 100 feet less than that given by Glennie. We are informed (p. 78 of paper) that the basal height upon which all other elevations are calculated is that of the plaza of the City of Mexico, which is assumed to be 7472.8 feet. The more recent leveling of the Mexican Railway shows, however, that this figure is in excess by 125 feet (Mexico 7347 feet), an amount which has consequently to be deducted from Sonntag's estimate. This would leave 17,660 feet, or about 140 feet in excess of my own measurement.

Most geographers still follow Humboldt's determination, made in 1804, which allows for the volcano little more than 17,700 feet. This measurement was made from the Llano de Tetimba, lying on the east or Puebla side of the mountain at an elevation, computed barometrically, of 2405 metres. The trigonometrical determination of the summit from this point gave 2993.7 metres, or an absolute

[1] Petermann's Mittheilungen, 1856, p. 361.

[2] Usually given as 17,720, 17,726, or 17,728 feet. The exact figure should be 17,713 feet (5399 metres, 2770 toises), as given in a letter addressed by Humboldt to Dr. Petermann, under date of December, 1856, and published in Petermann's Mittheilungen for the same year (p. 479). But Humboldt himself, or rather his translator, erroneously gives 17,729 and 17,728 feet, on pages 251 and 458 of the fifth volume of his Cosmos (Bohn's Edition).

elevation of the mountain of 5399 [1] metres (17,713 feet). But here, as in the case of Sonntag's measurement, we have to allow for the difference in the height of the Mexican plateau which has been established by the recent railroad levellings. There are as yet no data as to the "railroad" height ot the plain of Tetimba, the elevation of which was determined barometrically by Humboldt; but we have reason to believe that the measurement by the illustrious German traveler was made with the same instrument which also determined for him the elevation of the City of Mexico. This is given as 7470.6 feet (2277 metres[2]), which is in excess of the railroad levelling by 123 feet. Deducting this amount from 17,713 feet we obtain 17,590 feet as the expression of Humboldt's measurement. This is in marked correspondence with my own determination.[3]

Ixtaccihuatl.

The ascent of this mountain was made by Mr. Baker and myself from the side of Ameca on the 26th and 27th of April, just ten days after our ascent of Popocatepetl. This mountain, although less high than either Orizaba or Popocatepetl, is really the giant of the Mexican volcanoes, and it bears evidence of having been at one time much more elevated than it is to-day. The earliest recorded ascent, so far as I have been able to determine, was made in the November previous to our visit by a resident of Miraflores (Selis? by name), who, I believe, succeeded in reaching the virtual summit. We were somewhat less fortunate, as two impassable crevasses, cutting directly across the crest of the mountain, prevented further progress at a height of a little over 16,730 feet. This position I estimated to be some 75 yards below the highest point.

[1] This figure allows for a correction by Oltmanns; Humboldt himself obtained only 5387 metres (17,674 feet), but he admitted the correction made by his astronomical associate.

[2] Petermann's Mittheilungen, 1856, p. 481.

[3] If we take Humboldt's own measurement, without the correction suggested by Oltmanns, 17,674 feet, and deduct from this amount the excess of 123 feet, the result obtained (17,551 feet) will still more nearly approximate my own.—Messrs. Dollfus, DeMontserrat and Pavie, of the French Scientific Commission, ascended the mountain on the 23rd of April, 1865, but they were unable to attain the highest point, the Pico Mayor. They give 5,263 metres (barometric measurement) as the elevation of the highest point reached by them, the southeastern rim of the crater (La Naturaleza, 1870, p. 184; Archives de la Commission Scientifique de Mexique, II, p. 127, as quoted in Petermann's Mittheilungen, 1868, p. 98.)

Of the three giant volcanoes of Mexico this is by far the most difficult of ascent, and the only one which partakes of the full dangers of Alpine climbing. A vast covering of snow and ice, some 50–100 feet in depth, forming a true *firn* or *névé* shrouds the summit in one continuous mantle, from which several glacial streams descend the slopes to a depth of some 14,500 feet. It was across one of these, which I now propose to name the Porfirio Diaz Glacier, that our course was directed, a course that zig-zagged in steep windings around the deep *barrancas* (crevasses) which everywhere cut into the ice. We reached our ultimate position shortly before 11 o'clock of the morning of the second day. The data for our determination of height are the following:

Barometer on summit, with determined correction, 16.44 inches	(417.8 mm.)
Barometer in City of Mexico	587.4 mm.
Barometer in Vera Cruz	30 inches.
Temperature of the air on summit	32° F.
Temperature City of Mexico	21° C.
Temperature City of Vera Cruz (approx.)	85° F.

The elements of the calculation are as follows:

Tables of Delcros (computed from Mexico):

Difference of barometric values		2713.1 metres.
Addition for temperature		113.9 "
Correction for latitude (decr. grav.)		6.5 "
Correction for gravity (vertical)		8.6 "
Correction for elevation of lower station		2.3 "
		2844.4 metres.
=		9332.4 English feet.
Elevation from summit (estim.) 75 yards	225.0	
Elevation of Mexican Observatory	7403.0	
		16,960

Tables of Guyot (computed from Vera Cruz):

Difference of barometric values	15714.5 feet.
Addition for temperature	925.4 "
Correction for latitude	33.0 "
Correction for gravity	55.0 "
Correction for lower station	3.0 "
Distance of point measured from summit (estim. 75 yards.)	225.0 "
	16,956 feet.

This determination is in excess by 1250 feet of the results obtained by Humboldt (4786 metres,[1] or 15,702 feet), whose measurement is still followed by some geographers,[2] and nearly 900 feet above the estimated height given by Mexican geographers. Thus, Garcia Cubas, in the work already mentioned, gives 4900 metres (=16,076 feet), and the same figure also appears in a small work entitled "Geografia de Mexico," prepared by Alberto Correa, and adopted for use in the public schools of the Mexican Republic (1889). I am wholly at a loss to understand how, in view of the close proximity of Ixtaccihuatl to Popocatepetl, either Humboldt or the Mexican geographers could have felt satisfied with the low values obtained for this mountain. Both volcanoes appear to be so nearly of the same height that the eye almost fails to determine which is the loftier of the two, and, indeed, there are to-day many residents of the capital city who affirm that Ixtaccihuatl is the more elevated.[3] Sonntag, who made an ineffectual attempt to gain the summit, long since (1857) made careful measurements of the height of the mountain, and his results, obtained by triangulation, and published in the Smithsonian Contributions to Knowledge, XI, are strikingly confirmatory of my own. His value for the central elevation, the highest of the three summits or peaks, is 17,076.9 feet; deducting from this amount the 125.8 feet difference in the elevation of the City of Mexico, to which reference has already been made in our account of Popocatepetl, we obtain as a net result 16,951 feet, or a variation of less than 10 feet from my own measurement. It is rarely that so close a correspondence is established between the barometric and trigonometric measurements of a mountain of the altitude of Ixtaccihuatl.

Nevado de Toluca.

Mr. Baker and myself ascended this mountain from the side of Toluca, or rather from that of San Juan de las Huertas, on the 21st of April, three days after our descent from Popocatepetl, and five days before our journey to Ixtaccihuatl. Being considerably lower

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[1] Essai Politique Nouv. Espagne, XCI; 14,736 French feet, in Kleinere Schriften, p. 463.

[2] See article "Mexico" in Encyclop. Britann., 9th ed., p. 215.

[3] It is the belief of many tourists, and of natives of Mexico as well, that Humboldt ascended one or more of the three giant peaks of the Republic; this belief is ill-founded, since the highest point reached by him was the apex of the Nevado de Toluca, about 15,000 feet.

than either of the other volcanoes, its ascent is correspondingly easier; indeed, a horseman can ride with his animal to within about 900 feet of the summit. Beyond this point the ascent, which is conducted over a precipitous slope composed in great part of detached boulders, is very fatiguing, but not strictly dangerous. The crest of the disrupted crater-wall is exceedingly jagged and abrupt, and in places narrow enough to be straddled. We found very little snow or ice on the summit, and I believe none was visible except in rock shelters. The mountain is thus scarcely worthy of the designation of *nevado*. Our measurement for the height of the peak gives 14,953(5) feet. The data are as follows:

Barometer (with correction) on summit 17.53 inches (445.3 mm.)
Barometer City of Mexico (approx.) 23.01 inches (584.5 mm.)

Temperature of atmosphere on summit . .	44° F.
Temperature City of Mexico 21.°6 C. . .	70.°9 F.

The elements of the calculation are:

Tables of Delcros.

Difference of barometric values	2166.0 metres.
Addition for temperature	122.5 "
Correction for latitude (decr. grav.) . .	5.3 "
Correction for gravity (vert.)	6.6 "
Correction for elevation of lower station .	1.7 "
	2302.1 metres.
=	7552 English feet.
Elevation of Mexican Observatory .	7403 " "
	14,955

Tables of Guyot:

Difference of barometric values	7106.8 feet.
Addition for temperature	402.0 "
Correction for latitude	15.0 "
Correction for gravity	21.5 "
Correction for lower station	4.5 "
Elevation of Mexican Observatory . .	7403.0 "
	14,953 feet.

I am not sure but that there is a point on the crater-rim which rises some 15–20 feet above that where we made our measurement.

I was not, however, able to determine this, as the lateness of the hour prevented our reaching the position in question. Humboldt's barometric measurement of the Pico del Fraile gave 4621 metres[1] or 15,161 feet; deducting the excess of 123 feet from his determination of the elevation of the City of Mexico we obtain 15,038 feet, or about 80 feet more than my own calculations show. Garcia Cubas reduces this difference by some 18 feet, giving as the height of the mountain 4578 metres (15,020 feet).[2]

Tabulating the results of our measurement of the four highest volcanoes we find for:

Peak of Orizaba	18,205 feet.
Popocatepetl	17,523 feet.
Ixtaccihuatl	16,960 feet.
Nevado de Toluca	14,954 feet.

Some slight alteration of these values, due to the effects of a varying temperature upon the mechanism of the aneroid, ought perhaps to be made; but the correction is an unknown quantity, and I have found that a change of from 20 to 30 degrees F. failed to produce any appreciable difference in the reading.

The Culminating Point of the North American Continent.

The restoration of the Peak of Orizaba to the first place among Mexican mountains, and its increased altitude, open up the interesting question as to what constitutes the culminating point of the North American continent. The only other mountain that need be considered in this connection is St. Elias, situated approximately on the 141st parallel of W. longitude, and whose summit, is claimed for both the possessions of Great Britian and the United States (Alaska). The measurements of this mountain depart so widely from one another, however, that we are not yet in a position to affirm, even within limits of 1000 feet or considerably more, how nearly it approaches in height the Mexican volcanoes. We are probably justified in dismissing without further examination the

[1] Essai Politique Nouv. Espagne, XCI; 15,168 feet, in Cosmos, V, p. 281, Bohn's Edition.

[2] I was informed in the town of San Juan that a number of students from the engineer's college of Toluca determined trigonometrically the height of the Nevado to be 4444 metres or 14,580 feet. I feel certain that this estimate is several hundred feet too low.

measurement made by La Pérouse in 1786, which gave for the peak less than 13,000 feet; and seemingly not much more reliable is the datum (14,970 feet) which appears in Captain Denham's chart from 1853 to 1856, and is copied into the British Admiralty chart of 1872 (Humboldt's Cosmos, V, p. 419, Otté's Edition; Dall, Rept. U. S. Coast and Geodetic Survey for 1875, p. 159). This latter figure (4562 metres) is adopted by Petermann in his general map of North America prepared for Stieler's Hand-Atlas (1878–81). Malespina in 1791 determined the height, by means of angles taken from near the position of Port Mulgrave, to be 5441 metres or 17,851 feet, and the equivalent of this figure has been copied into the Russian Hydrographic charts (1847). Tebenkoff reduces this amount by somewhat over 900 feet.

No carefully conducted measurements of the mountain appear to have been made between the date of the publication of Tebenkoff's chart (1849) and 1874, when Mr. Dall, under the direction of the U. S. Coast Survey, surveyed a considerable portion of the Alaskan region.[1] This investigator found four different values for the height of the mountain as measured from four points respectively 69, 127, 132, and 167 miles distant: these are 19,464, 18,350, 19,956, and 18,033 feet. Mr. Dall dismisses all of these as having little value, except the measurement of 19,464 feet, made from Port Mulgrave. It is difficult to reconcile the vast range of these measurements, whose extremes vary to an extent of upwards of 1900 feet, or to one-tenth of the height of the entire mountain, except on the assumption that the angles of measurement were too small to permit of exactitude in the result. And, indeed, Mr. Dall himself rejects

[1] Mr. Dall, in his report above referred to (p. 159), quotes from Leopold von Buch an additional measurement of the mountain, namely 16.758 feet. Grewingk (Verhandl. Russ.-Kaiser. Mineralog. Gesellsch., 1848–9 [1850], p. 99), gives the same figure, referring likewise to Buch (Canar. Inseln, p. 390); and a further reference appears in Davidson's "Coast Pilot of Alaska," 1869, p. 142, note (16, 754 feet, according to Grewingk). But this figure is manifestly Malespina's measurement given in *French* feet, which resolved=17.860 feet; and Grewingk himself quotes Malespina's measurement (5441 metres) on p. 404 of his report. Humboldt (*op. cit.* V, p. 252) credits the measurement of 17,855 feet to Quadra and Galeano, but as these observers were associated with Malespina, it is more than probable that the data here given are those which have been generally attributed to Malespina. Humboldt intimates that the measurement is perhaps one-fifteenth too great, but whether this assertion rests on certain facts contained in Malespina's manuscripts, which the great German traveller found among the Archives of Mexico (p. 419), or not, is not stated.

all his measurements except those made from Port Mulgrave, giving them "no weight in the result, as they were all taken at great distances from the peak, and subject to various disturbing influences and uncertainty in most of the positions (p. 164)." And yet it is upon the accurate determination of the position "At Sea," 127 miles distant, that "the position of Mount Saint Elias depends" (p. 165); and necessarily upon the determination of this position must also depend the accuracy of the measurement of height. Malespina's measurement was made from a point apparently very close to that occupied by the Coast Survey Officers, and his results, as has already been seen, vary negatively by 1600 feet; but he estimated the distance separating him from the mountain at 55.1 nautical miles. Mr. Dall remarks, in relation to the discrepancy existing between the two measurements, that the doubt lies wholly with the distance. But this does not explain the great range in Mr. Dall's own results. And we are perhaps led to be the more suspicious regarding the value of these when we take into account the discrepancies which appear in the determination of the altitude of Mount Fairweather. Three series of sextant observations were made of this mountain from the region about Lituya Bay and Cape Spencer, with the result of obtaining an average value of 15,447 feet. Vertical circle measurements of the same mountain made from Port Mulgrave indicate 15,270 feet, while the average of all measurements is 15,423 feet. Mr. Dall calls attention to the close correspondence of these results, and comments more particularly upon the "unanimity in the Lituya Bay observations." [1] A reference to the exact results obtained, without recourse to the delusive system of extracting averages, shows, however, that in place of unanimity we have the reverse. Thus, the sextant observations taken from "Off Cape Spencer" indicate 16,009 feet, those from "Off Lituya Bay" 15,247 feet, and those from "Off Lituya" 15,085 feet (*op. cit.* p. 174) a difference in extremes of upward of 900 feet. This divergence in the measurement of a mountain three miles (±) in height from positions 20–50 miles distant makes very doubtful the results obtained in the case of St. Elias, where the distances were still very much greater, and the angles of observation correspondingly smaller.

In view of the broad divergence existing in these later measurements, and the fact that all earlier determinations give less than 18,000 feet for the height of Mount St. Elias, geographers will prob-

[1] Including here the measurements made off Cape Spencer.

ably consider the question of absolute height as still an open one. That the mountain closely approximates the giants of the Mexican plateau is almost certain, but it seems equally probable that its true position is after, and not before, the Peak of Orizaba.

CONTRIBUTIONS TO THE LIFE-HISTORIES OF PLANTS. NO. V.

BY THOMAS MEEHAN.

On the Anthers of Lappa major.

I have placed on record that the column of anthers of many composites, maturing before the style has finished its growth, is drawn up out of the floret until resistance is weak enough to allow the stigmas to escape from the staminal tube. As in almost every behavior of plants, there are extremes here as well. In some species the style easily escapes from the staminal tube, and the stamens are drawn but little, if any, above the mouth of the floret; in others the stamens are drawn to a considerable length before, they are drawn back to their normal position, by the elasticity of the filaments. In *Lappa* the other extreme is reached. The tube is drawn so far beyond the floret, that the caudate bases of the anthers are past the mouth of the corolla, and cannot get back again. The staminal tube, therefore, presents a condition unusual in composite flowers.

The Pollination of Crucianella stylosa.

In the Proceedings of the Academy of Natural Sciences, 1887, p. 325, I noted that the elongating styles of *Cephalanthus occidentalis* forced the clavate stigma through the four anthers, clearing out almost completely the pollen from the anther sacs and carrying up the densely pollen-covered stigma to its ultimate full growth, ensuring the most perfect self-fertilization. I also showed that the elongation of the style and full growth of the pistil were very rapid, commencing about 8 P. M. and reaching their full length in about half an hour.

Observing the past summer that another Rubiaceous plant, allied to *Galium* or *Asperula*, *Crucianella stylosa*, Trin., a native of Persia but growing in my garden, had long exserted styles, similar to *Cephalanthus*, I was moved to cut some branches and place them in water for study as in the former case.

We have here five stamens, instead of four, and the large stigma is forced through the center, just as in the manner described in *Cephalanthus*, evidently pushing up against the closed 5–parted limb of the corolla, which then expands, the style with the pollen-covered stigma continuing to its full growth. As in the case of the *Cephalanthus*, the pollen is so nearly cleaned out of the anthers by the upward growth of the stigma, that scarcely any is left in the anther cell, and yet so delicately is it done, that the five lines of pollen, as cleaned out from the five anthers, are generally discernible. Nature could not have made a better arrangement for making cross-fertilization impossible.

All attempts to ascertain the precise time of the opening and elongation of the style failed. Though I made several successive attempts with fresh flowers, none opened up to 11 P. M., unless touched with the point of a pin, when the limb would part with an elastic sort of spring, becoming expanded so instantaneously as to defy the eye to detect the motion. In the morning, two or three hours after sunrise, the room, however, being "pitch dark" from shutters, a number of newly opened flowers, with their pollen-covered stigmas would be found, but not with the styles much exserted. The elongation seemed to be done gradually through the day, not reaching full length till night-fall.

Note on Unisexuality in Connection with the Order of Flowering in Willows.

After the flower buds have been formed and in many species of plants have reached a certain size, they remain at rest until the axis has reached its full growth, when this has been accomplished the flower buds resume activity. In the well known case of *Liatris,* and indeed in most allied genera of Compositæ, the renewed development of these flower buds is from the apex downwards. In other cases, some Fumariaceæ for instance, the lowest bud on the spike or raceme starts the renewal. In most willows the renewal of growth is from the middle of the branch. If, for instance, there may be eleven catkins to be produced from as many axils along the stem, No. 6 will be the first to expand, 5 and 7 next, then 4 and 8, 3 and 9, 2 and 10, and finally 1 and 11. Singularly enough, this order does not extend to the catkins themselves. In them the growth ceases as soon as the anthers reach their full size, and the stamen remains at rest until the axis of the catkin has reached its final length. Then the filaments are formed and the perfect stamen assumes its full proportion but gradually from the apex downward.

It seems to me still more evident that, as I have already pointed out,[1] this arrest of growth at a certain period and subsequent resump-

[1] Proc. Acad. Nat. Sci., Phila., 1883, p. 85; 1884, p. 117; 1885, p. 117.

tion furnishes the clue to the law governing that abortion in flowers which renders the hermaphrodite unisexual. In the maple, as in the case referred to, there is a rest when the anther and pistil reach a certain point. When growth is again resumed, the filament is produced and the stamen elongates, while the pistil remains dormant. Then we have fully developed male flowers. In another case growth is resumed only by the gynœcium, the fully formed anthers remaining sessile and barren at the base. Then we have the female flowers in the maple tree. This arrest and resumption of growth in the parts of flowers was noted by the author many years ago in the flowers of the Compass Plant, *Silphium laciniatum*.[1]

The facts here noted in connection with the willow refer to the male aments.

On the Varying Character of Dichogamy in Flowers of Corylus Avellana.

In several papers, in recent years, I have noted that dichogamy is not a fixed character in plants, brought about by any relation between insects and flowers, but is affected by climate and season. A species proterandrous under one set of circumstances, will be proterogynous under another. I have also shown that certain conditions of temperature will affect the female flowers or female organs of hermaphrodite flowers when the male organs will remain quiescent, and that other conditions will advance the male organs rapidly, while the female organs remain at rest.

My observations on the hazel nut, *Corylus Avellana*, for several years past have shown remarkable variations. A few very warm days in cold winters will bring the male flowers to perfection two months before the female flowers open, dying away so completely as not to leave any for fertilization, so that the plants would be wholly barren for that season. Occasionally the openings of the male and female flowers have been nearly simultaneous, when a good crop of nuts from complete fertilization has resulted.

This season is the first since the observations have been undertaken when the results have been reversed. The female flowers are now (Jan. 11th, 1890) abundantly in bloom, while the catkins are far from mature. In former years the flowers have always been proterandrous—this season they are proterogynous.

Although the deductions I have heretofore made—that male flowers, or male organs of flowers, mature rapidly under a com-

[1] Ibid, 1870, p. 117.

paratively high temperature, while the female organs continue quiescent, scarcely needed further confirmation, the present additional point that under a prolonged moderate temperature the female will advance more than the male has not been brought out so well before. This, in the hazel-nut or filbert, has never been noted in America heretofore to the best of my belief. So unexpected was the fact as to make a statement in the Transactions of the Royal Horticultural Society of London, vol. V, 1824, p. 311, appear almost incredible to one not familiar with such observations as I have recorded. The Rev. Geo. Swayne says at the page quoted "casually passing by them (the trees) in the second week in February, 1820, I was rather surprised to see a considerable number of scarlet blossoms thereon in a state of expansion, but at the same time very few catkins, and those few seemed to be in a very imperfect state, not a single one being prepared to discharge its farina." Here we have a precisely similar observation in these Philadelphia plants, only four weeks earlier than Mr. Swayne saw them.

The season has been one of the most remarkable known for many years. Instead of the thermometer varying from the the freezing point to zero, with occasional spells of a day or two between at 50° or 60°, the thermometer has only once fallen just beneath the freezing point, while at no time has it risen above 50°. The general remark with English people is that it is an open English winter. The English hazel, therefore, finds itself pretty much at home, and has fallen back on its natural habit, as we may suppose, of producing both sexes nearly simultaneously.

The deductions from former observations may again be repeated :—

Under sudden high temperature the male flowers of the hazel will open and perfect, long before the female flowers are affected by the same temperature.

Under long continued temperate heat, the female flowers will advance more rapidly than the male.

There is no specific rule in dichogamous plants. A plant with flowers proterandrous in one season or one country, may be proterogynous in another.

My former observations were made on various flowers, though confined to the hazel in this paper.

DIOECISM IN LABIATÆ.

In some observations recorded last year I noted that the sexual disturbances observed in some European Labiatæ, did not seem to extend to distinctively American species, though Old-World species retained the peculiarities when translated here. I now find in *Pycnanthemum* similar conditions. *P. lanceolatum* Pursh, a large clump of which from one original plant growing in my garden produces flowers apparently perfect, wholly fails to perfect seed. Close beside it is a clump of *P. muticum* Pers. with no trace of stamens, but with an exserted and in every way perfect pistil, seeding abundantly. On close examination it is evident that the pistil in the former is not as perfect as it appears to be. It is never exserted, nor do the stigmatic lobes perfectly expand. There is no doubt that these plants practically represent staminate and pistillate plants respectively.

The abundant seeding of *P. muticum* under the above detailed circumstances, could only result from the abundant pollen of *P. lanceolatum*, and the seeds produced by the former must of necessity produce hybrid plants.

Prof. Gray notices in Synoptical Flora a number of variations near *P. muticum*, and of one, *P. leptodon*, remarks " perhaps a hybrid bebetween *P. muticum* var. *pilosum*, and *P. Tullia* var. *dubium*." The observations here recorded add greater probability to the suggestion of the hybrid origin of intermediate forms in this genus, by pointing out the exact method under which hybridism is brought about.

It may be repeated here that, as noted by the author long since, cross-fertilization must be regarded as the hand-maid of heredity, rather than as a factor in the evolution of form. Its duty is to bring nearer home that which has wandered.

Self-Fertilizing Flowers.

A large number of flowers are so arranged as to render self-fertilization difficult, and in many cases impossible. Numerous observers have placed on record what they have discovered in the line of these facts, and have rendered inestimable service to science. There may be a question whether the interpretation of such facts be legitimate; there can be no question as to the value of the facts themselves.

Observations on the other side have not been as numerous, yet they seem no less interesting. The number that are not only adapted to self-fertilization, but actually self-fertilized, seems as large as that of the other class. We may leave the interpretation till the record is more complete.

There is one salient point in connection with the whole subject worth placing prominently before the student, and which will be found sustained by the most superficial examination, namely: All plants that are arranged for self-pollination are abundantly fertile, and have a great advantage of numbers in the struggle for life, while those that have to depend on external agencies are usually much less productive, and even though the progeny may be found to have greater vegetative vigor, or some other element of strength. The influence of numbers is certainly with those which self-fertilize. If Providence is on the side of the strongest battalions, the argument of nature is on the side of self-fertilization.

It has come to be a rule with the author of this paper, whenever any plant is unanimously productive, to look for and to find arrangements for self-fertilization. A few instances of more than usual interest, drawn from last summer's experience, are herewith offered.

Trichostema dichotomum.—This pretty blue flowered Labiate is well known as "Blue Curls," and is common in sandy places along the Atlantic Sea-board. In many Labiates the lips of the cloven stigma remain closed till after protrusion from the flower. Such cases are commonly with those that are classed as arranged for cross-fertilization. In many, however, the lips expand before the flowers are open and receive pollen from their own anthers, which mature simultaneously. In this plant this is the case, and the inner face of the stigma lobes are so bent that they come in close contact with the anthers from the curved up filaments and finally emerge from the flower, as it expands, covered with own-pollen.

Buddleia curviflora.—Noting that this pretty Japan shrub was enormously fertile, evidences of self-fertilization were at once looked for. The narrow tube of the flower is nearly an inch long, the anthers being inserted about the middle, or at half an inch. The ovarium with the pistil occupies about a quarter of an inch. The half inch above the anthers is densely clothed with stiff hair, completely closing the narrow tube. The brush would effectually cleanse an entering proboscis of foreign pollen, or a withdrawing one of the flower's own pollen. But it is not necessary to speculate on what an insect could or might do, for the anthers burst before the flowers open, and cover the whole stigma with abundant pollen. No one examining these flowers can fail to be convinced that they are ingeniously arranged for self-fertilization. As in all cases of flowers with tubular corollas, the humble bees in this region rifle the flower of its sweets by boring the base of the corolla tube. *Buddleia Lindleyana* exhibits similar characters.

Vitex Agnus-castus.—This Verbenaceous plant from the south of Europe common in gardens as the "chaste tree," is abundantly fertile. The anthers burst their pollen sometimes as much as twenty-four hours before the flowers open. The pistil is cloven as in many Labiates, but is remarkable for having the lips expanded at a very early stage. The pollen as it escapes from the cells, falls on the stigmatic surfaces. The stigma at this time may be regarded as functionless; but the pollen remains attached, and is borne up as the style elongates and performs its part in the economy of plant life at once when the flower expands. After expansion the pistil curves upward. The flowers seem great favorites with insects, especially with Lepidoptera. Repeated observations failed to note a single case where a stigma was touched by a visiting insect. Humble-bees bore through the tube for their share of the nectar.

Hypericum mutilum.—This weed, common in damp ground, is abundantly fertile. An examination of an unopened flower, shows the anthers to be entangled among the styles from which on expansion of the flower, the weak hair-like filaments are unable to extricate them. The anthers mostly remain in this position, shedding their pollen over the stigmas, getting in their early work to the exclusion of intruding pollen. *H. Canadense* behaves in a similar manner.

Phytolacca decandra.—Assured, from its abundant fertility, that the common "Poke-weed," was adapted to self-fertilization, I was led to examine a flower, and found that it was fertilized before opening. The stamens are curved over, completely covering the gynœcium, and the anthers discharge the pollen in great profusion over the styles. These have their stigmas partially decayed before the flowers open, showing that their functions have been wholly concluded while the flower was unexpanded.

Lycopersicum esculentum. Noting that the common Tomato, and its neighboring Solanaceous plant, *Capsicum grossum*, the Bell-pepper of gardens, had nearly or quite every flower fertile, an examination of a few flowers late in the season, showed plainly that they are arranged to insure self-fertilization. The anthers of the Tomato are connate, and drawn together in a cone over the pistil. The anther-cells burst simultaneously with the expansion of the corolla, and the discharged pollen covers the stigmatic apex. It is impossible for the flower, under any ordinary circumstances, to receive foreign pollen. The large purple anthers of the Capsicum are drawn closely together and discharge pollen copiously over the stigma.

Lycopus Virginicus L.—It cannot be said that there is any arrangement of the parts of the flower suggestive of special adaptation to self-pollination, but the later flowers of the season, borne on the stolons, are often pushed into the earth in the bud and expand wholly beneath the surface, producing seeds as abundantly as those on the erect stems. No one will doubt, on carefully observing the plants that the flowers self-fertilize. Dr. Gray seems to limit the tuberiferous character of this species to a depauperate form growing from Lake Superior northwards. The tubers are freely borne by the typical form around Philadelphia, and they are often as large as Kidney Beans.

Hamamelis Virginiana L.—The arrangements for self-pollination here are among the most interesting known to me. It is well-known that the anther-cell opens by an operculate lid or valve. What might be termed the hinge to this lid is on the upper part of the stamen. When ready to expose the pollen, the lid previously pointing downward, becomes perfectly erect. The face which, previous to opening, faced one point of the horizon, is turned to the opposite, and the inside face becomes the outside. The pollen adheres to the inside face of the valve, and so complete is this adherence, that on the erection of the valve, every part of the pollen is withdrawn from the cell. The erection of this valve is, however, accomplished instantaneously, and the sudden jerk dislodges some of the pollen, which is scattered around. Some falls back into the cell, some over the adjacent stigmas, but a large portion still adheres to the face of the lid, falling away gradually as moved by the wind or other agency.

It may be well to note here the order in which the parts of the flower successively mature. As the four strap-like petals expand, neither anthers nor stigmas have reached maturity, which seems to be the work of the second day. As the stigmas become viscid, a pair of anthers only expose the pollen. One anther, and one cell only of each anther, bursts at a time, the other follows some time during the same day. Before evening of that day, the four cells expose the inner pollen-clothed surface of the lid. The pair of stamens that open first are those that are in front of the pair of styles—that is, the pair which alternates with them. The next day the pair on a line with the pair of styles go through the same process. It is customary to describe the stamens and petals of *Hamamelis* as in fours. These observations show them to be really in pairs.

The *Hamamelis* flowers in autumn when the leaves are falling. These observations were made between the 15th of October and 1st of November. The insect world has not wholly gone to its winter rest, but it is a very dull and inactive world. I see no insects at work on the flowers,—but I may be told this is an observation easy to be made on any plant. Such a remark has been made on one of my former recorded observations. One who has growing plants within a few score feet of his library, who has watched them many times a day, and many days during a couple of weeks, might almost venture to say no insects visited them, but accurate statement could only record that no insects were noted visiting the flowers. In the same spirit it is but fair to say that the author has not actually seen the valve of the anther fly up suddenly as described above. He has watched with a lens in hand assiduously for the pleasure of seeing one, without success. He has, however, seen them erect, where but a few seconds before they were closed, warranting him, as he believes, in assuming the fact as recorded.

ON THE MALE AND HERMAPHRODITE FLOWERS OF ÆSCULUS PARVIFLORA.

The enormous number of flowers in proportion to fruit produced in *Æsculus parviflora* Walt. may have attracted attention. It is recorded as being "polygamous." The flowers seem to be either perfect or male.

It seemed of some interest to carefully note the behavior of one I had the opportunity to examine several times daily. The plant is of some age, and forms a bush thirty-six feet in circumference. Counting over a few square feet and multiplying by the whole area, I estimated one thousand spikes of flowers. An average spike gave four hundred flowers, so that the total would be 400,000 on the plant. About one half of these had not a single perfect flower,—and the greatest number counted on any spike was forty-six. This would give an average of twenty-three to five hundred spikes or 12,500 hermaphrodite or perfect flowers as against 387,500 male flowers.

In the animal kingdom the number of males born to female is about equal. In the monoecious or dioecious plants it must have been noted that great disproportion exists, but one so great was unexpected.

In all cases where the branches of the previous year had matured in partial shade, the flowers on the spike proceeding therefrom were wholly male. This is in accord with the views heretofore developed by me that conditions unfavorable to perfect nutrition are unfavorable to the development of female flowers. In the branches that had been developed under conditions favorable to nutrition, some would have spikes less vigorous than others, but so far as I could see, this had no effect on the production of the sexes. As many perfect flowers would be found on a comparatively weak as on a strong spike.

What I have placed on record in relation to growth-rhythms in *Acer dasycarpum*, *Acer rubrum* and some other plants, occurs in these flower buds also. At an early stage in the bud, the anthers are fully formed and the gynœcium reaches a certain stage, when a resting time occurs. When growth is renewed the ovary with its pistil proceeds to move forward rapidly, while the filaments proceed slowly; or the latter move rapidly and the gynœcium continues wholly at rest. In the former case we have the perfect, in the latter the male only or barren one.

It is evident that up to the time when this last growth-rhythm begins, the flower may be male or female (hermaphrodite in this case.) It is male or female simply as the renewed growth-force is directed towards the gynœcium, or to the stamens alone.

The development of the stamens presents points of interest. In the hermaphrodite flower, the point of the stigma and points of the anthers appear simultaneously bursting through the petals, then rest for some twenty-four hours. The growth of these parts is then very rapid, the stamens and pistils extending to nearly an inch beyond the calyx. This renewed growth commences soon after sun-rise, and ceases with sun-down. The anthers do not burst their cells on the day this growth is in progress. The following day, however, one anther sheds its pollen, the next day another, the third day another and on the fourth day all the remaining burst nearly simultaneously.

It has become the habit in observations of this kind, to suspect that the whole behavior has some relation to the visits of insects, and to cross-fertilization. But though endeavoring to trace such a relation here, it could not be ascertained. If the division of the sexes is with a view to economy in energy, the enormous disproportion of male to female flowers strikes the thought unfavorably. If we watch the flowers closely we find bees and other insects visiting them in great numbers during the day, and numerous Lepidoptera by night. But none seem to be pollen gatherers; they collect nectar only so far as we can see. The stigma and anthers extended so far from the mouth of the corolla, are never touched by any insect and receive no insect aid whatever in pollination. The two earliest developing anthers are almost in contact with the stigma, which is at least quite as likely to receive pollen from them as from the other flower. Granting, however, that pollen may come from other contiguous flowers and reach the pistil before its own pollen has had the chance, it is physiologically of the same character, and could scarcely be considered as coming within the scope of cross-fertilization.

To my mind no deductions of economic value to the plant can be drawn from these observations.

On the Direction of the Spiral Twist in the Leaves of the Norway Spruce.

The true leaves of Pines are adnate, or perhaps more properly speaking, connate with the branches. Occasionally the apex is free as a mere membranous scale; or when the branch is young, or under circumstances not well understood, but evidently influenced by various phases of nutrition, instead of a mere scale, a regular green leaf, often articulated, is produced from the free apex. When the axial growth is arrested, the green leaves, having nothing to grow to, develop as ordinary leaves would do, and then we have the fascicles of Pine needles, or the verticils of leaves as in the Larch. The pine "needles," spring from a spur as do the leaves of the Larch, only that in the former the arrested woody axis is beneath the outer bark and invisible.

In the Norway Spruce, *Picea excelsa*, the adherent leaves are arranged around the branches from left to right as we look at them, or, as some would say, in a direction contrary to the sun. The free portion—that above the articulation—remains strictly erect, as a general thing, so far as the central or leading shoot is concerned. When the axial growth terminates, the membranous leaves having no axis to adhere to, usually form the bud scales, which are arranged as in miniature cones. We see that the cone of the Norway Spruce is but an arrested and metamorphosed branch, in which what might have been connate leaves, are now free and have become the bracts beneath the scales of the cone. These bud scales do not, however, always remain as scales, but develop to an articulation with a perfect green leaf, as in the regular growth along the stems just as in the

Larch or the regular Pine needles. Having no axis to adhere to, these true leaves in the Norway Spruce seem to grow the larger by reason of their freedom. In some cases these leaves from the bud scales are large enough to simulate those at the apex of *Sciadopitys*, and give the same parasol-like appearance to a spruce branch.

The chief point of this paper is to call attention to the direction of the spiral or twist of these free leaves. Along the central stem, as already noted, the free leaves are usually on a line parallel with that stem, but occasionally they twist to the right or to the left. The same is true of those of the buds. They nearly all twist one way or other. As the adult leaves around the stem all coil in one direction, one might reasonably expect the free leaves to do the same. It is surprising to find that they frequently do not, as many will be found on the same plant twisting in either direction, though every leaf in the same bud has the twist in the same direction.

Attempts have been made to explain the law underlying the spiral arrangement of the leaves of plants. The indifferent directions taken by the leaves of the Norway Spruce, as detailed, would indicate that, whatever that law may be, it is rather local than in control of the whole system governing the growth of the plant.

SEPTEMBER 2.

Mr. THOMAS MEEHAN, Vice-President, in the chair.

Nineteen persons present.

A paper entitled "The Corals and Coral Reefs of the Western Waters of the Gulf of Mexico," by Prof. Angelo Heilprin, was presented for publication.

SEPTEMBER 9.

Mr. BENJAMIN SMITH LYMAN in the chair.

Fourteen persons present.

A paper entitled "Echinoderms from the Northern Coast of Yucatan and the Harbor of Vera Cruz," by J. E. Ives, was presented for publication.

The death of Mr. William C. Henszey, Treasurer of the Academy, on the 7th inst., aged 76 years, was announced.

SEPTEMBER 16.

Mr. THOMAS MEEHAN, Vice-President, in the chair.

Nineteen persons present.

Papers under the following titles were presented for publication:—

"New and Old Trochidæ." By H. A. Pilsbry.

"The Perisomic Plates of the Crinoids." By Charles Wachsmuth and Frank Springer.

SEPTEMBER 23.

The President, Dr. JOSEPH LEIDY, in the chair.

Forty persons present.

Remarks on Ticks.—PROF. LEIDY remarked that in his visit to Beach Haven, N. J. to spend the summer, he found the mosquito less numerous than usual, but in the earlier part of the season the Tick more frequent. One day, in June, after passing for a few yards among some Myrica bushes he picked eight of them from his clothes.

They were repeatedly taken from a pet dog, but usually escaped notice until more or less filled with blood. Three in succession were unnoticed until fully distended and voluntarily detached themselves. One of these was weighed and found to be twelve grains. It was also found that it required nine unfed ticks to weigh one grain, so that the fed ones increase to more than one hundred times their weight and bulk. Curious to learn something of the life of the Tick, the three specimens were placed in a box in the beginning of July, in some moist sand and moss. They sought a slight hollow in the sand from which they afterward did not move. After a week they began laying eggs and this went on for a couple of weeks, until each Tick had extruded a mass nearly as large as itself. The eggs were laid in advance of the position of the body, discharged from between the anterior two pairs of legs—the Ticks remaining constantly in contact with them. The eggs were oval, brown and shining, and measured 0·5 mm. long. The parents became much contracted and shriveled and all died from the 16th to the 18th of August, about the time the eggs began to hatch. This continued for about a week until all were hatched.

The larval Ticks were brown, ovate and possessed three pairs of limbs. They measured 0·6 mm. long and 0·4 mm. broad. As many escaped between the side of the lid and box in which they were contained, they were transferred into a glass bottle with a cork stopper about an inch broad. The Ticks gradually collected into three compact swarms, the largest of which was formed beneath the cork its whole breadth, and sometimes, in part at least, nearly a line thick. Another swarm compacted itself in the interval of two crossing twigs about as long and thick as the little finger, and the third formed a dome-like mass, about one-third of an inch broad, on one of the twigs. From time to time they partially scattered and then collected again in the same close swarms.

Exhibited to the Academy, this evening, September 23d, the young Ticks appear yet to be alive and in good condition, though they have eaten nothing. Fruit and other parts of plants have been placed at their service but they do not even approach them. On two occasions some were placed on Prof. Leidy's arm, but they did not seem disposed to attach themselves.

The mature Ticks present two well marked varieties, probably the the two sexes. In the one there is a conspicuous white spot on the back immediately behind the head, sharply defining a thoracic shield. In the other there is no distinct appearance of the shield, but fainter white streaks lie outside of its position and extend in four feebler streaks on the abdomen, apparently defining the intestinal coeca. In the former the genital aperture is central between the anterior two pairs of limbs; in the latter it is between the second pair of limbs. The blood filled specimens that laid the eggs, accord with the former.

He was unable with certainty to refer our common Tick to its proper place among the multitude that have been named, but supposed it to be the *Amblyomma americanum* of Koch, indicated earlier by Linnaeus as *Acarus americanus*. There is much uncertainty in the knowledge of our Ticks. Koch ascribes nine species to North America, referring them to the genera *Amblyomma*, *Ixodes*, and *Dermacentor*: the last belonging to Pennsylvania. Say describes six other species of *Ixodes*, Packard two and Riley one. Say's *Ixodes scapularis*, which the author says is common in our forests and attaches itself to various animals, seems to approach closely the Beach Haven Tick, and Riley's *Ixodes bovis* also seems to accord pretty well, judging from the figure and characters given. If, however, the latter at maturity is half an inch long as stated by Packard, it is most probably a different species from the *Amblyomma americanum*. He had in his possession a Tick, distended with blood, half an inch in length, which came from Camp Sheridan, Nebraska, agreeing in all respects with those from Beach Haven.

Amblyomma differs from *Ixodes* in the possession of eyes; and he was by no means satisfied that the Beach Haven Ticks possess such organs, unless they form the prominent posterior angles of the head. The Ticks have been supposed to feed on vegetable matter, until they reach maturity. As the mouth organs of the larva do not differ from those of the adult, he thought this doubtful.

In the American Entomologist 1870, p. 160, Seed-Ticks found under the bark of apple trees, are stated to be the young of one of our most common wood-ticks, *Ixodes unipunctata*, but he thought this has not been positively determined to be the case.

He had been repeatedly told of a minute tick, commonly called the Seed-Tick, not uncommon in our vicinity, which attacks man, and buries itself beneath the skin. He had suspected it to be the young of *Ixodes*, but had no opportunity of determining the question.

Note:—The following day, September 24th, the young Ticks appeared generally less active and many were motionless and seemed dead. Thirty active ones were placed on the inner side of his forearm, and there retained for ten minutes, but as they wandered about aimlessly and with no apparent disposition to attach themselves, they were removed.

Though the young Ticks had not fed they actually seem to have grown, for at the present time they generally measure 0·725 mm. in length by 0·45 mm. in breadth.

The adult male and female appear about the same size, for the two range from $\frac{1}{8}$ to $\frac{3}{16}$ of an inch in length. One of those distended with blood measured $\frac{9}{16}$ of an inch long by $\frac{6}{16}$ in breadth: and similar specimens after having laid their eggs had shrunken to $\frac{7}{16}$ by $\frac{5}{16}$.

Finely the same day the Ticks were placed in alcohol for preservation.

Mr. Isaac C. Martindale was elected Treasurer to serve for the unexpired term of the late Mr. William C. Henszey.

SEPTEMBER 30.

The President, Dr. JOSEPH LEIDY, in the chair.

Twenty-eight persons present.

A paper entitled "On the Influence of Previous Pregnancies on Offspring," by Charles Morris, was presented for publication.

Parasites of Mola rotunda.—PROF. LEIDY stated that one day during his stay at Beach Haven, N. J., while men of the life saving station were directly off shore watching the bathers in case of accident, a Sun-fish, *Mola rotunda*, approached the boat, apparently, as they supposed, sleeping. The fish, weighing nearly two hundred pounds, was readily taken without resistance. It proved to be of additional interest from the great number and variety of parasites with which it was infested. Some of these had occasioned a considerable degree of ulceration along the base of the caudal fin. Chief among them was the large Lernea, *Penella filosa*, which hung in great clusters from the root of the dorsal and other fins. They were from five to nearly seven inches long, and had the head and neck, buried in the flesh of the fish from one to three inches. To many of them were appended the curious barnacle, *Conchoderma virgata*; on one *Penella* a bunch of seven, most of which were nearly two inches long. Were also more or less profusely covered with colonies of the Hydroid Polyp, *Eucope parasitica*.

The characters of the Penella are as follows: Head compressed spheroid, ventrally thickly papillate, dorsally with a median and lateral pair of obtuse horns. Neck long and cylindrical; with 4 pairs of minute black hooks just behind the head ventrally. Thorax thicker, cylindrical, annulated. Abdomen or tail shorter, narrower and annulated: with crowded, lateral filamentary appendages branching from the base. Ovaries long and filiform. Head, neck and ovaries straw-colored; thorax, abdomen and appendages black.

In the Règne Animal of Cuvier, it says, there is in the Mediterranean a species, *Penella filosa*, seven or eight inches long, which penetrates into the flesh of the Sword-fish, the Tunny and the Sun-fish, and torments them horribly. Similar cases of the wonderful bounty of nature are frequent and remind us of the remarks of Mr. Spencer, considered more favorable to the evolutionary than to the special creation theory. While to both may be applied the question, why the amount of suffering entailed on sentient beings by parasites could not have been avoided, to the former there does not arise the question, why are they deliberately inflicted?

Of other crustacean parasites of the Sun-fish there were three. Of these one, *Cecrops Latreillii*, Leach, was attached to the gills. Six mature females were about an inch in length, and three of them had the male appended, about half the length, and had well-stocked ovaries. Three additional young females were 14 mm. long.

The other two species were attached to ulcerated surfaces at the root of the caudal fin. One of them, *Læmargus muricatus* Kroyer, of which there were four females, were from 15 to 18 mm. long.

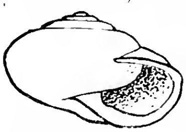
The remaining species, nearly resembling *Læmargus*, seems to be the *Dinematura serrata* Kroyer, of which there were three females, from 6 to 7 mm. long.

Gliding on the skin, at the sides of the body of the fish, was the circular Fluke-worm, *Tristomum Rudolphianum*, of which four ranged from 16 to 20 mm. in breadth.

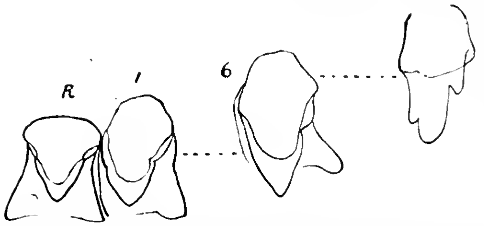
In the intestine was another apparently undescribed Fluke-worm, which may be named DISTOMUM PEDOCOTYLE. Of three individuals one was 20 mm. long by 0·5 mm. thick; the others were 40 to 45 mm. long and 1·5 mm. thick. The body is cylindrical, narrowest at the fore part and obtuse behind, with the ventral bothria larger than the mouth and projecting in advance to an extent equal to the body; with the skin smooth and transparent; the yellow intestine and the white and brown genitals shining through.

The soft, yellow liver was throughout pervaded with a cestoid worm, *Anthocephalus elongatus* Rudolphi. The organ looked like a bundle of tangled cotton cord packed in the hepatic substance. The larger worms were probably upward of several feet in length, but with much effort about a foot and a half of only one individual was disengaged from the liver. In the larger specimens the cystic envelope of the cephalic end appeared as a vesicle from a fourth to half an inch in diameter. When disengaged, the cephalic extremity appeared as a sausage-shaped expansion, from three-fourths to an inch long, within which was the inverted head and neck, from half to three-fourths of an inch long. The head provided with a pair of lateral oblique bothria, enclosed four thread-like proboscides armed with numerous recurved hooks.

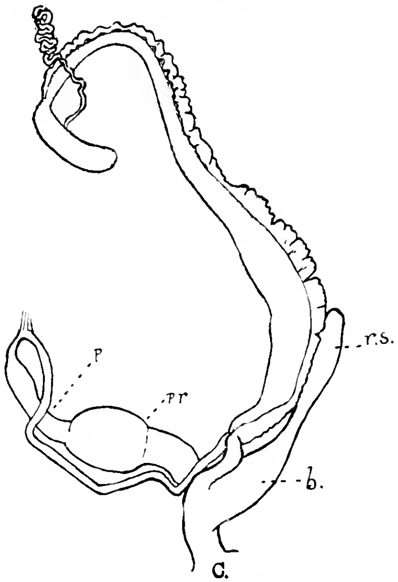
On Helix albolabris var. *maritima.*—MR. PILSBRY exhibited specimens of *Helix* collected by Mr. Witmer Stone on the sand hills at Cape May, New Jersey. The shells, he stated, are rather ambiguous in character, but referable to *Helix* (*Mesodon*) *albolabris* as a variety which the speaker proposed to call *maritima*. The shell is smaller than that of *H. albolabris*, measuring, alt. 13, greater diam. 22, lesser 18½ mm. The surface is very distinctly and beautifully decussated by spiral and oblique lines. The base is notably swollen near the umbilicus back of the lip. The lip is much narrower than in typical *albolabris*.



The dentition is like *albolabris* except that the side cutting-points of the central and inner lateral teeth are less developed than Binney's figures show. There is considerable variation in this character, however, in the real *albolabris*.



The genitalia show the affinities of the specimens more plainly than the shells, having the spermatheca or *receptaculum seminis* (*r. s.*) exactly as in Leidy's figures (Terr. Moll. I.). Its prominent character is in the greatly swollen base of the duct (*b.*), which is found in no other *Mesodon*, but which the observations of Dr. Leidy, W. G. Binney and my own numerous dissections prove to be a constant and very obvious specific character of *albolabris*. The penis-sack (*p.*) is swollen in the middle, as in *albolabris*. The vas deferens is as in *albolabris* except that it is much shorter, not being thrown into a knot or mesh of convolutions before it enters the penis as it is in true *albolabris*. This last character is an important one. The bundles of cœcæ of the ovotestis are shaped like those figured by Dr. Leidy for *H. thyroides*.



The specimens were collected in August of this year.

Mr. Charles P. Perot was elected a member of the Finance Committee to fill the vacancy caused by the election of Mr. Isaac C. Martindale to the Treasurership.

The following were ordered to be printed:—

DESCRIPTION OF NEW SPECIES OF SHELLS.

BY W. D. HARTMAN, M. D.

Bulimus ruga, Nobis. Pl. III, fig. 1.

Shell moderately thick, translucent, ovate elongate, body-whorl somewhat inflated. Whorls 5½, rounded, suture impressed, crenulate. Four apical whorls with minute spiral striæ, aperture rounded oval. Spire half the length, epidermis absent, oblique lines of growth coarse, umbilicus compressed, lip white, reflected, flat, with a heavy deposit on the pillar lip. Color white.

Height 28 mm., width 15 mm.; height of aperture 10 mm., width of aperture 6 mm.

Hab. Segou Island, New Hebrides.

Obs. This shell (of which I have seen but two weather-beaten examples) has the facies of a Partula (to which it may be eventually assigned). At every stage of growth, the upper angle of the labium leaves a fold on the suture, giving it the appearance of a ruffle, hence the name.

Bulimus Bernieri, Nobis. Pl. III, fig. 2.

Shell moderately thick, translucent, ovate elongate, whorls 5½, rounded, suture impressed, surface with fine elevated, regular longitudinal striæ. Spire more than half the length, epidermis absent. Color white, umbilicus compressed, aperture irregularly oval, of a beautiful reddish-orange color within, lip white, reflected and concave; pillar lip with a heavy deposit.

Height 23 mm., width 15 mm.; height of aperture 10 mm., width of aperture 7 mm.

Hab. Segou Island, New Hebrides.

Obs. From Mr. Bernier through Mr Rossiter.

Partula Kubaryi, Nobis. Pl. III, fig. 3.

Shell dextral, ovate elongate, thin and translucent, whorls 4½, rounded, suture well impressed, spire longer than the aperture, oblique striæ crossed by numerous very fine spiral lines, umbilicus open, columella wide at base, lip white, reflected and concave.

Height 14 mm., diam. 7 mm.; height of aperture 5 mm., diam. of aperture 3 mm.

Hab. Karakaut Archipelago, Bismarck, New Britain.

Obs. This shell is about the size of *Partula Coxi* Angas. Received from Mr. Kubary through Dr. Möllendorff of Manilla.

Melania rubricata, Nobis. Pl. III, fig. 4.

Shell ovate, very attenuate, decollate. Whorls 11 or more, turreted, flat, spirally striate. Color reddish, lighter below the suture, with darker red flammules in the light part. Aperture ovate, rounded at base, opercle absent.

Height 35 to 55 mm., diam. 6 to 8 mm.

Hab. Vanna Lava Island, Banks Islands, New Hebrides.

Obs. Mr. Rossiter possesses several examples from the locality.

Helicina albescens, Nobis. Pl. III, fig. 5.

Shell orbicular, thin, smooth and translucent, conoid, apex acute, base convex, whorls 5, compressed, rounded, irregularly and obliquely striated by fine lines, which are sparsely crossed by spiral ones, suture distinctly impressed, first 1½ embryonic whorls, irregularly foveate, base roundly convex. Umbilicus covered by a thin, white callus, semicircularly sulcate, columella short, aperture very oblique, semi-orbicular, with a faint reddish border within, lip reflected, pale yellow, finely punctate, narrower where it joins the short columella. Color white, opercle absent.

Height 5½ mm., width 7 mm.; height of aperture 3½ mm., diam. of aperture 2½ mm.

Hab. Segou Island. E. L. Layard, Esq.

Helicina hyalina, Nobis. Pl. III, fig. 6.

Shell globose, orbicular, depressedly conoid, apex obtuse, thin and hyaline. Whorls 4½, compressly rounded and finely striate, suture impressed, convex beneath, with the umbilical region covered by a very thin callus, the base of which is semicircularly sulcate, aperture semi-orbicular, lip slightly reflected. Color light amber, opercle semi-orbicular, very thin, with a thickened rim at the outer margin.

Height 4 mm., diam. 6 mm.; height of aperture 2½ mm., diam. of aperture 2 mm.

Hab. Mount Halcone, Mindoro, Philippine Islands.
B. Schmacker, Esq.

Helicina virido-colare, Nobis. Pl. III, fig. 7.

Shell globose, orbicular, depressly conoid, thin and translucent, apex obtuse, whorls 4½, roundly compressed, with numerous fine oblique striæ, suture impressed, last whorl rounded, base convex, umbilical region with a white callus which is semi-sulcate and thickly foveate, lip simple, not reflected, aperture semi-orbicular. Color canary yellow, lighter beneath the suture, opercle semi-orbicular, thin, corneous, depressed at the center, and of a silvery whiteness.

Height 4½ mm., diam. 5 mm.; height of aperture 2½ mm., diam. of aperture 2 mm.

Hab. Solomon Islands. Dr. Jas. C. Cox, datum (No. 192.)

Helicina Hakodadiensis, Nobis. Pl. III, fig. 8.

Shell solid, orbicular, conoid depressed, apex obtuse, convex beneath and slightly carinate at the periphery. Whorls 4, compressly rounded, coarsely and obliquely striate and crossed by spiral impressed lines, umbilical region covered by a white vitreous callus and semi-sulcate at base, which is coarsely punctate, aperture semi-orbicular, oblique, pale red within, lip white, slightly reflected. Color pale rose, mottled by irregular white blotches, opercle absent.

Height 3 mm., diam. 5½ mm.; height of aperture 2 mm., diam. of aperture 2 mm.

Hab. Hakodadi, Japan. B. Schmacker, Esq., datum.

Helicina Dominicensis, Nobis. Pl. III, fig. 9.

Shell moderately thick, compressly orbicular, apex obtuse, more convex above than beneath, slightly rounded at the periphery, whorls 4, with fine capillary striæ, suture impressed, aperture oblique, semi-orbicular, red within, lip reflected, white, umbilical callus white, vitreous, thickly punctate and semi-sulcate, color reddish.

Height 3 mm., diam. 4 mm.

Hab. Dominique, Marquesas Islands.

Obs. A. Garrett, datum (No. 74.)

Helicina bitaeniata Nobis. Pl. III, fig. 10.

Shell thin, semi-orbicular, translucent, vitreous, smooth, depressly conoid, apex obtuse. Whorls 4½, rounded at the periphery, aperture semi-orbicular, moderately oblique, lip thin, slightly reflected, base with a white vitreous callus which is punctate, pale horn color, with two pale rose colored bands, one above the periphery the other near the base, visible within the aperture, opercle corneous, reddish and thickly foveate.

Height 3½ mm., diam. 6½ mm.; height of aperture 2½ mm., diam. of aperture 2 mm.

Hab. Dominique, Marquesas Islands. A. Garrett, datum (No. 67).

Obs. Readily distinguished from the preceding species, by being larger, more globose and by its thin vitreous appearance.

Helicina Garrettiana, Nobis. Pl. III, fig. 11.

Shell thick, depressly conoid, apex obtuse, base convex and rounded at the periphery, suture strongly impressed, whorls 4, finely striate, aperture sub-ovate, dark red within, lip white, widely reflected, sometimes reddish, partaking of the color of the shell; color a light cardinal red, white beneath the suture, opercle thin, corneous with a cord-like rim at the outer margin.

Height 2½ mm., diam. 3 mm.

Hab. Too-apo Marquesas. A. Garrett, datum (67 bis.)

The animals of the genus Helicina are denizens of dank and hot climates, as the West Indies, tropical America, the Pacific, Australian and Philippine Islands, together with parts of Japan and China. Dr. Pfeiffer, in his Pneumonopomorum Viventium, enumerates about 338 species, to which, since the publication of his work in 1876, about 30 have been added. This genus, so numerous in individual species and so widely extended over regions favorable to molluscan life, seems to require a new classification or a rearrangement of the species which, would facilitate their study and identification. This will require a master hand like that of Dr. Pfeiffer's and a wide acquaintance with the species, to enable one to relegate to their proper positions the numerous and diversified species of this genus. At least four sub-genera could be founded with advantage from the genus Helicina.

Melania Rossiteri, Nobis. Pl. III, fig. 12.

Elongated, conic, cylindrical, regularly tapering, decollate, whorls probably 8 or 9, smooth or with very obscure plicæ beneath the suture, surface with sparse obscure spiral lines, suture well impressed, color a dull olive, aperture oval, dull white, with a deposit on the columella. Columella regularly curved.

Diam. at base 8 mm.

Obs. I possess three examples from E. L. Layard, Esq. who informs me that they were collected at Vate, New Hebrides by Mr. Rossiter. This species is distinguished by its being more uniformly cylindrical and tapering to the apex less rapidly than *M. Arthuri*, *M. Montrouzieri*, *M. Lamberti*, *M. Matheroni*, *M. Marie* or any other species from the N. Hebrides with which I am acquainted.

Trochomorpha pulcherrima Nobis. Pl. III, fig. 13.

Shell dextral, thin and sub-pellucid, lenticular, more convex above than beneath. Whorls six, rounded and finely striate, margin acute, suture impressed, with a fillet beneath, inferior surface more polished and very finely striate, umbilical region depressed, umbilicus small and perforate to the apex, aperture simple, lunate, margin of the last whorl partially occluding the umbilicus.

Height 5, diam. 12 mm.

Hab. Aura Island, N. Hebrides.

E. L. Layard, datum. This is certainly the most beautiful Trochomorph from Aura Island which has yielded three new Trochomorpha and four new Partula.

AN ACCOUNT OF THE VINCELONIAN VOLCANO.

BY BENJAMIN SHARP, M. D.

In no island of the West Indies, and probably nowhere in the world does the student of vulcanology find, in so small a compass, such a field for interesting research as in the island of St. Vincent.

If we take a boat and row from Kingstown, the capital, up the leeward or western coast, we find the slopes of the volcanic hills carved into deep valleys, which are separated from each other by vast lava streams. The ends of these have been cut off by the never-ceasing action of the sea and form perpendicular and often beetling cliffs, from one hundred to one hundred and fifty feet high. On these cliff faces we may read the expression of volcanic action, study the character and extent of the ejections and note the different periods of the eruptions.

At the foot of the cliff, where the sea has gnawed a deep groove, there are large stones varying from the size of one's fist to a foot or more in diameter. These were thrown from the crater first. Above this layer and filtering between the larger boulders, is a stratum of ash or mud which came down with the heavy rains that generally set in soon after the eruption has begun. The mud is now hardened into a compact mass enclosing the small boulders. Resting on the ash layer and often many feet in thickness, is the solidified lava.

On the top of the spur, in the loose soil that covered the lava, grow rank grasses; giant Cerei raise their gaunt candelabral forms, and Florida moss, or as they call it here, "old man's beard," droops from the many crevices.

About a mile from the beach, at the mouth of the Cumberland Valley, is a fine exposure of basalt, Pl. IV, fig. 1. The cliff, formed of basaltic columns, faces the north, and forms the southern wall of the valley, which runs east and west. The columns of basalt vary from two to three feet in diameter and run perpendicularly to the top of the cliff, which is about one hundred and fifty feet high. At its foot runs a small stream, known as the Cumberland river. There is no doubt but that this great lava stream extended across the head of the valley which at this point is a mile and a half wide, but what causes have been active in removing this enormous mass of material, I was unable to determine.

Just before reaching Chateau Belair, a little village, which strongly suggests a Swiss dorf, we pass through a break in a lava stream, which has flowed down the western slope of the island. It is made up wholly of basaltic columns, not so regular nor so large as those of the Cumberland valley, but smaller, more broken and slanting toward the sea at about an angle of 45.°

The Souffriere or volcano of St. Vincent forms the northern side of Wallabou valley, through which a stream of water wanders by great black boulders of lava. The sides of the valley are everywhere clothed with deep green primeval wood; here and there a tree fern spreads its softer green over the dark verdure, the crown of delicate fronds appearing at a distance like light green shields, laid upon the green hill side. Luxuriant vines and long lians or air plants, pour over the face of a perpendicular cliff, from the dark wave of forest that rolls back from its edge. After passing into this valley, the path leads to the north and we begin our ascent, on a ridge of a great lava stream, which leads to the crater, three thousand feet above us. The path on this spur is at times not more than a few feet wide and as we ascend we look on each side into a deep abyss of green. The cool wind from the peaks above, shoots in gusts about us and speeds away down the gorges; ruffling in its course the broad flat leaves of the trumpet tree which cause a spot of frosted silver to gleam on the dark green waste.

Winding past huge forest trees, the path is walled with broad-leaved Balisiers or wild bananas, the moisture dripping from their bright yellow spathes. We are obliged at times to tear our way through masses of pink and white Begonias; the wild tropical expressions of our diminutive hot-house plants.

About two thousand feet above the valley, the path widens into a level spot, shaded by two immense fig-trees; great "beard" hang from their branches, some still swinging in the wind while others have just taken root in the ground, and others still, having been long rooted, one of goodly size and are partially welded to the main trunk. These are called the "Maroon trees" and the spot is the resting ground for travellers going over "the hill" as the Vincelonians call this great mountain.

The path now becomes steeper; the tropical vegetation begins to lose its richness and to give place to more stunted forms; trees are replaced by bushy growth and the woods begin to resemble open northern scrub; mosses and lichens take the place of the huge dripping parasites of the forest below; the bush soon gives way to rough ferns and grasses, and here and there a black charred tree stem, shows us that we are nearing a sulphurous atmosphere. The path is now much steeper and more difficult to ascend as the earth and rock is covered with loose stones and scoria.

At last we come to an artificial cave shaded with ferns and creeping mimosa-like vines. A short distance above this we are on the brink of the crater, about 3700 feet above the level of the sea. Southward, stretching from our feet, is a carpet of bright green, which blends, a few hundred feet below, into the dark green of the forest. Opposite the mountain on which we stand, rises a vast green wall, a mountain 2500 feet high. This mountain slopes on either side to the sea coast of the island and forms the southern boundary of the transinsular valley of the Wallabou. Far below us we can see Chateau Belair, a mere speck on the curve of the blue bay and rolling away to the south, the foot hills melt into the deep Caribbean Sea.

Turning to the north, the crater and its lake open before us, Pl. IV, fig. 2. A blue sheet of water, set in a circular frame five hundred feet deep and a mile in diameter. On the steep sides, where the Souffriere bird whistles his ventriloquial notes, grow tall weeds and rank grasses; whiffs of sulphurous vapor come to us from the surface of the lake and wreaths of cottony mist form and vanish before our eyes.

Passing along the eastern rim of the Old Crater, which gradually rises in elevation, we come to a spot where a view of the New Crater may be obtained. There is no appearance of an ash cone so marked in the Vesuvian volcano; the ash and scoria have been washed away by the torrential rains of the rainy seasons. Along the path leading to the rim, and on the rim itself, boulders of lava and collections of pumice stone may be observed, but loose ash is nowhere to be discovered. Some may have remained but it has disintegrated and formed a soil which now supports rank weeds, scattering bushes and a coarse grass.

The New Crater was formed during the memorable eruption ot 1812, where the eruptive force, instead of relieving itself by the old channel, broke for itself a new one, on the northern slope of the Old Crater. A wall separates these two openings—the northern face of which is a perpendicular rock. Its upper edge is like a knife edge and impossible to travel over; it slopes directly south into the Old Crater, north it drops a sheer 700 feet into the new one, and from its base the land slopes some 300 feet to the bottom of the crater.

The lake in the Old Crater has been found to be about 100 fathoms deep (600 feet) making the depth of the crater about 1100 feet. It would appear to be about the same depth as the new one. Whether there be an outlet, or whether sufficient time has not elapsed since the formation of the New Crater, no water, save a shallow pond some two or three feet in depth, is found here.

As has been stated the Old Crater is an mile in diameter, and judging by the eye it is a perfect circle. The New Crater is about a mile and a half in diameter and quite irregular, a point to the north rising to 4000 feet, which is said to be the highest point on the island of St. Vincent.

The first recorded eruption of the Vincelonian Souffriere was in 1718 and has been described by Moreau de Jonnès. According to him the eruption was preceded by violent earthquakes. Loud subterranean noises were heard in the vicinity of a mountain which, he states, was situated at the eastern end of the island. This outburst must have been the most violent that St. Vincent has ever suffered, for besides the phenomena usually accompanying a volcanic eruption, the whole mountain must have been blown away. This statement of Jonnès is substantiated by the fact that no mountain, or any trace of one, now exists on the eastern side of the island. The Souffriere where the Old and New Craters are found, is situated at the northern extremity of a ridge, running north and south through the middle of the island, and from this ridge, the land slopes east and west to the sea, the windward or eastern slope being more gradual than the leeward or western, which is rugged and precipitous.

The destruction of this eastern mountain of Jonnès, probably accounts for the difference found in the older authorities as to the height of St. Vincent; Scrope (before 1718) gives the height of the island as 4,940 feet, while the present maps give it about 4,000.

There seems to have been a slight eruption at St. Vincent in 1785.

From the beginning of the year 1811 and lasting until 1813 an area of over six million square miles was affected by earthquakes and disturbed by subterranean noises. The enormous pressure that caused these tremblings of the earth was relieved by the eruption at St. Vincent, about the first of May, 1812. This area extended from the Azores in the east to the Mississippi valley in the west, and from the valley of the Ohio in the north almost to the Amazon valley in the south.

On the 30th of January, 1811, near the Azores there rose from the surface of the sea a sub-marine volcano, which by the 15th of June, 1812 had risen 320 feet above the sea level.

About the beginning of the year 1812, the valley of the Mississippi was the seat of frequent earthquakes, which often rapidly succeeded one another, but more feeble and less frequent east of the Alleghenies.

"The shock felt at Caraccas," says Humboldt "in the month of December, 1811 was the only one that preceded the horrible catastrophy of the 26th of March, 1812." The day on which the destruction of the city occurred was a remarkably hot one. "The air was calm and the sky unclouded. It was Holy Thursday and a great part of the population was assembled in the churches. Nothing seemed to presage the calamities of the day. At seven minutes after four in the afternoon, the first shock was felt; it was sufficiently powerful to make the bells of the churches toll; it lasted five or six seconds during which time the ground was in a continual undulating movement, and seemed to heave up like a boiling liquid. The danger was thought to be past, when a tremendous subterraneous noise was heard, and of longer continuance than that heard within the tropics in the time of storms. This noise preceded a perpendicular motion of three or four seconds, followed by an undulatory movement, somewhat longer. The shocks were in different directions from north to south and east to west. Nothing could resist the movement from beneath upward and undulations crossing each other. The town of Caraccas was entirely overthrown. Between nine and ten thousand inhabitants were buried under the ruins of the houses and churches. The churches of La Trinidad and Alta Gracia, which were more than one hundred and fifty feet high and the naves of which were supported by pillars of twelve or fifteen feet in diameter, left a mass of ruins scarcely five or six feet in elevation. The whole of the earthquakes, that is to say the whole of the movement of undulation and rising, which occasioned the horrible catastrophy of the 26th of March, 1812 was estimated at fifty seconds, by others at one minute and twelve seconds."

Seven large towns lying west of Caraccas and extending into the Columbian Republic, were destroyed by the same earthquake, and it was felt at Santa Fe de Bogota, nearly six hundred miles west of Caraccas.

One month and one day (*i. e.*, the 27th of April) after the destruction of Caraccas, the relief of this great pressure began. The great smoking mountain of Guadeloupe lay quiet, the craters of Dominica and Martinique were not affected, nor was there any commotion exhibited in the St. Lucian Souffriere. The eruption was so sudden, so rapid and so powerful that instead of clearing a way for itself in the old crater of St. Vincent, it burst from the northern side of that mountain and formed what is now known as the New Crater.

"A negro boy," so a story goes, "was herding cattle on the mountain side. A stone fell near him; and then another. He fancied that other boys were pelting him from the cliffs above, and began throwing stones in return. But the stones fell thicker; and among them one and then another, too large to have been thrown by human hand. And the poor little fellow woke up to the fact that not a boy, but the mountain, was throwing stones at him, and that the column of black cloud which was rising from the crater above was not harmless vapor, but dust and ash and stone."[1]

For three days and three nights the eruption continued increasing in energy, until the island was enveloped in Stygian darkness by the falling ashes. On the 30th, the lava came and, welling from the crater, rolled to the sea, which it reached in four hours.

The ash and scoria accumulated in such quantities in one of the eastern valleys, that the Rabaca river ceased to flow, and its bed, where water is now seen only in the wet season, is known as the "Dry River." Water constantly flows to the sea over the old course of the river but it is hidden by the great quantity of scoria lying in the old bed, and only after very heavy rains does it rise above this porous material.

The mass of material thrown out from this single vent relieved an area of the earth's crust nearly as large as that of Europe.

During the eruption of the Vincelonian volcano, subterranean noises were heard at Caraccas, a distance equal to that which lies between Boston and Washington. Not only were the inhabitants of Caraccas terrified by the noises, but also those who were in the midst of the llanos which cover a space of over 36,000 square miles. No shock seemed to accompany these noises and at Caraccas and Cala-

[1] Kingsley's At Last.

bazoo the inhabitants supposed an enemy to be advancing with heavy artillery and they prepared to put their cities in defence.

One of the harmless effects of this terrible explosion was noticed in Barbados, which island lies ninety-five miles to the windward of St. Vincent. The day following the eruption (May 1st), a sound resembling heavy cannonading was heard to the eastward: the inhabitants of course supposed the English and French fleets to be engaged in battle; at sunset the cannonading died away. The next morning the sun did not appear to rise; the island was enveloped in darkness, which increased as time advanced. The negroes imagined that the Day of Judgment had come and rushed in a panic to the churches. Nor were the whites any wiser, they too were seized by the panic started by the blacks and rushed with them to their places of worship.

A heavy, quiet rain of impalpable powder fell over the island: the trade wind blew not, the roar of the surf had died away: the dead quiet was only broken by the fall of some tree, crushed to the earth by the weight of the amassing dust.

Sir Joseph Banks awoke that morning and found everything shrouded in darkness; he went to the window to open it, but could not; he felt the ash that had sifted in upon the sill, and said: "The volcano of St. Vincent has broken out at last and this is the dust of it."

Explanation of Plate IV.

Fig. 1. View of basaltic columns of Cumberland Valley, St. Vincent, B. W. I.

Fig. 2. View of the Vincelonian crater looking north-west.

NEW AND LITTLE KNOWN AMERICAN MOLLUSKS, NO. 3.

BY H. A. PILSBRY.

In this third contribution toward a fuller knowledge of the mollusk inhabitants of our American streams and woods, the more notable paragraphs are those describing a new and exceptionally large *Vaginulus* from Bermuda, and the portion relating to the western helicoid, *Polygyrella Harfordiana*.

Bulimulus Ragsdalei, Pilsbry. (Pl. V, fig. 3).

This species was briefly described in the Proceedings for 1890, page 63; notes on the circumstances of its finding are given in the Nautilus for March, 1890, page 122. The specimen figured is rather wider than most of those before me. Measurements of three specimens are as follows:

Alt. 20, diam. 11 mm.; alt. of aperture 10 mm.

Alt. 21, diam. 11 mm.; alt. of aperture 10 mm.

Alt. 16½, diam. 8 mm.; alt. of aperture 8 mm.

Thus far, the species is known only from Cook and Montague Counties, Northern Texas. Collected by Mr. G. H. Ragsdale, of Gainesville, Texas.

Pupa syngenes, Pilsbry. (Pl. V, figs. 1, 2).

Shell sinistral, cylindrical but somewhat wider above, blunt at each end; light brown, whitish toward the apex; surface shining, delicately obliquely striate; apex large, obtuse; suture impressed; whorls 8, the last one compressed and flattened around the lower-outer portion, its last third ascending on the next earlier whorl, and elevated into a high rounded ridge or crest a short distance behind the outer lip; aperture slightly oblique, truncate-oval in form; the outer lip narrowly expanded, basal and columellar margins broader; about the middle of the parietal wall, or nearest the upper end, there is a small parietal lamella; far within there may be seen a blunt columellar lamella; and some specimens exhibit far within the outer lip the trace of an inferior or lower palatal fold.

Alt. 3½, diam. 1⅓ mm.

Habitat, Arizona; exact locality of the specimens before me not known.

I had at first considered this form as a variety of *P. muscorum*. It differs from that species in its sinistral convolution, in being broader above the middle, having more numerous whorls, the last one more ascending on the penultimate; the ridge back of the outer lip is much stronger than in *muscorum*, and the lip itself less broadly expanded. The same characters will separate the species from *P. muscorum* var. *Blandi*.

Zonites Shimekii, Pilsbry. (Pl. V, figs. 9, 10, 11).

A shell of about the size and shape of *Z. nitidus*; moderately umbilicated; chalky-white, without epidermis, on account of its fossil condition. Surface sculptured with strong curved riblets above, rather finely striated beneath. Spire low-conoidal; apex obtuse; first (or nuclear) whorl planorboid but noticeably projecting, a trifle mammillated, snowy-white, smooth and polished. Whorls 4½, the outer three ribbed-striate. Aperture oblique, nearly circular, the ends of the peristome approaching.

Alt. 4, greater diam. 5⅞, lesser 5¼ mm.; width of umbilicus 1¼ mm.

Habitat, Loess formation (Quaternary) of Iowa, at Iowa City, Ia.

This species has been familiar to me for some years, under the name of *Zonites limatulus*. It agrees with that form in the number of whorls and sculpture, except that the *Shimekii* is more strongly, regularly ribbed above. It differs from *limatulus* in being far more robust, more elevated, with rounder mouth and narrower, deeper umbilicus. Upon comparing specimens of the two species, I am surprised that they were ever confused; for, except in sculpture, the *Z. Shimekii* is far more like *Z. nitidus* than to *Z. limatulus*. The specimens described and figured were collected by Prof. B. Shimek, now of Lincoln, Nebraska.

This form is interesting as being the only well-defined species of Loess fossil which seems to have become extinct; although there are a number of others, such as *Helicina occulta* and *Patula strigosa* var., which survive in greatly reduced numbers in a few limited localities, or only in a distant part of the country.

Vaginulus Schivelyæ, Pilsbry. Pl. V, figs. 6, 7, 8.

Description of alcoholic specimens:

Light yellowish-gray above with two ill-defined longitudinal dark bands formed by the aggregation of black flecks and dots on either side of a dorsal light line. There are dark flecks scattered sparsely over the rest of the surface; and the middle area of the back is more or less smoke-colored; the lateral margins are grayish.

The underside is of a clear yellowish-gray tint. Upper tentacles blue-gray, lower yellowish-gray.

Body long, broadest in the middle, a little narrower in front, quite convex above, almost flat beneath except for the projecting sole. Surface above seen under a lens to be densely minutely punctate; coarsely more or less wrinkled toward the side-margins, and obscurely rather coarsely pitted. Sole rounded behind, its edges scalloped. Lung orifice somewhat lateral.

Measurements.

	Specimen No. 60,964.	Another specimen.
Total length	65 mm.	68 mm.
Length of the sole	61 "	63 "
Total breadth in the middle	18 "	16 "
Altitude in the middle	9 "	10 "
Breadth of mantle beneath:		
on right side of sole	7 "	5 "
on left side of sole	5 "	4 "
Breadth of sole in front	3 "	4 "
Breadth of sole in the middle	6½ "	7 "
Breadth of sole behind	5 "	4 "
Distance of genital opening:		
from front end	35½ "	37½ "
from tail end	28 "	30½ "
from the sole	1½ "	1 "
from the edge of mantle	4½ "	3½ "

Of this slug two specimens are before me: one (the type) in the collection of the Academy, the other belonging to Miss Mary A. Schively. They were collected in the Public Garden at St. George, Bermuda, in July, 1888. The more prominent external characters are the large size, dark, mottled coloration, and rather unusual nearness of the genital opening to the sole. One of the specimens is but slightly curved, the other is decidedly curved toward the ventral side; both are nearly flat below.

There may be some doubt entertained as to the origin of *Vaginulus* in Bermuda. The lists of Bland and others show the snail-fauna of the island to consist of three elements, viz.: indigenous or peculiar forms,[1] forms introduced by natural means from the West

[1] This includes only the genus *Pœcilozonites* with four species and a number of varieties. See Pilsbry, in Proc. Acad, Nat. Sci. Phila. 1888, p. 285.

Indies,[1] and species imported by the agency of man from the United States and Europe.[2] In none of the countries named is there, however, a species of *Vaginulus* so large, or similar in characters to the one described; nor have I been able to find any description at all agreeing with the specimens, although I have examined the literature for the *Vaginulus* species of all countries.[3]

Helix (Polygyrella) Harfordiana Cooper. Pl. V, figs. 12, 13, 14.

Dædalochila Harfordiana Cooper, Amer. Journ. of Conch., vol. V, pt. 4, p. 196, plate 17, fig. 8. See also *tom. cit.*, p. 214.

Helix (Dædalochila) Harfordiana Coop., Tryon, Manual of Conchology, 2d Series, vol. III, p. 130, pl. 27, figs. 55–57.

Polygyra Harfordiana Coop., W. G. Binney, Manual of N. A. Land Shells, p. 114, fig. 81, *but not the description!*

Not *Triodopsis Harfordiana Cp.*, W. G. Binney, Terr. Moll. U. S. etc., V, p. 309, fig. 203, 1878.

This shell has been so much misunderstood and so incorrectly figured that I feel impelled to refigure it and to offer a few suggestions concerning the systematic position of the species. It was discovered in the year 1869 by Mr. W. G. W. Harford in the "Big Tree" district, Fresno County, California. The locality is an elevated one, lying 6500 ft. above the sea level, in lat. 37°.

In thus devoting space to the consideration of this question of systematic position, I do not wish to be understood to attach any great importance to those divisions of our Helices which some authors call *sections*, some *subgenera*, and still others designate as full fledged *genera*. I am fully aware that many of these divisions coalesce; we can no more trace the separating line between their species than we can unmix mingled milk and water. Thus, the species *Texasiana*, *triodontoides* and *Levettei* bridge the space between *Polygyra* and *Triodopsis*; *Mullani*, *appressa* etc., form passages from *Triodopsis* to *Mesodon*: and through *germana* with its allies on either side, *Mesodon* flows into *Stenotrema*. The recognition of the fact that these sections are all varying manifestations of one type, and

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[1] Such as *Polygyra*, *Helicina*, *Succinea*, *Pupa*, the same species of which also inhabit various West Indian Islands.

[2] *Helix ventrosa*, *Stenogyra decollata* from Europe; *Helix appressa* from the United States; the last is not abundant in Bermuda and the colony may not be a permanent one.

[3] The principal works are Fisher's Monograph of the genus in Nouv. Arch. du Mus., VII, 1871, Heynemann's valuable articles in Jahrbücher Deutsch. Malak. Ges. XII, 1885, and Semper's beautiful work on the Philippine Island fauna.

that a native American one, lead me to associate them under the oldest name, *Polygyra*, in my check-list of our land shells.[1]

So much for the one side. And on this side there is full as much danger in holding extreme views, as on the side of excessive analysis. Let us not profess sweeping views on coalescence of minor groups until we have the species which actually show transition; and (to pass from generalizations to a special case), it may be noted here that while the species of the *Polygyra* + *Triodopsis* + *Mesodon* + *Stenotrema* group, invariably have a reflected lip, the two species belonging (as I claim) to *Polygyrella* have a blunt lip, not in the least expanded or reflexed. I prefer to keep very different things apart.

Dr. Cooper's original description is excellent, but the figures are bad. The latter are copied by Tryon in the Manual of Conchology. Binney describes a wholly different shell in his two publications—a shell which has, he states, an expanded lip. In his Manual of American Land Shells the species is said by him to have four whorls and is placed in *Polygyra*. Still later (3rd Supplement to Terr. Moll. V.) Mr. Binney seems to entertain a suspicion that the *Triodopsis Roperi* Pils. (which he strangely enough places in *Polygyra!*) is the same species. The mistakes and inconsistencies of this record would be indeed perplexing were it not for the fact that Mr. Binney has never seen the *H. Harfordiana*. A single examination would doubtless have convinced him that it is, as Dr. Cooper states in his original description, most intimately allied to *Polygyrella polygyrella*. Figure 81 of the Manual of American Land Shells is incorrect in showing the parietal tooth too far within the aperture. The original figures have the same defect.

With *Polygyrella polygyrella* this species agrees in general form, color, sculpture and texture, as well as in the form of the aperture and the *blunt, not at all expanded* lip. In texture and character of the lip both species are very different from *Polygyra* and *Triodopsis;* the species of these last two sections have the lip expanded and reflexed.

The section *Polygyrella* may be defined thus:

Shell disk-shaped, the spire nearly flat, periphery rounded, even in the young; umbilicus wide within, showing all the whorls. Texture somewhat vitreous and subtranslucent; ribbed-striate above, polished beneath; color yellow, yellowish-green or light brown. Whorls six to eight, narrow, slowly widening, the last a trifle descend-

[1] Proc. Acad. N. S. Phila. 1889, p. 193.

ing in front. Aperture subtriangular, oblique; peristome blunt, not expanded, thickened within, with or without lip teeth; parietal wall bearing a stout, triangular, erect entering tooth.

The species may stand as follows.

(1.) Peristome with two lip-teeth; no denticles inside the body-whorl. *H. Harfordiana.*

(2.) No lip-teeth; body-whorl with several internal pairs of denticles visible through the base. *H. polygyrella.*

Dr. Cooper's ingenious supposition that the internal denticles of *H. polygyrella* are "swallowed" lip teeth I find to be erroneous, as they are formed quite a distance within the whorl, not at the edge of the advancing lip.

H. Harfordiana has been found only at the spot named above, and only two specimens are known: that figured on the plate accompanying this paper, and one other, a young shell, in the collection of Dr. Cooper.

Goniobasis Crandalli. (Pl. V, figs. 4, 5).

Shell turreted, moderately tapering, truncated, with three and one-half whorls remaining. These are very convex, separated by deep sutures, and are more or less malleated (encircled by flattened facets). The texture is exceptionally thin for a Melanian. Color a very pleasing shade of olive-green, either unicolored or having two chestnut bands, a narrow one above the periphery and a wider on the base. The young are much more conical, more rapidly tapering than the adults, with an acuminate spire, and when quite young the body-whorl is seen to be angulated at the circumference. The aperture is ovate, less than half but exceeding a third the length of the whole shell; the lip is a trifle sinuous. The umbilical region is somewhat indented, and the inner lip is folded over upon it, very much as in *Limnæa.*

Alt. 12½, diam. 6 mm.; alt. of aperture 5 mm., breadth 3½ to 3¾ mm.

Habitat, Mammoth Spring, Arkansas.

A large number of shells have been examined by me, and comparisons made with all of the lengthened *Goniobases.* The only form really near in appearance is the western *G. nigrina,* which has similar round whorls. Of the species occupying the same geographic section, Professor Call's *G. Ozarkensis* is perhaps nearest; but no one could confuse specimens of the two, both young and adult shells having a completely diverse facies. Of the latter species I have seen very many specimens; and through the courtesy of my friends Messrs O. A. Crandall and F. A. Sampson of Sedalia, Missouri, I have been enabled to study and compare a large number of other Trans-Mississippi Strepomatids.

THE CORALS AND CORAL REEFS OF THE WESTERN WATERS OF THE GULF OF MEXICO.

BY PROFESSOR ANGELO HEILPRIN.

One of the peculiarities of Vera Cruz which almost first arrest the eye of the traveler is the vast quantity of coral that has been used in construction. The pier-fronts, the sea-wall, and the more ancient houses show equally the use that has been made of this material, the *piedra de mucar* of the inhabitants. Alexander von Humboldt, in his Essai Politique sur la Nouvelle Espagne, speaks of this *piedra de mucar*, and others after him refer to the same material. The species of coral contained in the rock are mainly *Orbicella cavernosa* (?), *O. annularis*, *Diploria cerebriformis* and *Maeandrina strigosa*, and since these species all inhabit the waters of the warm Atlantic, in and out of the Gulf region, it would seem but natural to assume that the Vera Cruz rock was obtained somewhere in the vicinity of the city. On entering the port on a calm day the growing coral-masses can be distinctly seen from the bow of the vessel, and all around are a number of islets and banks which closer inspection shows to be made up almost entirely of living and dead coral. The larger vessels anchor in the deeper waters that separate the growing banks, while the smaller craft drop their anchors directly on the heads of living coral. The small boat which lands passengers from the steamers carries the traveler directly over a line of reef, whose contours, barely removed more than a pole's length from the eye of the observer, appear sharply defined through the perfectly clear and transparent waters.

In view of the peculiar conditions which surround these reefs, it is difficult to understand how it has come to be the general belief among scientists that coral-reefs are not found in the western waters of the Gulf of Mexico, a belief that has held its own for a period of nearly half a century, or ever since Darwin published his classical work on the "Structure and Distribution of Coral Reefs" (1842). Thus, neither in the first edition of this work nor in the last (1889, edited by Prof. Bonney) is mention made of the occurrence of such reefs, nor do they appear on the map of distribution which accompanies the work. Prof. Dana, writing in 1890 ("Corals and Coral Islands," 3d edition), says: "But the west shores of the Gulf of

Mexico, as well as the northern, like West Florida, are mostly low. and without reefs; they are within the influence of the Mississippi and other large rivers" (p. 352). Can it be assumed that all travelers to the region have so far feared a visitation of the yellow fever as to force them to speed their journey in such a way as not to permit an examination of the ground that was about them? Or has this fear kept scientists away generally? I must admit that the ten days of June which I, in company with my associate, Mr. Frank C. Baker, spent in exploring the reefs and sands of Vera Cruz were all that could have been desired, and neither of us experienced any ill effects from out-door labor. When we were not on the water we were on the hot sands, but the highest registry of the thermometer was only 92° F., and after 10 o'clock in the morning the in-draught of cool air from the sea was such as to render travel and work not only tolerable but pleasant.

The species of coral collected by us are the following:

Madrepora prolifera, Lam.

A very abundantly represented species, rising to within about six feet, or less, of the surface of the water. It corresponds in all essentials of structure with specimens of the same species from the Dry Tortugas and from the Florida Reefs generally.

Madrepora palmata, Lam.

This magnificent species occurs in association with the above, forming heads from five to ten feet, or more, in expanse. It covers large areas in the shallower reef-waters, where its rich brown and yellow colors are seen to great advantage. Many of the older specimens show the palmations in distinct tiers or series, and not merely on a single plane; the crateriform protuberances, largely covering annelid tubes, are very abundant, and give to the corallum a singularly striking and robust appearance.

I feel doubtful if the palmate form of the corallum, as seen in *M. palmata*, *M. flabellum* and *M. alces* (East Indies), is in itself a character sufficient to distinguish the species from those forms, agreeing with the palmate types in other respects, in which the corallum is strictly digitate. My associate, Mr. J. E. Ives, has called my attention to the tendency in the direction of digitation which many individuals of the palmate species exhibit. This is carried so far in some of the specimens contained in the collections of the Academy of Natural Sciences that it becomes difficult, if not really impossible, to class the individuals. The tendency toward digitation shows itself more particularly on the plane of the frond, and is but rarely marginal.

It seems to me likely that certain special conditions of the environment are directly instrumental in bringing about some of those modifications in outline which have been held to be of specific value; but if such is the case, I was unable in the present instance to determine any governing cause. In the Bermudas I thought that the crowding of the calyces on one side of the stem of *Oculina* was due to the action of local currents, or to one-sided deposit of shore-sediment; and I believe that a similar observation, or one much in harmony with it, has been made in the case of certain digitate species of madrepore.

Porites furcata, Lam.

A number of individuals of this species were found washed up on the shingle banks of the Isla Verde and of Sacrificios Island. The frequency of fragments shows that the species must be abundant, but we failed to find the exact locality of its occurrence. Not unlikely it is in the waters of Anegada Reef.

Porites astræoides, Lesueur.

Abundant among the more massive corals of the inner waters.

Siderastræa galaxea, Ellis and Solander.

Several specimens obtained in the inner waters; also washed up on the beach of the Isla Verde.

Orbicella annularis, Lam.

I identify with this form several rolled or worn fragments, whose partially obliterated characters do not, perhaps, allow of absolute specific determination. This is one of the common forms in the Vera Cruz walls.

I suspect that several of the generally recognized species of *Orbicella* are only varietal types, but the material at my command does not permit me to determine this point with positiveness. The specific characters are drawn in very close limits, and I doubt if they can be made applicable to a large series of individuals of any one group. We dredged undoubted specimens of the *Orbicella annularis* —at least of the form figured as such by Pourtalès in his report on the Florida corals—off the coast of Yucatan, near Progreso, in about 20 feet of water. The cœnenchyma is of a brilliant vermilion color. Neither Dana nor Milne-Edwards mentions the color of the animal, and it is singular that the latter author states that the habitat of the species is unknown.[1]

Orbicella sp.?

A well-preserved, washed fragment of a subglobose form, whose characters do not seem to fit in with those of any described species. In general appearance it at once recalls *O. annularis*, and not impossibly it may be a variety of that species; but the septa of the corallum are compound, divaricating or trivaricating, and appear in transverse section 24 in number. They are much finer than in typical *O. annularis*, as are also the irregular and multiple cells in the intercalicular wall.

Found on the beach of the Isla Verde.

? Orbicella cavernosa, Esper.

Several fragments from Sacrificios Island and elsewhere which I doubtfully refer to this species. The intercalicular spaces are largely cellular, with the form in part of the letter V, and the species thus approaches *O. radiata*, Ellis and Solander. From the latter it is, however, distinguished by the smaller size of the calyces, and by the more compact corallum. In certain respects, again, the species approaches *O. glaucopis*, of Dana, from the Fiji Islands.[2]

This species of coral is largely represented in the wall-structures of Vera Cruz, but a second related species, possibly *O. radiata*, occurs associated with it. We failed to obtain any living *Orbicellæ* in the Vera Cruz waters, and the species are probably most abundant on the outer border of the reef-sea.

Mæandrina strigosa, Dana.

This is one of the two common forms of brain-coral which enter into the construction of the reefs. It forms large orbicular or elliptical heads, four or five feet, or more, in diameter, and shows to great advantage in the shallower waters through its brilliant orange coloring. The basal attachment is often limited in area, and "rotten" besides, so that a strong jerk will frequently dislodge the head from its moorings. In this manner we obtained a number of large specimens, the divers using principally their hands alone in forcing.

[1] Histoire Naturelle des Coralliaires, II, p. 474 (Heliastræa.)

[2] The Mexican form agrees absolutely with a coral from the Post-Pliocene deposits of Santo Domingo, contained in the collections of the Academy, and which has been determined by Pourtalès to be *O. cavernosa*. But in this form, as in its more western representative, the intercaliculars spaces are largely cellular.

This is the only *Mæandrina* that was found in these waters, and I searched in vain among our specimens for *M. labyrinthica*—at least, for that form which Dana identifies with Ellis's description and figure. I have little doubt that Ellis himself included in his species the form which is now referred to *M. strigosa*, but there certainly appears to be a well-marked difference between the two species. The upright and very thin calicular walls, and the closely packed septa (45–50 to the inch), plainly identify the Vera Cruz species with Dana's *M. strigosa*. I found both species in the Bermudian waters.

Diploria cerebriformis, Lam.

This species is found in close association with the last, which in general habit and in coloring it also resembles. Both species are very numerously represented in all stages of development, and they build up a perfect pavement of coral—a pavement of giant cobble-stones, as it were. Their weathered masses are seen everywhere in the old stone constructions of Vera Cruz, where they constitute the true *piedra de mucar*.

Both species of brain-coral rise to within a very short distance of the surface, and we nowhere found them to descend below about 25 feet: usually they keep within a zone of some 5—15 feet. They occur closely packed, and where largely developed, in a way monopolize a given area, to the exclusion of the upright *Madreporaria*.

Oculina sp.?

I obtained a fragment of a species of this genus, but unfortunately it was misplaced before I had a chance to determine its specific characters.

Cladocora (**Caryophyllia**) **flexuosa**, Lamarck, Anim. Sans. Vert., 2d. Ed., II, p. 352. Ellis and Solander. "Zoophytes," pl. 32, fig. 1. (no description). Lamouroux. Expos. Méthod. Polypiers p. 49, pl. 32, fig. 1.

I identify with this species a form that is found in bunched masses on the bases of some of the Mæandrinas and gorgonians, and agrees well with the figures of Ellis and Solander, and with the descriptions furnished by the authorities above quoted and by Dana ("Zoophytes," p, 381). Lamarck doubtfully refers the species to the Indian Ocean, but Dana, more correctly, believes it to be West Indian. Verrill, in his synonymic list of species described by Dana, appended to the latter's "Corals and Coral Islands," doubtfully identifies the form in question with *Cladocora stellaria*, of Edwards and Haime (*Annales des Sciences Naturelles* Ser. 3, Zoology, XI, p.

307—X, pl. 7. figs. 9, 9a). This identification is, I believe, erroneous. *Cladocora stellaria* is a Mediterranean species, and is distinguished by a shallow cup; in the form from the Mexican Gulf the cup is deep, almost profound. The species is likewise distinct from that figured as *Cladocora arbuscula* in Agassiz's report on the Florida Reefs.

Plexaura (Gorgonia) flexuosa. Lamour. *Gorgonia anguiculus*, Dana (U. S. Exploring Expedition, Zoophytes, p. 668.)

This is the only species of gorgonian that we obtained in the Vera Cruz waters, but I have little doubt that others are present. We observed, however, none of those large Gorgonia fields which so beautify the waters of the Bermudas and excite the wonder of the visitor to those islands.

We obtained from the shallows about Progreso, northern shore of Yucatan, the *Xiphigorgia anceps* of Pallas (Elenchus Zoophytorum, p. 183). The species is fairly common there. I feel confident that the *Xiphigorgia Guadalupensis* of Duchassaing and Michelotti (Mémoire sur les Coralliaires des Antilles, Mem. Accad. Torino, 2d ser., XIX p. 309, pl. IV, fig. 3) is only this species, and likely the same is true of *X. Americana* of these authors (*Op. cit.*, XXIII (2d ser.) p. 113, pl. II, fig. 6). These investigators, while furnishing good illustrations of their material, have been singularly unfortunate in their determinations and descriptions of species.

The Reefs.

The reefs of the Vera Cruz waters consist of a number of detached islands or island banks, from less than half a mile to a mile and a half in length, which extend eastward from the coast line for a distance of nearly six miles. They are known as the Gallega (on which is built the famous Castle of San Juan de Ulúa) Galleguilla, Blanquilla, Anegada de Adentro, Isla Verde, Islote de Pajaros and Sacrificios. Of these, the Gallega, which is separated medially by a channel of water of moderate depth, is the largest, measuring in a north-and-south direction, considerably over a mile. Two other banks of very much smaller dimensions are the Lavandera, lying to the southeast of Gallega, and Terranova, between Sacrificios Island and the Islote de Pajaros. The outer boundaries of these reefs enclose a triangular body of water whose base is the coast line and whose apex is the Anegada de Adentro.

A second series of reefs begins about eight miles to the southeast, or opposite the promontory of Anton Lizardo, and likewise extends triangularly out to sea. The islets of this series (Arrecife de Chopos, Medio, Cabeza, Anegada de Afuera, etc.) are considerably larger than those of the first, the Chopos reef measuring nearly three miles in length (N. W.—S. E.) Owing to the limited time at our command, we were unable to visit these lower reefs, and from personal observation, therefore, I am unable to say in how far they are purely of coral structure. But from the statements of those who are acquainted with the waters, I gather that they are largely identical in formation with the islets lying off Vera Cruz, and their general position and direction lead me to infer that they have a common origin. On the hydrographic charts all the dangerous banks are marked as reefs, but this should not be taken to necessarily mean "coral reefs." Thus, the reefs off Punta Gorda, lying 3–4 miles to the northwest of Vera Cruz, I found to be serpuloid and not coral, and the same is true, in great measure, of the Hornos reef, which lies about a mile to the southeast of the city. It should also be stated that the "coral sand" of hydrographic charts is not necessarily a sand of triturated coral, but may be of other limestone formation.

An examination of the accompanying maps (Pl's. VI and VII) shows that the main axis of nearly all the islands is directed in a N. W. —S. E. line, or in a direction parallel with the coast, a condition doubtless due to the interaction of prevalent winds and local currents, the latter of which shape the position of the detrital material. This is well shown by the heaps of shingle, coral-fragments, shells, etc., which have accumulated on the southeastern faces of some of the banks—the general lee-side of both wind and current—either as the result of long-continued action or of a single storm. Such deposits are especially well developed on Blanquilla and the Isla Verde; the island portion of the Sacrificios reef is likewise situated in the southeastern half of the circle of coral by which it is surrounded. Much the same contours that we see in the banks to-day already existed a century ago, as may be learned from the magnificent chart prepared by Ponzoni, in 1807, for the use of the Spanish Hydrographic Service.[1] This shows that the dry mass of Blanquilla already then

[1] This extremely rare map of the harbor of Vera Cruz, of which, I am informed, only two copies exist to-day in the whole of Mexico, was published in 1816. It is by far the most detailed of all the maps illustrating this portion of the Gulf waters, and it is especially interesting in connection with the study of coral reefs, as it carries back the authentic history approximately one hundred years. For the use of this map, and the permission to make a copy of it, I am indebted to Captain Powell, of Vera Cruz, Chief of Construction of Docks of the Mexican Railway. To the same gentleman, and to Messrs. Hall and Santiago Shirley, representing also the Mexican Railway, I am further indebted for many facilities offered for the exploration of the reefs and the accomplishment of our mission generally.

existed, but an additional structure, in the form of a stone wall much resembling a piece of masonry, has been superadded as the result of a single heavy storm, the hurricane of Sep. 8, 1888.

All of the reefs receive a breaking water, caused by the up-throw of disjointed boulders, and the heavier break is on the lee or shore-side, where the rock-masses have accumulated in greatest abundance. The long rolling surf, occurring in scattered patches over the blue waters, is a beautiful sight of the harbor. The more or less regularly oval shape of the reefs recalls the atoll-form, and a hasty examination of the region might lead to the assumption that the islets are true atolls. But this is not the case. It is true that a circular or elliptical form distinguishes some of the reefs, and that in others a patch of dry land is found surrounded by a more or less continuous ring of coral and a separating channel of water; but the conditions as they are presented are not those of true atolls. The form is that of almost any bank that rises either out of the water or close to its surface—the tendency of water-action being to round off the obstructions that may interpose themselves—and the included water is only a shallow pan, and not the distinctive lagoon of an atoll. The depth of water over the reefs generally is inconsiderable, from one and a half to perhaps six or seven feet, and some of the reefs are almost laid dry in low-water. This was the condition of the Gallega Reef when we finally left the harbor of Vera Cruz. The actual "ring" of the reefs, where it exists at all, is thus necessarily insignificant, and it is largely due to the mechanical action of water; in some parts it may arise from accelerated organic growth, but on this point I could not satisfy my mind. Be this as it may, the lagoon is certainly neither a lagoon of solution nor one of subsidence.

In the case of some of the reefs, as Gallega and Galleguilla—indeed, I am not sure if this is not true of most of the reefs—the greatest development of coral growth seems to be on the lee- or shore-side, or opposite to that which is generally supposed to receive the greatest supply of organic particles. The brain-corals and madrepores are there developed in immense profusion, although barren areas of sand here and there project themselves into the living mass. The scarcity of animal life on these sand tongues or patches is very remarkable; for long reaches we saw absolutely nothing in the shape of animal existence, while at other points there may have been a few shells (*Triton*, *Murex*) thinly scattered about. We did not see a single starfish, nor were we more successful in our search after holothurians; the latter animals are especially conspicuous on the corresponding sands of the Bermuda Reefs. Far otherwise was it among the growing heads of coral, although even here the luxuriance of the Bermudas was wanting. The *Diadema setosa* among sea-urchins was very plentiful, and we observed a number of large annelids, besides mollusks of various kinds. But the bristling forest of millepores and sea-fans (gorgonians) was wanting, and with them the host of brilliantly colored forms which live in association.

The water separating the reef-patches is of moderate depth, but at many points it descends below the 20–fathom line, or beyond what is generally considered to mark the zone of living-reef structures. Thus, for most of the distance between the Isla Verde and Blanquilla (a little more than a mile and a half) the depth exceeds 100 feet, and at several places it varies from 120 to 130 feet; and much the same depth is found between Blanquilla and Galleguilla (one mile) and between the Isla Verde and the Islote de Pajaros (somewhat over a mile). We frequently sounded in these greater depths, and nowhere obtained positive indications of a coral growth; the greased lead invariably brought up sand particles, but no impressions of either dead or living corals. I could not say positively, however, that living corals may not be found in these deeper parts, as our "grease" was perhaps a little too soft to retain distinct impressions; but it is certain that wherever our sight penetrated the perfectly crystal waters to a depth exceeding 30–35 feet it fell on barren sand; and I am not sure that we anywhere could see living coral even at this depth. Usually the barren sands bounded the reef-zone at a depth lying between 15 and 25 feet.

The oceanic slope of the reefs is in most part a very moderate one, but there are places where it is as much as 1 in 5 or even 1 in 4 (12–14 degrees). Of course, this is small in comparison with that which is found in the case of many true atolls. Off the western point of the Islote de Pajaros we obtained 75 feet at a distance of little more than 200 feet from the breaking crest. As regards the permanence in depth of the water-ways between the reefs it may be said that many of our soundings corresponded absolutely with the soundings registered in the Ponzoni map of 1807 (1816). This correspondence was especially noticeable in the water-ways between the Islote de Pajaros and the Isla Verde and between the latter and

Blanquilla. On the other hand, immediately west of the Islote de Pajaros, and at various points southeast and south of Gallega, there seems to have been a considerable amount of shoaling, some places to the extent of 8 or 10 feet, or more, but in most parts I suspect that this shoaling is due almost wholly to the displacement of shifting sands, and not to coral encroachment. Apart from the testimony of the depth of water which is still found over these shallows, this condition seems to be largely indicated by the circumstance that at a few points a greater depth was found than appears on the map, probably the result of uncovering. It is not improbable that at a few places south of the Gallega Reef, or between the reef and the mainland, the shallowing that we observed is actually due to coral up-growth; at any rate, the discrepancy in the depths is here very marked, as much as 12–15 feet (depth of water 21–27 feet), and the waters cover a rich growth of brain-coral (*Mæandrina, Diploria*). It is hardly possible that a layer of corals approaching so closely to the surface should have completely escaped the early hydrographers, or that these investigators could have been in error in their determinations of the then existing depths. But then if neither proposition is tenable, and we are compelled to fall back upon the assumption of simple coral up-growth—which to me appears every way plausible—we must assume a rate of growth much more rapid than has until recently been allowed these lowly organisms. A number of instances are, however, on record where individual specimens of *Mæandrina* are known to have increased in height from a half-inch to an inch per annum, and of *Madrepora* where the increase for the same period has been three inches.[1] An average growth of an inch and a half per year would add in a period of ninety years eleven feet.

The reefs which have been described in the preceding pages manifestly belong to that group which Darwin recognized as being

[1] Dana "Corals and Coral Islands," 2d ed., 1890, pp. 123–127 (quoting Pourtalès, Hunt, Verrill, etc.). On the other hand, the observations of Mr. H. T. Woodman (communicated to Prof. Dana under date of Jan. 25th, 1890—*Op. cit.*, appendix, pp. 418–419), conducted over a period of fourteen years, would seem to indicate a very much slower growth. During the above-mentioned period the following upward growths (among others) were registered: *Orbicella annularis*, one and a quarter inches; *Diploria cerebriformis*, nearly three-fourths of an inch; *Mæandrina sinuosa*, an inch and a quarter; and *Mæandrina labyrinthica*, an inch and seven-eighths. Specimens of *Madrepora cervicornis*, however, seem to have encroached upon the channel under observation to an extent of 6–8 or even 10 feet.

built upon shoals or beds of sediment "lying a little beneath the surface, ready to serve as the basis for the attachment of coral" ("Structure and Distribution of Coral Reefs," 1842, p. 58), a class of structures which the opponents of the subsidence theory of reef-formations fail to recognize as being in consonance with the Darwinian hypothesis. They are, according to a strict classification, neither encircling, barrier, nor fringing reefs, and as a fourth class might, perhaps, with advantage be grouped as "*patch*" reefs. They belong to the same category as the Florida reefs and banks, whose formation has been largely appealed to as evidence against the Darwinian hypothesis of subsidence. But neither the Florida reefs nor the reefs of Vera Cruz give any evidence either in favor of or against great subsidence, since they are mere shallow-water formations, and, so far as direct evidence goes, they represent only surface deposits. Yet it is by no means either impossible or improbable that some of them are actually placed on subsided areas, while it is all but positive that others have been brought to their present positions through elevation. Certain it is that movements of elevation have taken place in the Floridian region during a very recent geological period, and it is at least probable that movements in a contrary direction were not wanting at about the same, or a somewhat earlier, period, and again later.[1] In the case of the Vera Cruz reefs we have more

[1] I have discussed these points in my report on the geology of the peninsula of Florida ("Explorations on the West Coast of Florida and in the Okeechobee Wilderness"—Trans. Wagner Free Institute of Science, Phil., 1887—pp. 15, 26–33, 64b), and again in my observations on the coral reefs of the Bermudas ("The Bermuda Islands. A Contribution to the Physical History and Zoology of the Somers Archipelago," 1889—pp. 61, 73, 227). Alexander Agassiz well recognizes the nature of the "patch" reefs, and the possibilities of their formation (following Darwin) without the necessity of either elevation or subsidence ("The Tortugas and Florida Reefs." Memoirs Amer. Acad. Arts and Sciences, XI, part. II, 1885, pp. 118–19). But I fail to see the evidence in support of the statement that "on the Yucatan, as on the Florida Bank, the conditions favorable for coral reef growth have been produced, not by the uplifting of the continent, but by the gradual rising of the bank itself into suitable depths in consequence of the accumulation of animal *débris* upon it" (*loc. cit*); or for the further statement that "there is practically no evidence that the Florida reef, or any part of the southern peninsula of Florida which has been formed by corals, owes its existence to the effect of elevation" ("Three Cruises of the Blake," I, p. 61, 1888). In my work on the Bermuda Islands, above referred to, I have considered these points, and attempted to show that the actual geological evidence that we possess in the premises tends largely, I might say, almost wholly, to a conclusion opposite to that which was reached by Mr. Agassiz. Prof. Shaler, in a

definite data regarding the condition of the surface upon which those structures are reared. The position San Juan de Ulúa, on the Gallega Reef, is evidence that there have been no changes of level of any consequence for at least 300 years, or since the year (1582) when the construction of the fort was first begun; the recent development of the reefs has been in a stable area.

Manifestly, in a region of stability there could have been no "atolls of subsidence" formed, and we find no reefs that can even remotely be associated with the atoll structure. The facts thus far neither favor nor oppose the Darwinian theory of coral formations, but they are fully in consonance with it; and, so far as I see, they neither favor nor absolutely disprove the substitute theory which has been advanced by Mr. Murray and his followers. It is, however, a significant (if perhaps not remarkable) circumstance that with peripheral acceleration (in growth) and internal solution—the two determining conditions of atoll formation of most of the adherents of the new school—we should still fail to find in a region of stability, atoll-reefs. It is true that, with the very slow rate of solution which has been assumed to be possible, a well or lagoon of any depth could barely be formed in a period of three hundred years:

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somewhat singular paper on "The Topography of Florida"—singular for reason of its failing to take account of the geological work done in the State prior to his own researches—supplements my proof of the geologically recent uplift of the southern portion of the Floridian peninsula with testimony bearing directly upon the reefs themselves: thus the reef of Biscayne Bay "gives proof of a recent elevation of the shore to the height of about twenty-five feet" (Bull. Mus. Comp. Zool., XVI, 1890, p. 143). This statement is, of course, directly antagonistic to the position held by Mr. Agassiz. In my description of the rocks of Sarasota Bay, west coast of Florida (Trans. Wagner Free Inst. Science, 1, 1887, p. 15), I state that it is "more than probable that this portion of the coast has quite recently been undergoing subsidence"; Prof. Shaler (*Op. cit.*, p. 148) corroborates this position by the statement: "There is a good deal of evidence to the effect that the whole peninsula of Florida has undergone a subsidence of ten or twenty feet in altitude since the last period of elevation."

With direct evidence thus in favor of both elevation and subsidence of the Floridian region during the existing period of coral-growth, nothing remains of the assumption that the formation of the Florida Reefs is in any way opposed to the Darwinian theory of reef structure, for it absolutely nullifies the three leading propositions that are embodied in that assumption: 1. That there has been no subsidence in the coral making tract; 2, that there has been no elevation in the same region; and 3, that great banks, organically constructed, have been built up without assisting movements of the crust. The same argument applies to the reefs of the Yucatan bank.

the rate of $\frac{1}{10}$ inch per annum, which has been assumed by Irvine,[1] would yield in this period of time a depth of water no greater than actually exists on some of the reefs to-day, about two or three feet.[2] But then it should not be forgotten that the three centuries represent merely the least time for which we have a record of the completion of a single reef; the identical condition of stability may have existed for centuries before, and certainly a long period was consumed in the growth of the reef before it reached the surface. Surely some decided evidence of solvent action, in the form of a true basin-structure, might have been expected in this time; and the more if we further take into account peripheral acceleration. But such evidence is clearly wanting. So little, however, is as yet known regarding the amount and capabilities of solution that, perhaps, too much stress should not be laid upon this negative evidence—especially, as we seem to be dealing with a somewhat mysterious force, whose workings are, at least to me, a little inscrutable. The solvent "power" that permits to build up and then, apparently without cause, suddenly reverses and begins to remove, is possessed of a

Mr. Agassiz, in a note to Prof. Shaler's paper, seems to think that the Florida Everglades may be largely of a reef formation, or to be due to sedimental accumulation behind and between reefs. This is a revival in part of the old reef-theory of growth of the Floridian peninsula, which recent researches have abundantly disproved. Mr. Agassiz recognized that this theory is no longer tenable, but he manifestly lays too much stress upon the probability of a like structure holding good for that part of the peninsula which lies south of the "northern extremity," or even for that which is mainly comprised within the region of the Everglades itself. My own researches, which have since been supplemented by those of Dr. Dall, show that heavy fossiliferous deposits of Pliocene age are found nearly half across the peninsula on the Caloosahatchie, and their position there makes it practically certain that they largely underlie the region of the Everglades. I have so stated it in my report (p. 65): "The evidence, further, is very strong that beyond Lake Okeechobee and the Caloosahatchie the structure of the State is for the most part identical with that above it, and the observed facts clearly prove that this correspondence must exist over at least a considerable portion of the unexplored region of the Everglades." Mr. Agassiz has apparently not read my report (beyond possibly the opening sentence), otherwise he could hardly have stated (p. 157) that my "explorations were limited to the portions of the west coast of Florida included between Cedar Keys and Punta Rassa, and did not touch the Everglade district."

[1] Nature, March 15, 1888; this point is discussed in my "Bermuda Islands," pp. 203–205, 1889.

[2] It has already been remarked that the central reef-depression is in most cases merely a negative one, a rim having been formed through up-throws by the beating waters.

capacity for work which requires special examination. Individually, I must confess, I have thus far failed to find a fragment of a fact which supports the solution theory of lagoon-formation ; and so long as the construction of the reef-lagoon remains unexplained, so long must all theories explaining the formation of atolls be considered defective.

ECHINODERMS FROM THE NORTHERN COAST OF YUCATAN AND THE HARBOR OF VERA CRUZ.

BY J. E. IVES.

The Echinodermata which form the subject of this paper were collected on the northern coast of Yucatan and at Vera Cruz, in the spring of the present year, by an expedition from the Academy of Natural Sciences of Philadelphia to investigate the natural history of Yucatan and Mexico. The writer, who was a member of the expedition, is indebted to Professor Angelo Heilprin, the Director, for the opportunity of working up this portion of the collection.

The results in this department are interesting. One new genus and three new species are described in the following pages, a little known species is figured for the first time, the synonymy of this species and of some others has been studied with profitable results, and the majority of the species collected supply new localities which form connecting points between the northern and southern portions of the great West Indian, or eastern tropical American littoral fauna.

The northern coast of Yucatan possesses a sandy beach largely made up of shell fragments. The water, off the coast, is very shallow, the 10 fathom line being 20 miles from the shore, and the 100 fathom line about 150 miles. Three miles off the shore, in the neighborhood of Progreso, the bottom is of a sandy character, although a few small corals were brought up in the dredge. Along the shore to the westward of Progreso is a small Serpuloid reef. Large quantities of sea-weed and sponges are thrown upon the beach and lie decomposing in the sun. These and numerous water-worn specimens of *Orbicella annularis* and a large Escharine species of Bryozoan, with some specimens of *Xiphogorgia anceps*, indicate the existence of a region rich in animal and vegetable life not very far from the shore. The following species were collected on this coast in the neighborhood of Progreso and the Port of Silam: *Holothuria Heilprini, Holothuria Silamensis, Holothuria nitida, Toxopneustes variegatus, Echinaster Brasiliensis* and *Luidia alternata*. No Ophiurans were found on the beach, or in the dredgings off the shore, although careful search was made for them.

The harbor of Vera Cruz is an area of luxuriant coral growth, madrepores and brain corals being especially abundant.[1] No holothurians were collected here, but on the other hand two species of ophiurans were obtained. The forms from this locality are the following: *Diadema setosum, Echinometra subangularis, Mellita pentaporus, Thyraster serpentarius, Astropecten articulatus, Ophiura cinerea* and *Ophiothrix angulata.*

After the detailed account of the species collected which follows, in which they are separated into the two regions from which they were obtained, I have advanced some general considerations based upon their geographical distribution. A chronological list of all the important memoirs dealing with the Echinoderms of the West Indian region, has also been compiled which I believe will be of use in the future study of this area.

YUCATAN.

Holothuria Heilprini, n. sp. Pl. VIII, figs. 1–6.

Body cylindrical, narrowed toward the anterior end. Specimen very much contracted, probably to half the length of its extended condition. Anus round.

A few large wart-like prominences scattered over the dorsal surface, each surmounted by a papilla containing a rudimentary terminal plate and smooth rib-like rods with the ends enlarged and perforated. Pedicels present upon the dorsal and ventral surfaces: upon the dorsal surface they are evenly distributed and are slightly smaller than those of the ventral surface. The ventral pedicels are very numerous and closely approximated. In the specimen collected there is no trace of a linear arrangement.

The specimen obtained has ten tentacles, the most ventral of which is much smaller than the rest.

The body wall is very thick in the much contracted example.

The calcareous ring is very similar to the figure of that of *Holothuria Floridana* given by Selenka[2] in his "Beiträge."

There are two bundles of short madreporic canals attached to the dorsal surface of the œsophagus on the right and left sides respectively of the dorsal mesentery. In the specimen obtained there are twenty canals on the right side and nineteen on the left.

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[1] See Professor Heilprin's Report upon "The Corals and Coral Reefs of the Western Waters of the Gulf of Mexico" in this volume, p. 303.

[2] Zeit. wiss. Zool. Bd. xvii. pl. xviii, fig. 47.

The distal portions of the canals are enlarged, so as to form elongated heads. Two of the canals on the left side are branched, thus possessing two heads.

A single long and slender Polian vesicle exists, which is more than half the length of the animal, and terminates in a vesicular enlargement of considerable size.

Cuverian organs are not present.

In the walls of the dorsal pedicels are tables of the ordinary type described below, and a few rosettes. Around the terminal disks there are also tables which lack disks, the four rods bending inwards and uniting at the point where they meet. The ventral pedicels occasionally possess a few diskless tables around the edge of the terminal disk similar to those of the dorsal pedicels, and their walls contain a few rosettes. The calcareous deposits of the body-wall are collected into heaps which give its surface a granulated appearance. They consist principally of rosettes which occur in great abundance. They are usually about ·015 mm. in diameter. The branches of the rosettes, in rare instances, coalesce to form irregular perforated plates. On the dorsal surface the accumulations of rosettes are accompanied by a number of tables, which possess well developed disks and are of the *Holothuria atra* type, usually with a hole at the base of each rod. Exceptionally the hole is absent or it may be represented by two or three similar holes. The rods are connected by a single cross-bar. Each of the rods is surmounted by three prominent teeth, two horizontal and one vertical. The height of the tables and the diameter of their disks is about ·1 mm. The tables are almost entirely absent from the accumulations of the ventral surface.

The color in alcohol, of the granulated portion of the body is a dirty olive green; the portions free from deposits are slate-color with a purplish tinge; the sides of the pedicels grayish and their disks straw-color; tentacles very light straw-color.

Length of the much contracted specimen about 80 mm.

Collected among the wet seaweed of the beach at the Port of Silam.

I have named this species after Professor Angelo Heilprin, the Director and promoter of the expedition.

This form is related to *Holothuria atra* of Jæger. The most prominent difference is the arrangement of the calcareous deposits into heaps in *Holothuria Heilprini*, producing an appearance of granulation over the surface of the body. The branches of the rosettes also, in this species, very rarely coalesce to form plates, and the wart-like prominences sparsely scattered over the dorsal surface are also a distinguishing feature. True papillæ are confined to the summits of these prominences, and the remainder of the dorsal surface is evenly covered with pedicels only slightly smaller than those of the ventral surface. In the superficial appearance of granulation it resembles *Holothuria grisea* of Selenka, but the deposits of this species are collected into circles, and not heaps. It also differs from *Holothuria grisea* in the fact that the disks of the tables have a hole at the base of each rod and are not provided with spines, and that there are two well developed bundles of madreporic canals, instead of a single free canal.

Holothuria Silamensis, n. sp. Pl. VIII, figs. 7–9.

Body cylindrical, equally rounded at both ends, about three times as long as broad. Anus round, not stellate. Surface smooth to the touch. Dorsal and ventral surfaces possessing pedicels of small size, more numerous upon the ventral than upon the dorsal surface, but not crowded. The ventral pedicels show an imperfect arrangement in three rows, of which the middle row is the widest. A few papillæ are scattered amongst the dorsal pedicels.

The pedicels possess a well developed terminal disk. In two out of many pedicels that I examined I found extremely rudimentary tables around the edge of the disks. The tables are apparently of the type which is found in its perfect form in *Holothuria atra.*

In the one case there were two present and in the other, one. These must be regarded as exceptional structures as I did not find any trace of tables elsewhere in the specimen. Probably they are rudimentary structures derived from an ancestor possessing tables. The walls of the pedicels are free from deposits. The papillæ contain a rudimentary terminal disk and several smooth rib-like rods with perforated ends, such as are characteristic of them. The calcareous deposits of the body-wall are not numerous and consist entirely of small, irregular, perforated plates, which are formed by the coalescence of the branches of rosettes. They usually have one diameter longer than the other; the long diameter being about ·03 mm. and the short diameter, ·02 mm. They occur in small heaps, but the heaps are not sufficiently large or numerous to produce the granulated appearance, which is possessed by the previous species.

In the specimen obtained there are twenty tentacles of nearly uniform size.

The body wall is thick.

The calcareous ring is well developed, but its component pieces are not very coherent.

There are numerous short madreporic canals, arranged in two bundles, one on either side of the dorsal mesentery above the œsophagus, three on the left side and ten on the right. The distal portion of each canal is enlarged, forming an elongated head as in the preceding species.

There is one long and slender Polian vesicle, more than half the length of the animal, with two considerable vesicular enlargements, one near its end, and the other near its middle.

The specimen possesses a very small bundle of Cuverian organs.

The color in alcohol is a dirty white mottled with dark gray. The dark gray predominates on the anterior portion of the dorsal region. The tentacles are a dirty white, the walls of the pedicels and papillæ light gray, and the disks of the pedicles straw-colored.

Length of the specimen, 80 mm.

Collected at the Port of Silam among the wet sea-weed of the beach.

This form is characterized by rosette-like plates, absence of tables, two bundles of madreporic canals, non-stellate anus, absence of wart-like prominences on the dorsal surface, general distribution of pedicels and the very small number of papillæ. The number of tentacles, presence of Cuverian organs and character of its Polian vesicle, are probably not important characters, on account of the want of stability of structure of these organs.

It falls into the section of the genus *Holothuria* defined by Théel as "possessing more or less incomplete rosettes." Seven species are included by him in this section, *H. marmorata* Jäger, *H. Argus* Jäger, *H. Vitiensis* Semper, *H. tenuissima* Semper, *H. Koellikeri* Semper, *H. clemens* Ludwig and *H. similis* Semper. He thinks it probable, however, that they represent one or more species capable of great variation. They have hitherto only been reported from the tropical Indo-Pacific region.

Holothuria Silamensis differs from all of them in the possession of two well-developed bundles of madreporic canals, instead of a single canal. It can also be distinguished from *H. marmorata*, *H. Argus* and *H. Vitiensis*, by the circular instead of stellate anus; from *H.*

Koellikeri and *H. tenuissima*, by an unequal instead of an equal distribution of papillæ over the surface of the body, and from *H. clemens* by the absence of the fifteen small papillæ which surround the anus of the latter species.

These distinctions are given for the sake of convenience. Many minor ones exist, but the difficulty, even with the characters given above, is to estimate their real value. It is possible that a larger amount of material may in the future enable us to unite these forms as varieties of one or a few species. The existence of the three rudimentary tables, previously mentioned, even suggests a relationship to *Holothuria atra* and its allies.

This species I have named after the Port of Silam where it was collected.

Holothuria nitida, n. sp. Pl. VIII, figs. 10–15.

Body cylindrical. Specimen collected, in a moderately extended condition, four times as long as broad, slightly acuminate at both ends. Surface of the body smooth. Pedicels and papillæ on the dorsal surface and pedicels alone on the ventral surface.

Dorsal pedicels not very numerous, smaller than the ventral. Containing well developed tables, of the type found in *Holothuria atra*, around the edge of the terminal disks, and also rosettes. Tables about ·1 mm. in height, and their disks about ·09 mm. in diameter. A very few imperfect tables (see Pl. VIII, fig. 11.) also occur around the edge of the disks. Rosettes usually with a longer and shorter diameter, the former being on an average ·03 mm. and the latter ·02 mm. Some very much larger rosettes of abnormal form are found in the pedicels, Pl. VIII, fig. 15. The ventral pedicels lack deposits in their walls but possess well developed terminal disks. They are arranged in three imperfect longitudinal rows, the two outer having a width of three or four pedicels, and the inner of four or five. The papillæ are arranged in a row of about seven in number along the lower edge of the dorsal surface, on either side, and in two longitudinal rows upon the intervening portion. They contain many rib-like rods with branched or perforated extremities. Tables and rosettes also are sometimes present. The deposits of the body-wall are few and consist entirely of rosettes which usually occur in very small and scattered groups. The branches of the rosettes occasionally coalesce, forming imperfect perforated plates.

There are twenty tentacles of nearly equal size.

The body-wall is moderately thick.

The calcareous ring is well developed and is of the shape given in Pl. VIII, fig. 13.

There is a bundle of five madreporic canals on the right side of the dorsal mesentery and a single canal on the left side. The canals are short and have an elongated head.

A single, long and slender Polian vesicle is present, possessing a vesicular enlargement at its distal end.

A very small bundle of Cuverian organs exists.

The sexual glands are divided.

The color of the dorsal surface, in alcohol, is indigo-black relieved by a number of large white spots arranged on either side along its edge, and also forming irregular longitudinal rows upon the intervening area. From the centres of these white spots arise the papillæ described above. The ventral surface is dirty white, speckled with indigo. Each of the interambulacral areas of the ventral surface is marked by a dark line. The pedicels and papillæ have a yellowish tint. The tentacles are of a dirty white color.

Length 35 mm.

A single specimen was collected among the wet sea-weed washed up on the beach at the Port of Silam.

It is closely allied to *Holothuria atra* of Jäger, but is distinguished by the presence of pedicels upon the dorsal surface, by the absence of tables in the integument of the body-wall and by the well-defined color pattern.

Toxopneustes variegatus, Lamk. Anim. Sans. Ver., 1816, p. 18.

A. Agassiz, Mem. Mus. Comp. Zool., Vol. III. 1872–1874, pp. 168, 289, 500. Pl. II, iva, vi, vii, xxv.

Three specimens were dredged in shallow water on a sandy bottom off Progreso and three specimens were collected on the beach. They are evidently not very abundant in this locality. None were found upon the beach at Silam.

In the specimens obtained the spines are very short and those of the abactinal surface, rather slender and pointed.

Prof. Alexander Agassiz in the Revision of the Echini mentions the presence of two specimens of this species in the Museum of the École des Mines, from Yucatan. The species was also dredged on the Yucatan Bank, by the "Blake."

This species is found throughout the West Indian region, extending northwards to Beaufort, N. C. and southwards to Armação, Brazil. Professor Agassiz also records it from Cape Dos Bahias, Argentine Republic.

Echinaster Brasiliensis, Müller and Troschel. System der Asteriden 1842, p. 22. Tab. 1, fig. 4. (?)
Perrier, Arch. de. Zool. Exp. Vol. IV, 1875, p. 367.
Lütken, Vidensk. Meddel. 1859, p. 93.
Rathbun, Trans. Conn. Acad. Vol. V, 1879, p. 148.
Ludwig, Mem. Cour. Acad. Roy. Belg. T. XLIV, 1882, No. 5, p. 7.

Two starfishes obtained upon the beach at Progreso have been referred to this species. The larger specimen is about 80 mm. in diameter. The length of the radius of the disk, to that of the arm, is about as one to five. The arms are cylindrical and tapering. The spines of the surface of the arms and disk are small, not longer than the ambulacral spines, and form nine irregular rows upon the surface of the arms. There are about twenty five spines in a row from the middle of the disk to the tip of the arm. The ambulacral spines are arranged in three more or less perfect rows. The two outer rows are of equal size and the spines are opposite to one another; the spines of the innermost row are much smaller and alternate with the larger spines.

The smaller specimen is about 70 mm. in diameter and has only seven imperfect rows of spines, with about 20 spines in a row.

The specimens when alive were of a rust-red color, darker above than beneath. In alcohol they have become a light dirty brown.

I have figured the larger of the two specimens collected, Pl. VIII, figs. 16–18.

The specimens found in Yucatan, agree with the description of the forms referred by Mr. Rathbun to this species from Rio Formoso, Pernambuco, Brazil.

The synonymy of *Echinaster Brasiliensis* and of the other species of Echinaster inhabiting the western shores of the tropical Atlantic is in a very unsatisfactory condition. Müller and Troschel give *Othilia multispina* of Gray [1] as a synonym of this species, but it appears to me very doubtful if this form is the same.

The locality of the specimen described by Gray is unknown. His description runs thus: "Rays short, depressed, broad, rather more

[1] Annals and Mag. Nat. Hist., Vol. VI, 1840, p. 282.

than twice as long as the width of the body, blunt at the end, with eleven rows of acute distant spines." According to Müller and Troschel their species is distinguished by its small and numerous spines. The authors who have described the form subsequently, viz Lütken, Dujardin and Hupé, and Rathbun have characterized the species principally by this character, and have associated with it that of slender arms.

Müller and Troschel also refer to Seba's [1] figure of *Pentadactylosaster spinosus regularis virginianus* as an illustration of their species. Not only, however, is this figure entirely out of accord with their description but it is almost identical with the figure of *Pentadactylosaster spinosus regularis* of Linck, [2] which forms their type of *Echinaster spinosus*, the species described immediately before *Echinaster Brasiliensis*. Seba's specimen came from Virginia and he distinctly identified his figures with Linck's previous figure. Both figures are good representations of *Echinaster spinosus*, with large distant spines, and cannot by any stretch of the imagination be considered as identical with *Echinaster Brasiliensis.*

The figure of this species given by Müller and Troschel does not at all agree with their description of it, but rather with that of their *Echinaster spinosus.* It is possible that the figure may have been wrongly named.

If the views expressed above are correct it is very doubtful whether *Echinaster Brasiliensis* has any synonyms.

This species is distributed throughout the West Indies and extends northwards to the Florida channel and southwards to Rio Janeiro.

Florida channel (A. Agassiz). Kingston, Jamaica; Puerto Cabello; Rio Janeiro (Lütken). Brazil (M. & T.). Rio Formoso, Brazil (Rathbun). Cap Vert, Brazil, (Ludwig). Rio Janeiro, (Perrier.).

The following list represents the species of Echinaster[3] found in waters of the Western Tropical Atlantic.

Echinaster spinosus, Retzius. Dissert. Sist. Spec. Cog. Asteriarum, 1805, p. 18.

Asterias echinophora, Lamarck, Hist. Nat. Anim. Sans. Vert. t. ii, p. 560.

Echinaster sentus, Say. Jour. Acad. Nat. Sci. Phila., 1st Ser., Vol. 5, p. 143.

The two specimens referred to by Say in his description of *Echinaster sentus,* which were presented by Lieut. Gandtt, are preserved

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[1] Thesauri Vol. iii, p. 13, Tab. 7, Fig. 4.

[2] De Stellis Marinis, Tab. iv, Fig. 7.

[3] *Echinaster serpentarius* (Val.) Müller and Troschel, has been placed by the author in a separate genus, see below.

in the collection of the Academy, and after comparison of them with examples of *Echinaster spinosus* from New Providence, Bahamas, also in the collection of the Academy, I am unable to find any well marked characters separating them from the latter species.

West Indies; Brazil to Virginia.

Echinaster crassispina, Verrill. Trans. Conn. Acad. Arts and Sci., Vol. 1, p. 368, pl. iv, fig. 7.

This species may prove to be a variety of the preceding species. Bahia, Brazil.

Echinaster Brasiliensis, Müller und Troschel. System der Asteriden, p. 22. (Taf. 1, fig. 11 ?.)

West Indies; Florida Channel to Rio Janeiro.

Echinaster spinulosus, Verrill. Proc. Bost. Soc. Nat. Hist., XII, p. 386.

West Coast of Florida.

Echinaster modestus, Perrier. Nouv. Archives Mus. Hist. Nat. t. VI, p. 206, Pl. III, fig. 7.

Below 100 fathoms, West Indies.

Luidia alternata, Say. Jour. Acad. Nat. Sci. Phila. (1) Vol. V, 1825, p. 144.
Lutken, Vidensk. Meddel., 1859, p. 42.
Perrier, Arch. Zool. Expér., 1876, T. V, p. 254.
Ludwig, Mém. Cour. Acad. Royal. Belg., 1882, T. XLIV, No. 5, p. 9.
Sladen, "Challenger" Report on the Asteroidea, 1889, p. 250.
Luidia granulosa, Perrier, Ann. Sci. Nat., (5) t. xii, p. 301, Pl. II, fig. 18.
Luidia variegata, Perrier. Arch. Zool. Expér., 1876, t. v, p. 257.

A single specimen of this species was collected off Progreso at a depth of about 20 feet. The living animal was straw-colored, with black markings forming three or four irregular, transverse bands upon the dorsal surface of the arms: black markings absent from the ventral surface: spines more or less greenish: ends of the ambulacral feet orange red. The same coloration is preserved in the alcoholic specimen, with the exception of the loss of the greenish color of the spines, and of the orange color of the ends of the feet.

The distinctive characters of this species are the three well-marked rows of paxillæ on either side of the arms, and the existence of two or four imperfect rows of spines upon the dorsal surface of the arms, one or two rows on each side. In the specimen collected, there are traces of three rows of spines on either side of the arm, at its base.

A few three valved pedicellariæ exist in our specimen between the adambulacral and the ventral rows of spines. They closely resemble Perrier's figures of those of *Luidia granulosa*.

Radius of the disk 10 mm., length of an arm from center of disk, 70 mm.

This species is found in the West Indies, and extends northwards to Florida, and southwards to Bahia, Brazil.

Florida (Say). Florida Channel, 40 fms. (Agassiz). Antilles: Tortugas; Ile Breton, Mississippi R.; 60 m. N. Ile Jolbos, 14 fms.; Montserrat, 88 fms. (Perrier). St. Thomas (Lütken). Brazil (Ludwig). Bahia, 7–20 fms. (Sladen).

The following species of *Luidia* are found in the West Indian region.

Luidia clathrata, Say. Jour. Acad. Nat. Sci. Phila. (1) Vol. V, p. 142. A. Agassiz, Mem. Mus. Comp. Zool., V, p. 117, pl. xx.

West Indies; Beaufort, N. C. to Rio Janeiro.

Luidia Senegalensis, Lam. Anim. Sans Vert. t. iii, p. 255. Perrier. Arch. Zool. Exp., Vol. V, p. 262.

Luidia Marcgravii, Lutken. Vidensk. Meddel. 1859, p. 43.

West Indies, southward to Rio Formosa, Brazil. Also upon the West Coast of Africa (Senegal).

Luidia elegans, Perrier, Arch. Zool. Expèr., t. v, p. 256.

Florida straits (101 feet), Barbadoes (200 fathoms.)

Luidia convexiuscula, Perrier, Nouv. Arch. Mus. Hist. Nat. (2), T. VI, p. 268.

Lesser Antilles, and off S. W. of Florida. (56–208 fathoms.)

Luidia alternata, Say.

West Indies; Florida to Bahia, Brazil.

Luidia Barbadensis, Perrier, op. cit., p. 267.

Barbadoes and off S. W. of Florida. (40–209 fathoms.)

This species may be a long armed variety of *Luidia alternata*.

A complete list of the literature of these species will be found in Ludwig's List of Brazilian Echinoderms, Perrier's "Stellérides des Dragages du Blake," and Sladen's Monograph of the "Challenger" Asteroidea.

Vera Cruz.

Diadema setosum, Gray, Ann. Phil., 1825, p. 4. A. Agassiz, Mem. Mus. Comp. Zool. Vol. III, 1872–1874. pp. 103, 274, 408., Pls. IIb, IIc, IVa, VI, VIa, XXIV, XXVII, XXVIII.

Very abundant among the reefs of the harbor of Vera Cruz. Found upon the coral sand in shallow water or in rock and coral recesses. Especially numerous in the shallows off the Gallega reef.

This species has not before been recorded from the Gulf of Mexico. It is found throughout the West Indies and extends northward to Cape Florida and southward to Fernando de Noronha. It is also found throughout the whole tropical region of the globe with the exception of the West Coast of America.

Echinometra subangularis, Leske, 1778. Kl. Add.

A. Agassiz, Mem. Mus. Comp. Zool. Vol. III, 1872–1874, pp. 116, 283, 431, Pls. Xa, XXVI.

Svén Lovén, Bihang Kongl. Svensk. Vetensk. Akad. Handl. Vol. 13, IV, 1888, p. 153.

A large series of specimens of this species were collected at Vera Cruz. They were found in great quantities in the shallows lying to the northwest of the town, especially upon the rock and serpuloid reef known as the Caleta. They are characterized by a somewhat flattened and circular test. The spines show a great range of variation in their coloring. They are of various shades of reddish-brown, purple and olive. Some specimens are of very light tints and others are almost black. The spines are often tipped with different colors.

This species is found throughout the West Indies, and as far northward as Charleston, S. C. and southward as Desterro, Brazil. It is also found upon the West coast of Africa, and at Ascension Island.

Mellita pentapora, Gmelin, 1788, Linn. Syst. Nat. 3188.

Mellita testudinata, Klein,[1] 1734, Nat. Disp. Ech., p. 30, Pl. XXI, fig. C. D.

A. Agassiz, Mem. Mus. Comp. Zool., Vol. III, pp. 141, 322, 538, Pls. XI, XIIa, XIIe.

This form is very abundant in some places upon the beach at Vera Cruz.

The specimens collected are considerably shorter in their antero-posterior diameters than the typical forms of this species. Both Klein and Louis Agassiz[2] based their description of *Mellita testudinata* upon specimens received from Vera Cruz, and it is an interesting fact that the figures given by each of these authors illustrate this peculiarity. Evidently it represents, not an individual variation,

[1] As Klein's names are not admissible under the British and American Association rules, I have adopted the first post-Linnæan binomial, viz, *Echinus pentaporus* of Gmelin.

[2] Monographie d' Echinodermes. Des Scutelles, 1841, p. 40, Tab. 4a, figs. 7–10.

but a local variety. The typical form is seen in the figure given by Professor Alexander Agassiz in his Revision of the Echini.

This species is found in the West Indies, extending northward as far as Cape Hatteras, and southward to Itabapuana, (100 m. N. E. Rio Janeiro) Brazil.

Professor Verrill in his Report upon the Invertebrata of Vineyard Sound says that the specimens found north of Cape Hatteras are rare and dead.

Thyraster serpentarius, Muller und Troschel.

Echinaster serpentarius (Val.) Muller and Troschel, System der Asteriden, p. 24. Perrier, Arch. Zool. Expér., t. iv, p. 370.

A single specimen of this interesting form was collected at Vera Cruz. It corresponds well with Müller and Troschel's description. They described their species from specimens in the Paris Museum, also obtained from Vera Cruz. The specimen collected by the expedition is superficially characterized by the numerous very small, short, blunt spines forming irregular longitudinal and transverse rows upon its dorsal surface, and by the peculiar arrangement of the ambulacral spines. There are four of these spines arranged in a row upon the aboral edge of each adambulacral plate. The innermost spine is the smallest and bears at its base a rudimentary spinelet. Each plate of the series of ventral plates adjoining the adambulacral plates has three or four spines upon its aboral edge. Each of the lateral plates also has a row of three spines upon its aboral edge. The ambulacral, ventral and lateral spines of the arms are very small, but not so small as those of the dorsal surface. The distal portions of all the spines have a rough appearance when viewed with the naked eye, and when examined with the microscope are seen to be thorny. The reticulated skeleton is made up of a number of qudrilateral plates, connected at their angles and arranged in longitudinal rows. The abactinal spines are borne upon the edges of these plates.

The ventral and lateral plates are connected by an intermediate ossicle. Intermediate ossicles occasionally occur between the other plates of the skeleton. The central portion of the surface of these plates is covered with minute tubercles which give them a granulated appearance. Figs. 19, 20 and 21, Pl. VIII, represent dorsal, ventral and lateral views of a portion of the skeleton of an arm, enlarged about four diameters.

The regular arrangement of the plates produces a superficial resemblance to an *Asterias*.

The specimen collected has a diameter of about 50 mm. R = 5r.

This species has as yet only been recorded from Vera Cruz. It differs essentially from *Echinaster* as defined by Perrier,[1] Viguier[2] and Sladen,[3] and even as defined by Müller and Troschel[4] themselves, for they say, "in der Haut ein zusammenhängendes netz von Balken," and quadrilateral plates certainly cannot be termed "Balken." The abactinal and lateral skeleton of an *Echinaster* consists of small, narrow, imbricated plates forming an irregular network. The skeleton in this species, on the contrary, consists mainly of quadrilateral plates arranged in regular longitudinal series. It is also distinguished by the minute tuberculation of the plates, the arrangement of the spines along their edges and the thorny character of the distal portion of these spines. I have, therefore, erected a new genus for this species, which may be characterized as follows:—

THYRASTER, n. gen.

Ambulacral pedicles biserial. Actinostomial margin defined by the adambulacral plates. Arms subcylindrical, skeleton composed mainly of quadrilateral plates, united at their angles by imbrication and arranged in longitudinal series. Plates minutely tuberculated, supporting spines upon their edges. Distal portion of the spines microscopically thorny.

I hope at a future period to consider the question of the relationship of *Thyraster* to the Echinasteridæ in general.

Astropecten articulatus, Say, Journ. Acad. Nat. Sci. Phila. (1) Vol. 5. p. 141. Perrier, Arch. Zool. Exp., Vol. 5, 1876, p. 290.
Astropecten duplicatus Gray, Ann. Mag. Nat. Hist. Vol. VI, 1841, p. 181. Perrier, op. cit. p. 271.
Astropecten Valenciennii, Muller and Troschel. System der Asteriden, p. 68.
Astropecten variabilis, Lutken, Vidensk. Meddel., 1859, p. 59.

A single specimen of this species was collected at Vera Cruz.

It is found in the West Indies, extending northward to Beaufort, N. C. and southward off the island of Jolbo on the northeast coast of Yucatan.

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[1] Arch. Zool. Exp. t. iv, pp. 283 and 289.

[2] Ibid. t. vii, p. 123.

[3] Challenger Report, pp. xxxviii and 536.

[4] System der Asteriden, p. 22.

Beaufort, N. C. (Nachtrieb). South Carolina (Ives).[1] Georgia and East Florida (Say). Tampa Bay, West Florida (Ives.) Florida Channel (L. Agassiz). Vera Cruz (Müller and Troschel). St. Thomas, St. Croix (Lütken). St. Vincent (Gray). 60 m. N. Ile Jolbo; Banc de Yucatan (Perrier.)

There appears to be no important difference between *Astropecten articulatus* of Say and *Astropecten Valenciennii* of Müller and Troschel. The only supposed difference between the two species was the existence of two rows of spines upon the supero-lateral plates of the latter, in distinction to one row in the former species. But upon examination this character proves to be very variable. Perrier[2] describes a specimen of *Astropecten articulatus* in which the spines upon the supero-marginal plates are entirely lacking, and an examination of the specimens in the collection of this Academy has convinced me that this character is subject to great variation. Both series of spines may be developed along the whole length of the arm or one or both may be more or less imperfectly developed, or according to Professor Perrier they may be both entirely absent. Professor Perrier found upon examination of original specimens that *Astropecten Valenciennii* was identical with *Astropecten duplicatus* of Gray, and *Astropecten variabilis* of Lütken. Müller and Troschel described their species from a specimen obtained at Vera Cruz.

Ophiura cinerea, Muller and Troschel, System der Asteriden, p. 87.

Lyman, Mem. Mus. Comp. Zool., Vol. I, p. 27.

Ophioderma Antillarum, Lutken, Vidensk. Selsk. Skrift. Bd. V., 1859, p. 190, Tab. 1, fig. 1.

A single specimen of this species was brought up with a coral at Vera Cruz, from about eight feet of water.

It is distributed throughout the West Indies, upon the Florida reefs, and southward as far as the Abrolhos Islands, Brazil.

Tortugas, Fla.; Key Biscayne, Fla.; St. Thomas; Jeremie, Hayti; south of Vera Cruz in the Gulf of Mexico; Aspinwall; Bahia, Brazil, 7–20 faths. (Lyman). St. Jan, 1 fath.; St. Thomas, 1 foot to 4 faths. (Lütken). St. Barthelemy (Ljungnan). Fernando de Noronha; Parahyba do Norte; Plataforma; Mar Grande; Bay of Bahia; Abrolhos Reefs (Rathbun).

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[1] Catalogue of the Asteroidea and Ophiuroidea in the collection of the Academy of Natural Sciences of Philadelphia, Proc. Acad. Nat. Sci. Phila. 1889, p. 169.

[2] Arch. Zool. Exp. t. 5, 1876, p. 291.

Ophiothrix angulata, Say, Jour. Acad. Nat. Sci. Phila. (1) V, p. 115.

Lyman, Mem. Mus. Comp. Zool., Vol. I, p. 162, Pl. II, Figs 1–3; "Challenger" Report on the Ophiuroidea, 1882, p. 219.

A young specimen was brought up on a coral from about eight feet of water in the harbor of Vera Cruz.

This species is found abundantly throughout the West Indies, and extends northward to Beaufort N. C., and southward to Rio Janeiro.

Beaufort, N. C. (Nachtrieb). Fort Johnston, N. C. (Ayres). Charleston S. C. (Say). Waccamaw, S. C.; Key West, Fla. (Lyman). Charlotte Harbor, Fla.; Tortugas (Ayres). Off Bermudas, 32 faths. (Lyman). Guadiana Bay, Cuba; Bahia Honda., Cuba; Jeremie, Hayti; St. Thomas (Lyman). St. Barthelemy; Tortola, (Ljungman). Sombrero, 54 faths.; Barbadoes, 100 faths. (Lyman). Mugeres Island, Yucatan; Aspinwall; Fernando Noronha, (Lyman). Parahyba do Norte; Pernambuco; Rio Formoso; Plataforma; Mar Grande, Mapelle; Bay of Bahia; Abrolhos Islands (Rathbun). Off Bahia, 7–20 faths.; Off Cape Frio, Brazil, 35 faths. (Lyman). Rio de Janeiro (Rathbun).

Geographical distribution.

In indicating the geographical range of the species collected by the Expedition, I have endeavored to confine the area of distribution, so that it should include only those localities in which the species are constantly found in greater or lesser abundance; and I have, as far as the data at my disposal would permit, avoided including those localities in which only occasional or dead specimens occur. A good illustration of this principle is the distribution of *Mellita pentapora*. Dead specimens are found as far North as Vineyard Sound, but living specimens according to Professor Verrill do not occur north of Cape Hatteras, and I have therefore given Cape Hatteras as the northern limit of distribution of this species. The amount of collecting that has been done upon the shores of the southern United States is quite small, and it is therefore difficult to define with accuracy the limit of the northerly distribution of West Indian Echinoderms. The same observation with respect to the southern limit of distribution applies to the coast of Brazil, although much valuable information has been acquired through the collections made by Mr. John C. Branner, Professor Chas. Fred. Hartt, and their associates and assistants. It is desirable that thorough collections should be made on these coasts and also in the West Indian islands, with the object of ascertaining accurately the distribution of the littoral Echinoderms in the Western tropical Atlantic region.

A paper by Mr. H. F. Nachtrieb[1] upon the Echinoderms collected at Beaufort, N. C. in connection with the Marine Laboratory of the John Hopkins University, throws some light upon the question of the northern limit of the West Indian Echinoderm shore fauna. Of the three species of starfish collected, two belong to the West Indian fauna and one to the northern; of the Ophiurans the three species are all West Indian; of the sea-urchins three species are West Indian and one northern. The Holothurians are unidentified. Thus it is seen that at Beaufort, which is about 70 miles to the southeast of Cape Hatteras, the Echinoderm fauna is distinctly West Indian.

Commander Bartlett[2] of the United States Coast and Geodetic Survey, in connection with the work of the steamer "Blake" has come to the conclusion that the Arctic or Labrador current does not extend south of Cape Hatteras, but at that point goes under the Gulf Stream and to the eastward, being deflected that way by the form of the Blake plateau. He also states that the Gulf Stream has for its western bank the 100 fathom curve which is on an average about 70 miles from the shore as far north as Cape Hatteras, and that the water inside of the 100 fathom line to the shore, appears to be an overflow of the stream as the temperature to five, ten and fifteen fathoms is nearly as high as that found in the stream. North of Cape Hatteras the Gulf Stream is deflected northeastwards and is separated from the coast by the cold Labrador current. It will be apparent from the above statements that Cape Hatteras marks the northern limit of an area of temperature which may be regarded as essentially that of the West Indian littoral region.

The following list of species collected by the Expedition will readily show their distribution.

Holothuria Heilprini.
Holothuria Silamensis. } Port of Silam, northern coast of Yucatan.
Holothuria nitida.

Diadema setosum, West Indies, Cape Florida to Fernando de Noronha.

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[1] Notes on Echinoderms obtained at Beaufort, N. C., Johns Hopkins University. Studies from the Biological Laboratory, Vol. iv, p. 81.

[2] Report of the United States Coast and Geodetic Survey, 1882, p. 37 and "Three cruises of the Blake" by Alexander Agassiz p. 257, fig. 176.

Echinometra subangularis, West Indies, Charleston, S. C. to Desterro, Brazil.

Toxopneustes variegatus, West Indies, Beaufort, N. C. to Armação, Brazil.

Mellita pentapora, West Indies, Cape Hatteras to Itabapuana, Brazil.

Thyraster serpentarius, Vera Cruz.

Echinaster Brasiliensis, West Indies, Florida Channel to Rio Janeiro.

Astropecten articulatus, West Indies, Beaufort, N. C. to off Jolbo, off the N. E. coast of Yucatan.

Luidia alternata, West Indies, Florida to Bahia, Brazil.

Ophiura cinerea, West Indies, Florida Reefs to Abrolhos Islands.

Ophiothrix angulata, West Indies, Beaufort, N. C. to Rio Janeiro.

It will be observed that with the exception of the Holothurians, and *Thyraster serpentarius*, the Echinoderms obtained are all common to the West Indies, and their method of distribution points to this region as their center of propagation. Four of them have a longitudinal range of about 4,000 miles, extending approximately from Cape Hatteras in the north to Santa Catharina in the south. The others have a more limited range, one extending from the Florida channel to Rio Janeiro, two from Florida to Bahia, one from Florida to Fernando de Noronha, and one is only known as yet from Vera Cruz. A range is thus indicated, comprehending all the species referred to, limited by Cape Hatteras in the north, and the island of Santa Catharina, off the southern portion of Brazil, in the south. These northern and southern limits represent points crossed by the isotherms of 15° C. (60° Fahr.) in both hemispheres during the coldest month of the year. South and north of these localities respectively the surface temperature of the water never falls below this degree of warmth. Of the five littoral species of Echini, however, recorded by Professor Alexander Agassiz from Cape Dos Bahias, Patagonia, in his Report upon the Echini of the Hassler Expedition, two belong to the West Indian fauna. The question is thus raised of the true southern limit of the West Indian fauna.

The localized habitat of the Holothurians collected is in striking contrast to the broad ranges of the other species. This localization is largely characteristic of the shallow water Holothuroidea. The greater number of known species are confined either to one locality or to a very circumscribed area. This fact was illustrated by the

Echinoderms collected by the Academy's Expedition to the Bermuda Islands in 1888 under the direction of Professor Angelo Heilprin. The species obtained with the exception of the Holothurians were all common, widely distributed forms, but of the six species of the latter four were new. The limited habitat of so many members of this group is probably due to their poor locomotory qualifications.

It is of some interest to make a comparison of the species collected in Yucatan, at Vera Cruz and in Bermuda. The Holothurians found at Yucatan, three species of the genus *Holothuria*, are distinct from the three species of the same genus collected in Bermuda. Three other species representing the genera *Semperia* and *Stichopus* were also obtained in Bermuda. Of the Sea Urchins, one species is common to Yucatan and Bermuda, two species are common to Vera Cruz and Bermuda. *Mellita pentaporus* at Vera Cruz is represented by *Mellita sexforis* in Bermuda: and two species were found in Bermuda which were not obtained in Yucatan or at Vera Cruz. The two species of starfishes from Yucatan, and the two from Vera Cruz are generically different from the two species obtained at Bermuda. The two species of Ophiurans differ generically from the six species collected in Bermuda. Considerable local difference in the littoral Echinoderm fauna is thus seen to exist between these three portions of the West Indian region.

It is remarkable that the common West Indian species *Toxopneustes variegatus* was not collected at Vera Cruz, although three other species of sea urchin are abundant in that locality. It was the only species of sea urchin collected in Yucatan. Can it be that at Vera Cruz its place is taken by *Echinometra subangularis?*

It is a noteworthy fact that although *Diadema setosum* is found in the West Indies, upon the West African coast and throughout the Indo-Pacific region, it is absent upon the west coast of America. A large number of species of Holothurians, Sea Urchins, Starfishes and Ophiurans, although not found in the Atlantic tropical region, are similarly distributed throughout the entire Indo-Pacific region, being present in the islands of the Pacific, the East Indies, the Indian Ocean and upon the Eastern Coast of Africa, and resemble *Diadema setosum* in their absence, with a few rare exceptions, from the West Coast of America. This interesting fact appears to me explicable in the following way:— The littoral species of the tropical regions are probably distributed principally by the warm equatorial currents flowing from east to west. The equatorial currents of the Pacific arise upon the western coast of America,[1] and flowing through the islands of Polynesia and the East Indies distribute their species westward, and it would be naturally supposed that the species occupying the area where the currents arise would be also carried in that direction. This, however, is not so; probably for two reasons. 1. The equatorial counter-current impinges upon the greater portion of the western coast of Central America and produces a quiet area in which there is apparently little circulatory motion. Further, the north and south equatorial currents arise respectively off the coasts of Lower California and Peru, and probably come little into contact with the littoral fauna of west Central America. 2. The eastern portion of the Pacific Ocean contains very few islands which could serve as connecting points in the distribution of littoral forms. These are probably the reasons why the west Central American forms are not found in the Indo-Pacific region. The equatorial counter-current, which could form the only possible means of communication from the Indo-Pacific tropical region to the west Central American tropical region, traverses a tract in which there are only a few scattered islands which are probably not sufficient in number to bring about the introduction of the fauna of the one region into the other.

General Literature of the Echinoderm Fauna of the West Indian Region (not including the Crinoids).

1825. Thomas Say. On the species of the Linnæan genus Asterias inhabiting the Coast of the United States. Jour. Acad. Nat. Sci. Phila. (1), Vol. 5, p. 141.

1826. Thomas Say. On the species of Linnæan genus Echinus inhabiting the Coast of the United States. Ibid, p. 225.

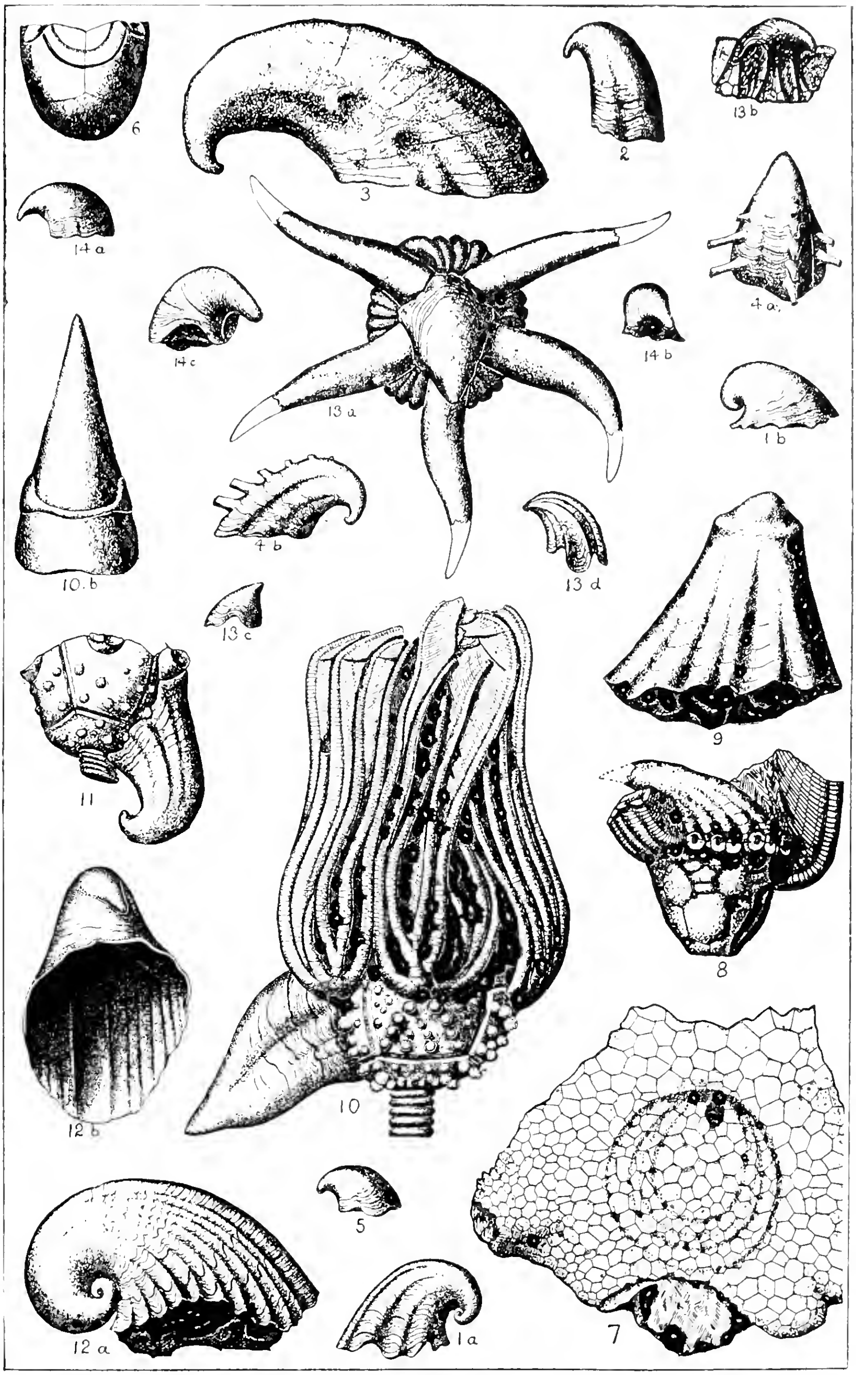
1851. L. F. Pourtalès. On the Holothuriæ of the Atlantic Coast of the United States. Proc. Amer. Assoc., 1851, p, 5.

1856. Chr. Lütken. Contributions to the Knowledge of the Serpent-Stars. II. Review of the West Indian Ophiurans. Vidensk. Meddel. Kjöbenhavn, p. 1.

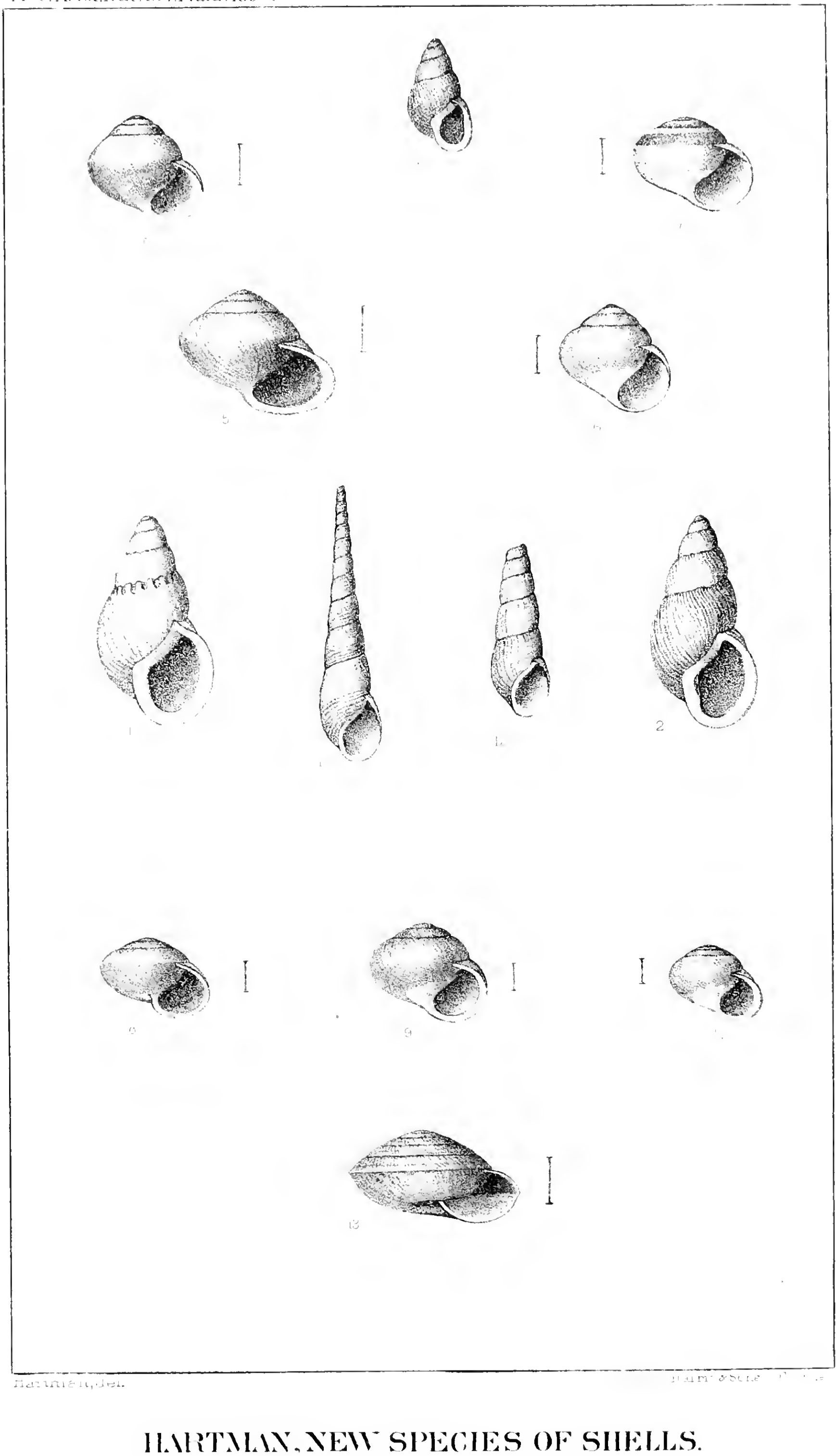
1859. Chr. Lütken. Contributions to the Knowledge of the Starfishes of the Coasts of Central and South America. Vidensk. Meddel. Kjöbenhavn, p. 25.

1859. Chr. Lütken. Addimenta ad historiam ophiuridarum. II. Description of little known Serpent-Stars from the West Indies

[1] See Dr. Van Bebber, Lehrbuch der Meteorologie, Stuttgart, 1890, Tab. ii.

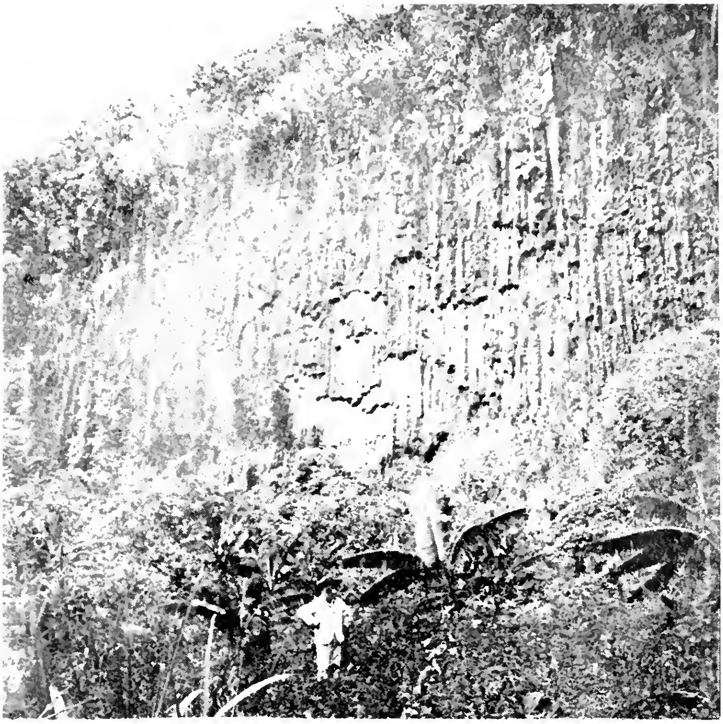


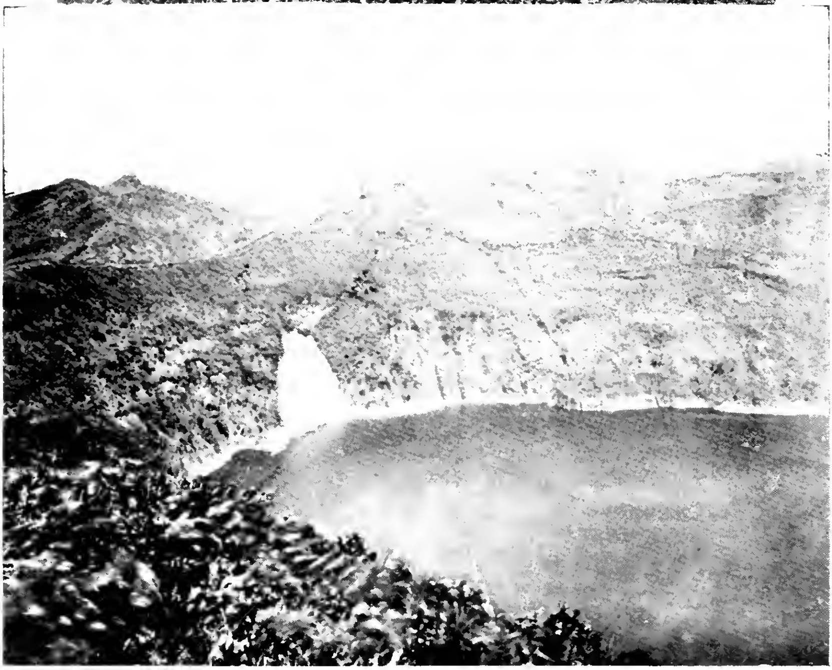
KEYES ON CARBONIC CALYPTRÆIDAE.



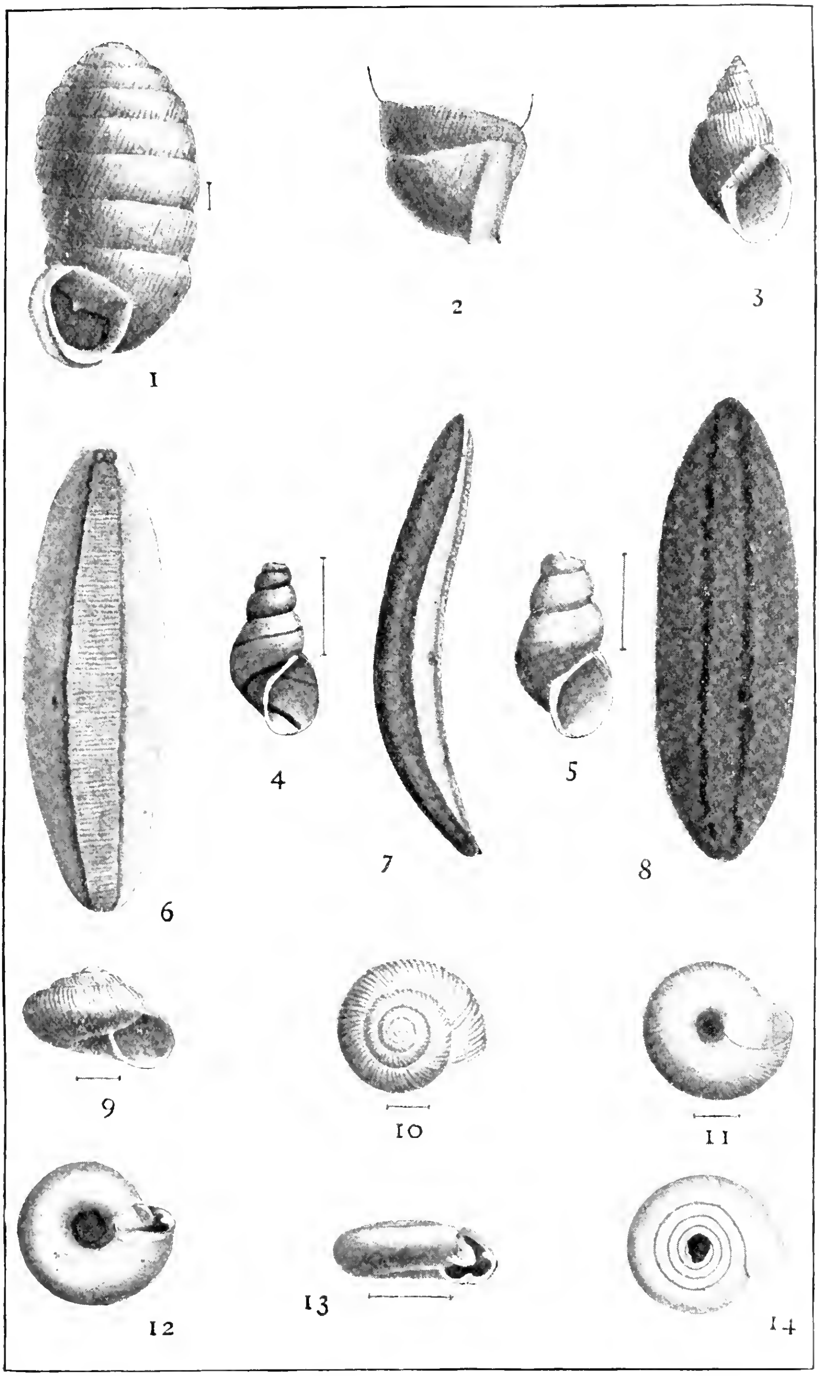
Hartman, del.

HARTMAN, NEW SPECIES OF SHELLS.

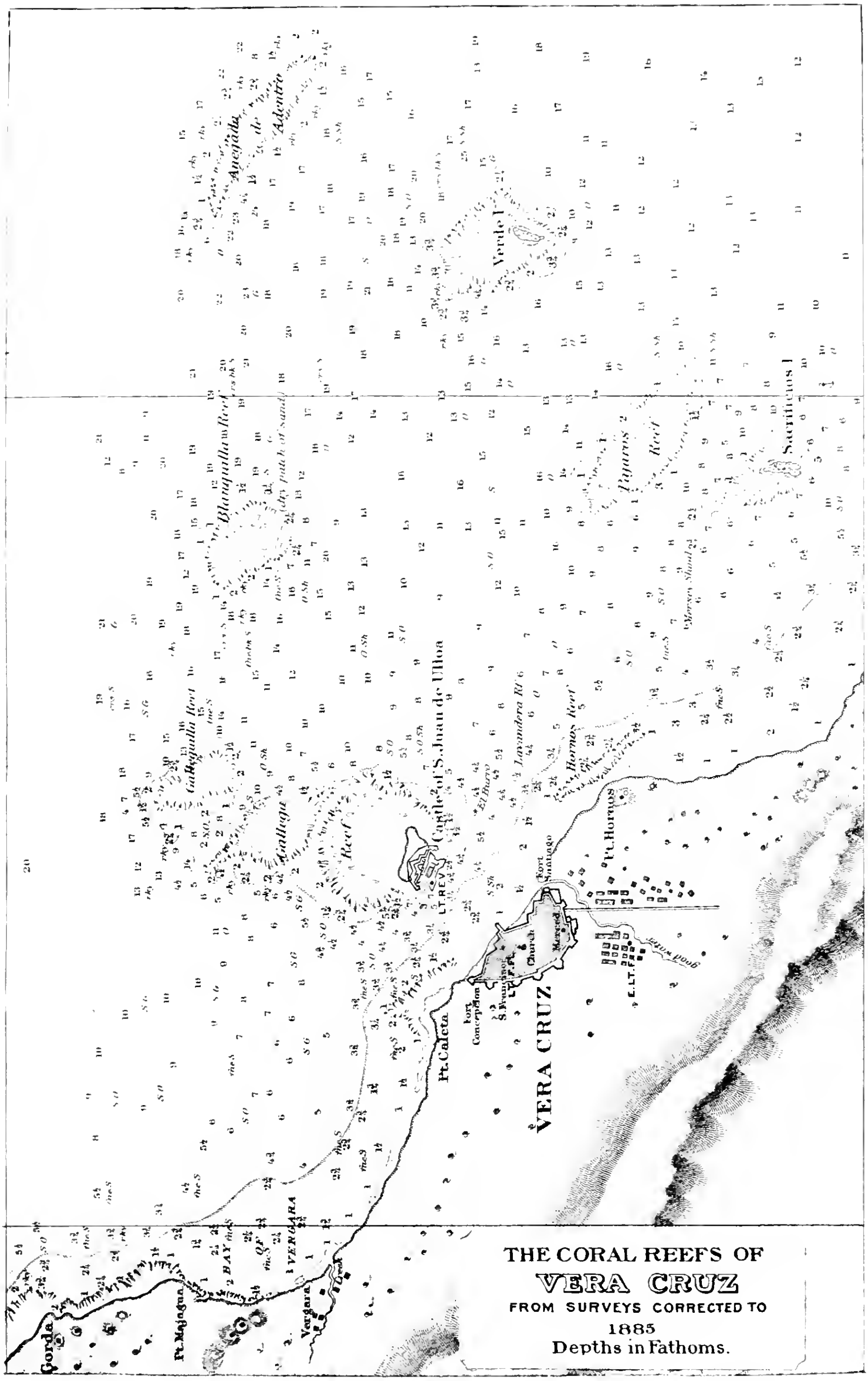




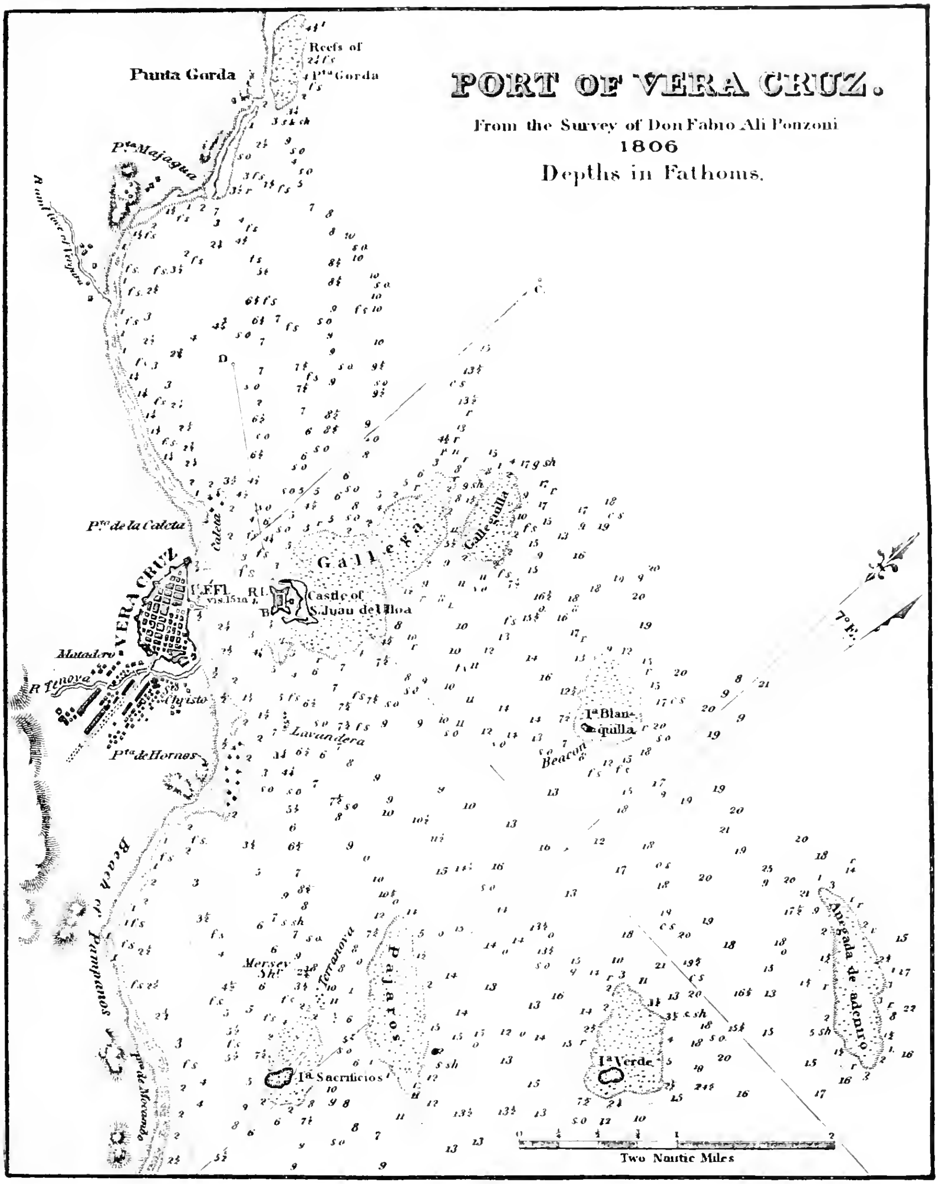
SHARP, ON VINCELONIAN VOLCANO.

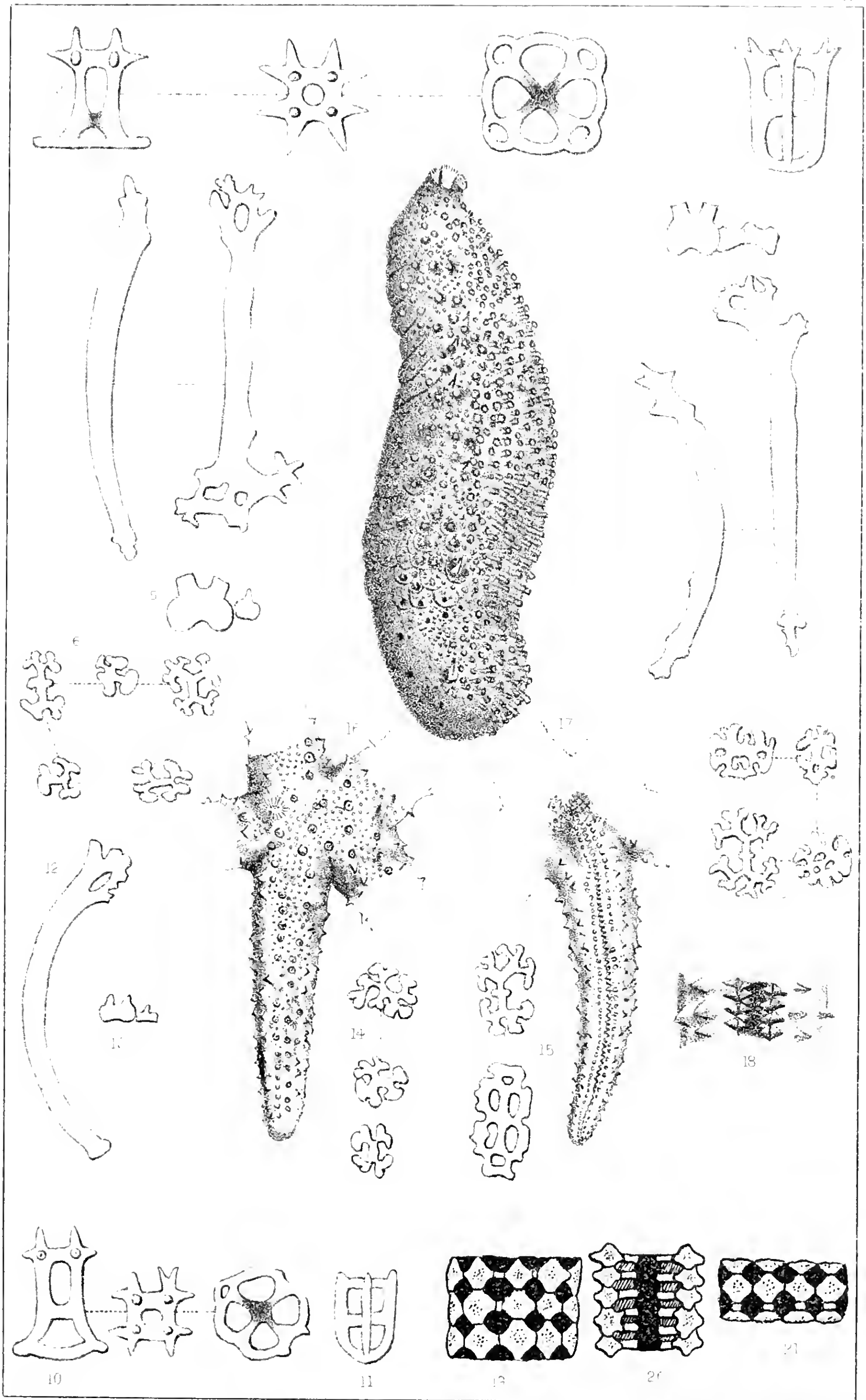


PILSBRY, NEW AMERICAN MOLLUSKS.



THE CORAL REEFS OF
VERA CRUZ
FROM SURVEYS CORRECTED TO
1885
Depths in Fathoms.


PORT OF VERA CRUZ.
From the Survey of Don Fabio Ali Ponzoni
1806
Depths in Fathoms.
Punta Gorda
Reefs of Pta Gorda
Pta Majaqua
Pta de la Caleta
Caleta
VERA CRUZ
Castle of S. Juan de Ulloa
Gallega
Gallesquilla
Matadero
R. Tenoria
Christo
Pta de Hornos
Lavandera
Ia Blanquilla
Beacon
Beach of Pampanos
Mersey Shl
Terranova
Pajaros
Ia Sacrificios
Ia Verde
Anegada de adentro
Two Nautic Miles



Ives del. Geo. Harris & Sons Lith.

IVES, MEXICAN ECHINODERMS.

and the West Coast of Central America. Vidensk. Selsk. Skrift. Kjöbehavn, p. 179.

1865. Theodore Lyman. Illustrated Catalogue of the Museum of Comparative Zoology at Harvard College. No. 1 Ophiuridæ and Astrophytidæ. Mem. Mus. Comp. Zool., Vol. 1. Includes a description of the principal West Indian Ophiurans.

1867. A. E. Verrill. Comparison of the Tropical Echinoderm Faunæ of the East and West Coasts of America, Trans. Conn. Acad., Vol. 1, p. 339.
Notice of the Corals and Echinoderms collected by Prof. C. E. Hartt, at the Abrolhos Reefs, Province of Bahia, Brazil, 1867, Ibid, p. 357.

1869. Alexander Agassiz. Preliminary Report on the Echini and Starfishes dredged in deep water between Cuba and the Florida Reef by L. F. de Pourtalès, Assist. U. S. Coast Survey, Bull. Mus. Comp. Zool., Vol. 1, p. 253.

1869. Theodore Lyman. Preliminary Report on the Ophiuridæ and Astrophytidæ dredged in deep water between Cuba and the Florida Reef by L. F. de Pourtalès, Assist. U. S. Coast Survey. Ibid, p. 309.

1869. L. F. de Pourtalès. List of Holothuridæ from the deep sea dredgings of the United States Coast Survey. Ibid, p. 359.

1871. Axel. Vilh. Ljungman. Förteckning öfver ute Vestindien af Dr. A. Goës samt under Korvetten Josefinas Expedition in Atlantiska Oceanen samlade Ophiurider. Ofvers. Kongl. Ventensk. Akad. Förhandl. No. 6. Stockholm.

1871. Theodore Lyman. Supplement to the Ophiuridæ and Astrophytidæ, Mem. Mus. Comp. Zool., Vol. II, No. 6. Description of deep sea and shallow water Ophiurans from Florida.

1871. Chr. Lütken. Fortsatte kutiske og beskrivende Bidrag til Kundskal an Söstjernerne (Asteriderne) Vidensk. Meddel. Kjöbehavn. Includes a revison of the tropical American species of Echinaster.

1872. Alexander Agassiz. Echini of the Eastern Coasts of the United States together with a report on the deep sea Echini collected in the straits of Florida by L. F. de Pourtalès Assist., U. S. Coast Survey in the years 1867–1868. Mem. Mus. Comp. Zool., Vol. III, Part II.

1874. The Zoological Results of the Hassler Expedition.

i. Alexander Agassiz and L. F. de Pourtalès. Echini Crinoids and Corals.

ii. Theodore Lyman. Ophiuridæ and Astrophytidæ, including those dredged by the late Dr. Stimpson. Mem. Mus. Comp. Zool., Vol. IV. Includes descriptions of West Indian species.

1878. Edmund Perrier. Etude sur la répartition géographique des Astérides. Nouv. Arch. Mus. Hist. Nat. (2) t. 1, p. 1.

1879. Richard Rathbun. A list of the Brazilian Echinoderms with notes on their distribution, etc. Trans. Conn. Acad. vol. 5, p. 139.

1879. Reports on the results of dredging, under the supervision of Alexander Agassiz, in the Gulf of Mexico, by the United States Coast Survey steamer "Blake," Lieut.-Commander C. D. Sigsbee U. S. N. commanding. II, Bull. Mus. Comp. Zool. vol. 5, p. 181.

Alexander Agassiz. Report on the Echini.

L. F. de Pourtalès. Crinoids and Corals.

Theodore Lyman. Ophiurans.

1881. Alexander Agassiz. Report on the Echinoidea dredged by H. M. S. Challenger during the years 1873–1876.

1882. Theodore Lyman. Report on the Ophiuroidea, dredged by H. M. S. Challenger during the years 1873–1876.

1882. Hubert Ludwig. Verzeichniss der von Prof. Dr. Ed. Van Beneden an der Küste von Brasilien gesammelten Echinodermen. Mem. Cour. Acad. Roy. Belgique, Vol. XLIV, No. 5.

1883. Alexander Agassiz. Reports on the Results of Dredging under the supervision of Alexander Agassiz, in the Gulf of Mexico (1877–78), in the Caribbean Sea (1878–79) and along the Atlantic Coast of the United States (1880), by the U. S. Coast Survey Steamer "Blake." Report on the Echini. Mem. Mus. Comp. Zool., Vol. X, No. 1.

1884. Ed. Perrier. Memoire sur les étoiles de mer recueillies dans la mer des antilles et le Golfe de Mexique. Nouv. Arch. Mus. Hist. Nat. (2), t. vi.

1885. Richard Rathbun. Report upon the Echini collected by the U. S. Fish Commission Steamer "Albatross" in the Caribbean Sea and Gulf of Mexico, January to May, 1884, Proc. U. S. Nat. Mus., Vol. viii, p. 83.

Report upon the Echini collected by the U. S. Fish Commission Steamer "Albatross" in the Gulf of Mexico from January to March, 1885, ibid. p. 606.

1886. Hjalmar Théel. Report on the Holothuroidea dredged by H. M. S. Challenger during the years 1873–1876. Includes faunal lists and description of West Indian species.

1886. Hjalmar Théel, Report on the Holothuroidea, dredged by the "Blake." Bull. Mus. Comp. Zool. Vol. xiii, p. 1. Report upon species collected in the West Indian region.

1887. H. F. Nachtrieb. Notes on Echinoderms obtained at Beaufort, N. C. Johns Hopkins University. Studies from the Biological Laboratory, Vol. iv, p. 81.

1888. Angelo Heilprin. Contributions to the Natural History of the Bermuda Islands. Proc. Acad. Nat. Sci. Phila. p. 309.

1889. W. Percy Sladen. Report on the Asteroidea collected by H. M. S. Challenger during the years 1873–1876. Includes faunal list and description of West Indian species.

Explanation of Plate VIII.

Fig. 1. *Holothuria Heilprini*, side view, natural size. Drawn from the contracted alcoholic specimen.

Fig. 2. Perfect table viewed from the side, above and below.

Fig. 3. Imperfect table from around the disks of the pedicels, viewed from the side.

Fig. 4. Rib-like rods of the papillæ.

Fig. 5. Two segments of calcareous ring.

Fig. 6. Rosettes.

Fig. 7. *Holothuria Silamensis.* Two segments of the calcareous ring.

Fig. 8. Rib-like rods of the papillæ.

Fig. 9. Rosettes.

Fig. 10. *Holothuria nitida.* Perfect table, viewed from the side, above and below.

Fig. 11. One of the imperfect tables occurring around the disk of the pedicels, viewed from the side.

Fig. 12. Rib-like rod from the papillæ.

Fig. 13. Two segments of the calcareous ring.

Fig. 14. Small common rosettes.

Fig. 15. Larger uncommon rosettes.

Fig. 16. *Echinaster Brasiliensis* natural size, dorsal surface.

Fig. 17. Ventral surface.

Fig. 18. A portion of the ventral surface, enlarged two diameters to show the three rows of ambulacral spines.

Fig. 19. *Thyraster serpentarius.* Portion of the dorsal skeleton of an arm, enlarged about four diameters.

Fig. 20. Portion of the ventral skeleton of same.

Fig. 21. Portion of the lateral skeleton of same.

OCTOBER 7.

The President, Dr. JOSEPH LEIDY, in the chair.

Thirty persons present.

Papers under the following titles were presented for publication:—

"Eocene Mollusca of the State of Texas." By Prof. Angelo Heilprin.

"The Fossils of the Orizaba Marble of Mexico." By Prof. Angelo Heilprin.

The Publication Committee reported in favor of publishing a paper entitled "On the Influence of Previous Pregnancies on Offspring," by Charles Morris, in a medical journal to be selected by the author.

Beroe on the New Jersey Coast.—PROF. LEIDY exhibited drawings of a Beroe, which he had observed in considerable numbers in Little Egg Harbor, at Beach Haven, N. J., the end of last August. In swimming, it ranged from an inch to about four inches in length; the larger ones being red, the smaller ones much paler or even colorless, while occasionally some of intermediate size appeared yellowish. It was compressed cylindrical, prominently ribbed, domed at top and truncate at the mouth. Specimens caught and kept in a dish became shorter, proportionately broader and to a variable degree more bulging above. The ciliated ribs, or ambulacra, were variably prominent and the intervals variably concave or convex in accordance with the contractile movements of the body and the projection of the ribs. The mouth was elliptical and as wide as the body, but contractile so as to become narrower. All the ribs extended from the summit of the dome to the margin of the mouth. The coloring was superficial and especially well marked in the course of the ambulacral vessels and their lateral ramifications. The endoderm was colorless, as were also the lateral gastric vessels beneath it.

Several individuals were taken with masses of colorless jelly in the stomach, seemingly portions of *Cyanea arctica*, fragments of which occurred abundantly on the open sea coast in the vicinity.

The summit of the body of the Beroe, the seat of the sense organs, appeared specially sensitive, as on near approach of an instrument without touching, it would suddenly retract and become depressed. At night, on irritation of the Beroe, it displayed brilliant bands of light with iridescent hues streaming along the ribs, but not elsewhere.

The New Jersey Beroe is probably the same as that found on the New England coast, described by Agassiz as *Idyia roseola* (Contrib. pl. I, figs. 1, 2); very like the *Beroe ovata*, of the Mediterranean, of Chun, (Die Ctenophoren des Golfes von Neapel, pl. xiv, fig. 1), which seems to accord with the *B. Forskalii* of the Règne Animal, pl. 56, fig. 1, but not that of the latter author.

Eschscholtz describes *Beroe ovata*, from the West Indian seas, as a large colorless species with only two of the ribs reaching the mouth, (System der Acalephen, p. 36.)

The aboral view of our Beroe is like that given of *B. Forskalii* in the Règne Animal, fig. 1b, and those of *Idyia roseola*, fig. 99 and *Idyiopsis Clarkii* fig. 102, in the Contributions of Agassiz.

OCTOBER 14.

Mr. CHARLES P. PEROT in the chair.

Twenty-six persons present.

OCTOBER 21.

The President, Dr. JOSEPH LEIDY, in the chair.

Eighty-three persons present.

Papers under the following titles were presented for publication:—

"Note on the soft parts and dentition of Stomatella." By H. A. Pilsbry.

"Notes on some Entozoa." By Joseph Leidy.

OCTOBER 28.

The President, Dr. JOSEPH LEIDY, in the chair.

Ninety-one persons present.

The death of Prof. Wenzel Gruber, a correspondent, was announced.

A paper entitled "An attempt to illustrate some of the primary laws of Mechanical Evolution," by John A. Ryder, was presented for publication.

Messrs Chas. S. Welles and Thomas B. Harned and Miss Ida Keller, Ph. D. were elected members.

Prof. Ernst Haeckel of Jena and Prof. Edw. L. Greene of Berkeley, Cal. were elected correspondents.

The following were ordered to be printed:—

TROCHIDÆ, NEW AND OLD.

BY H. A. PILSBRY.

Since my monograph of this family[1] was written, a number of specimens inviting notice have come into my hands.

Monodonta labio Linné, var. **granulata** Pilsbry.

I have received from two sources specimens of a *Monodonta* referable to *labio*, but having an interstitial row of granules in each interliral groove; these intervening grained liræ becoming almost as prominent as the principal ones on the last whorl. The number of granose liræ is thus about doubled, giving quite a distinct aspect to the shells. This is the more remarkable from the fact that in the large suite of *M. labio* before me last year, none showed any trace of granose interstitial lirulæ. The color is uniform ashen, one shell showing small subsutural purple spots. All of the liræ are markedly granose.

Fig. 1

Monodonta neritoides Philippi.

This shell I placed in the Section *Neodiloma* of the genus *Monodonta*, in the Manual of Conchology, although with considerable doubt. From an examination of specimens recently presented to the Academy by Mr. John Ford, it becomes obvious at once that both *M. neritoides* Phil. and *M. perplexa* Pilsbry belong not to *Neodiloma* but to typical *Monodonta;* being furnished with a strong tooth at the base of the columella.

The description of Philippi applies to the specimen before me except that this has a green streak outside the columella, and is larger; alt. 14, diam. 16 mm. The aperture is much more oblique than in any other toothed species of *Monodonta*, except the *M. perplexa*, a shell closely allied to *neritoides*, differing in color-pattern, the more elevated acute spire, and the obvious spirals visible on the whorls and within the mouth.

Dunker's figures of *neritoides* (Index Moll. Mar. Jap. pl. 6, figs. 22, 23) are much more globose and smaller than Mr. Ford's example, but agree well with numerous specimens before me collected by Mr. Frederick Stearns in Japan. See also Manual of Conchology, xi, p. 468, pl. 38, figs. 20, 21.

[1] Manual of Conchology, 1st series, vol. XI, 1889.

Euchelus alabastrum Reeve.

This shell has the globose-conical form common to the more elevated species of the genus. The aperture occupies less than half the altitude of the shell. It is umbilicate, solid and thick, the surface lusterless and chalky-white having a few dark dots on the spiral carinæ. The sculpture consists of elevated spirals, flange-like and curling upward, with a very beautiful fine crenulation on the concave upper surfaces of the flanges. The third spiral is at the periphery of the body-whorl; below it there are six spiral cords, the lower four exquisitely serrated, the last one within the edge of the funnel-shaped umbilicus. The whorls of the spire are tri-carinate; sutures excavated. The mouth is very oblique, closely lirate within; columella nearly straight, toothed near the base.

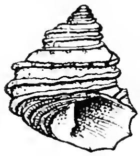


Fig. 2.

Alt. 17, diam. 16⅔ mm.; oblique alt. of mouth 13 mm.

This form was badly described by Reeve in P. Z. S. 1854, p. 209. It has not been noticed by subsequent authors. As it is so well-marked a species, it seems worth while to have a recognizable description and figure published. The habitat is Diego Garcia, a little island near Mauritius.

The specimen figured was given me by Mr. C. W. Johnson.

THE PERISOMIC PLATES OF THE CRINOIDS.

BY CHARLES WACHSMUTH AND FRANK SPRINGER.

In nearly all Crinoids, recent and fossil, in which the free arms do not start out directly from the (first) radials, the lower arm joints are incorporated into the calyx either by soft tissues, or by means of plates to which the term *interradials* has been applied. The interradials are exceedingly variable in form and character, being in some groups well developed, rigid plates; while in others they are irregular, ill-formed pieces or mere limestone particles resting within soft tissues. The great difference in their structure among different groups led to the belief that the rigid and regularly arranged plates, which are so characteristic of the Camerata, did not belong to the same system of plates as the irregular, small pieces which unite the rays of recent Crinoids, and Dr. P. H. Carpenter applied to the former the term "calyx" interradials, as opposed to the interradial plates of the disk.

A somewhat similar distinction has been made respecting the plates which form the ventral pavement. The heavy, rigid plates of Palaeozoic forms were called "vault" plates, the small, irregular pieces of later and recent Crinoids "perisomic" or "disk" plates. The term "vault" was applied generally in cases in which mouth and food grooves are permanently closed, and "disk" where mouth and food grooves are opened out.

In the Camerata the interradials are arranged on a definite plan. They are stout, large, and united by close suture, so as to make the whole test to the bases of the free arms extremely rigid. In the Actinocrinidae the interradial series invariably commence with one plate which is followed by two in the second row, and two, three or four, according to species, in the succeeding ones. The posterior interradius is wider and split vertically into two halves by a series of anal plates which support the anal tube. In the other families of the Camerata, the Reteocrinidae excepted, the arrangement of the interradials is similar and equally regular. But in the Platycrinidae and Hexacrinidae the first row consists of three or more pieces, and in the Rhodocrinidae the first interradial is interposed between the radials. The plates forming the ventral side of the calyx are as rigid as those of the dorsal side, and none of them are described as pierced by water pores. They consist normally of five irregular orals, of which the posterior one is larger and pushed in between the four others, and of the so-called interradial dome plates, which connect with the interradials of the dorsal cup. Occasionally there are outside the orals, a few other large pieces known as the radial dome plates. In some species the orals are unrepresented, and the whole ventral surface of the calyx is studded with interradial plates. The mouth in none of the Camerata is exposed, but the ambulacra with tightly closed food grooves are frequently visible.

The inner floor of the ventral covering in most of the Actinocrinidae is deeply grooved so as to form well-defined galleries which lead to the arm bases. Within these galleries is observed quite frequently, but, so far as we know, only in *Batocrinus*, *Eretmocrinus*, *Dorycrinus*, *Actinocrinus*, *Teleiocrinus* and *Physetocrinus*, a sort of second integument[1] parallel with the upper, which we took to be the disk. It consists of rather irregular, ill-formed plates, arranged like those at the upper surface. Each plate is connected with the corresponding upper one by small surfaces or pillars, but the plates among themselves are not in contact laterally leaving open spaces or meshes between them. They constitute, as it appears, a kind of internal lining or net-work, which extends from the first costals[2] and first interradials uninterruptedly to the margins of the orals, but no further. In some specimens the inner plates are less distinct, and we find at the inner floor small pillars or nodes, but nothing like plates. Within the galleries the intervening spaces are occupied by the ambulacra. The latter take the form of radiating tubes which run parallel with the inner floor, and branch as often as there are bifurcations in the calyx. Each tube is composed of four rows of plates, two above and two below, the upper ones alternately arranged with a furrow along the median line. The arrangement of the tubes and their mode of branching are best observed in natural casts. Looking at such a specimen, it seems indeed as if it could be scarcely possible that the surface as it there appears, with the vault plates removed, the ambulacra stretched out upon the upper face, resting within an integument of irregular pieces, could represent anything but the disk as exposed at the ventral surface of the Comatulae.

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[1] For a more complete description of this integument see Revision of the Palaeocrinoidea, Pt. III, p. 60.

[2] The terms costals, distichals and palmars are explained in a paper of Dr. Carpenter. (Ann. and Mag. Nat. Hist., July number, p. 15).

As another proof that there actually were two integuments in some Crinoids, we considered *Siphonocrinus armosus* from the Niagara group. This species, so well known from natural casts, apparently has a large trumpet-shaped, subtegminal anal tube, which crosses the mouth, overlies the upper part of the anterior ambulacral tubes, and is continued subtegminally all the way to the anterior side of the calyx, even beyond the arm regions, where it bends outward. The case is best illustrated if we imagine the disk of a recent Crinoid, with an anal tube like that of *Antedon regalis* (Chall. Rep. on Comat., Pl. 46, fig. 2), extended out all the way to the arm bases of the anterior ray, and covered by a vault.

It seemed to us beyond a doubt that in the foregoing cases two distinct structures covered the body, and it was upon these specimens, principally, that we based the opinion that the Camerata had a vault and a subtegminal disk. In taking this view, we did not overlook the fact that in many of these Crinoids, throughout different groups, the covering plates of the ambulacra are exposed upon the surface; but this seemed to us not to offer any serious objection, for the ambulacra in all Camerata, at one place or another, come to the surface from beneath the "vault," whether within the limits of the calyx or at the bases of the free arms. A very interesting case was illustrated by us in our Revision of the Palaeocrinoidea, Pt. III, Pl. V, fig. 9; in which the ambulacra do not enter the surface at the outer edges of the orals as in most species of *Platycrinus,* nor at the arm bases, but at a place midway between orals and arms, from beneath the smaller vault plates.

It is a striking fact, in the Crinoids as elsewhere, that some characteristics which are of the utmost importance from a morphological point of view, prove to be of comparative little value for classificatory purposes. This is the case to a very high degree with regard to the ambulacra of the Platycrinidae and Actinocrinidae, which may be tegminal or subtegminal. In the Platycrinidae the covering pieces are generally exposed in the calyx; in the Actinocrinidae, however, they are, as a rule, hidden from view, or were supposed to be so. But the opposite is also the case in both groups, and even within the limits of a genus. *Actinocrinus stellaris* from Belgium has large, well-defined covering pieces passing out from the outer edges of the orals; while most species of *Actinocrinus* only have in place of them so-called radial dome plates of a first, second and third order, according to the number of bifurcations in the calyx.

Physetocrinus, which is but a modified *Actinocrinus*, in some species has orals and radial dome plates, while in others the whole ventral surface is covered by numerous irregular pieces. *Actinocrinus multiradiatus*, on the contrary, has but few very large ventral plates which interlock with those between the rays. In most of the Actinocrinidae the interradials pass insensibly into the vault, there being no dividing line; while in *Batocrinus* generally, but not always, the interradials of the dorsal side are distinctly separated from those of the ventral side by the overarching brachials, a structure which led us at first to suppose the plates of the two sides to be morphologically distinct.

Similar differentiations we find in the ventral structure of the Platycrinidae and Hexacrinidae. In some of their species the pavement is made up entirely of massive plates, in others of comparatively thin pieces; while in still others the ventral surface is occupied almost exclusively by the orals. In both these groups absolutely no distinction can be made between interradials and vault plates. The first row, which generally consists of three plates, is peripheral, and is followed by other rows which are strictly ventral. The plates forming the second and upper rows, when such are present, interlock with each other and those of the first row, in a similar manner as the interradial plates of the dorsal cup in an *Actinocrinus*.

The conditions of the ventral pavement in the Melocrinidae, Rhodocrinidae and Glyptasteridae are very similar to those in the Actinocrinidae and Platycrinidae; many of them have uninterrupted rows of covering pieces exposed upon the surface, but the plates as a rule are smaller, less regular in their arrangement, and the orals and radial dome plates are more rarely represented. The lower interradials in all of them are definitely arranged, and there is no line of demarkation between the two hemispheres except that produced by the arms which pass out between them. In the Reteocrinidae, as in most of the Silurian Camerata, the whole ventral surface is covered by minute irregular pieces, and similar plates, with a few somewhat larger ones scattered among them, are interposed between the rays from the basals up. In the Crotalocrinidae and Acrocrinidae, the calyx ambulacra are exposed; their covering pieces are comparatively small, and remarkably regular in their arrangement.

Dr. P. H. Carpenter (Chall. Rep. on Stalk. Crin., pp. 165 and 166) agrees with us that the calcareous network beneath the vault of an *Actinocrinus* "corresponds to the limestone particles on the surface of the internal casts, and represents the ambulacral plates developed in the perisome of recent Crinoids." He also admits "the complete resemblance between the ventral perisome of a recent Crinoid and the upper surface of the body beneath the vault of an *Actinocrinus*." Vault and ventral disk, he says, "are entirely distinct structures." Of the vault, he says further (p. 172) "I believe the oral or actinal system forming the vault of *Actinocrinus* to have been developed on the left larval antimer, in exactly the same way as the apical or abactinal system is developed on the right; but the oral system, instead of being limited to five oral plates as in Neocrinoids, reached a very extensive development, so that in its completest form it represents such a parallel to the apical or abactinal system as is to be met with in no other Crinoid." From these passages and others in the Challenger Report, especially on p. 180,[1] to which we shall refer again, it appears Dr. Carpenter supposed that in *Actinocrinus* all plates of the calyx up to the arm bases were abactinal, and all constituting the ventral side actinal, not only the orals and the so-called radial dome plates, but also the smaller plates, the so-called interradial dome plates, surrounding them. Similar views were held by us and advocated in Pt. II of the Revision (pp. 14 to 21), but abandoned in Pt. III, (pp. 16 to 27) as to the interradial dome plates, which we regarded as a continuation of the interradial plates of the dorsal cup, and not as actinal structures.

All interradial and interaxillaries, not only in the Camerata but wherever they exist in recent or fossil Crinoids, increase by multiplication in the growing animal, and as such, are auxiliary pieces filling up spaces between the rays and their sub-divisions. They increase primarily in an upward direction, but partly also by intercalation, secondary plates being introduced between the primary ones. It is owing to the intercalation of these supplementary pieces that the arrangement of the interradial plates in the upper rows is less regular than it might be otherwise. In the simpler forms such supplementary pieces are wanting, or they occur only around the arm bases; while in the Reteocrinidae they constitute the greater part of the interradial and interaxillary areas. In this family small pieces in large numbers continually formed in the growing Crinoid along the margins of the radials and brachials, and between

[1] All quotations from the writings of Dr. Carpenter, if not otherwise stated, are from the Challenger Report on the Stalked Crinoids.

the regular interradials, so as to isolate these from their fellows and from the plates of the rays.

The interradial plates, as stated before, are continued into the vault, and in species in which there are but one or two bifurcations in the calyx, this is quite readily perceived; but in the more complex forms the primary structure is frequently obscured by the introduction of numerous supplementary pieces, and it appears as if the plates of the ventral side belonged to a distinct system. Looking at a specimen of *Strotocrinus*, with its broad flanging rim, its hundred and more arms crowded around it, and its thousands of minute vault plates, decreasing in size outward, and in no way connected with the interradials of the dorsal side, it is not surprising that Carpenter regarded them, as we did at first, as structurally distinct from the latter.

To understand the structure of *Strotocrinus* let us refer to the allied genus *Steganocrinus*, in which in a similar way the arms branch off alternately like pinnules from the two main divisions of the rays; but while in *Strotocrinus* the lower part of the arms is incorporated into the calyx, forming a continuous rim, from which the free arms start off, in *Steganocrinus* the two divisions of the rays with their small alternate arms are free, and extend out laterally in the form of free tubular appendages. Now, it is very interesting to find that in *Steganocrinus* the interradials meet the plates of the dome in such a manner that it is absolutely impossible to draw a line between them (see *Steganocrinus pentagonus*, Iowa Geol. Rep. Hall., Vol. I, Pt. II, Pl. 10, figs. 6 a, b.). The case of *Steganocrinus* becomes the more instructive because this genus with its free arms may be regarded as representing an early stage in the developmental history of *Strotocrinus*.

A structure similar to that of *Steganocrinus* is found in all Camerata in which the arms become free after the first bifurcation, and from this condition all gradations can be traced to the complex structure of *Strotocrinus*. We are therefore of the opinion that the interradials interposed between the rays, and those at the dome, must be regarded as parts of the same element, and as representing a system of plates introduced between the actinal and abactinal systems, but actually belonging to neither.

More than in the Actinocrinidae, Dr. Carpenter differs from us as to the structure of the Platycrinidae. The ventral pavement of an *Actinocrinus* he calls "a structure sui generis," *i. e*, different from that of a *Platycrinus*. He is inclined to believe (Chall. Rep. on Stalk. Crin., p. 180), "that the vault of a Platycrinoid corresponds collectively to the orals, interradials, ambulacral and anambulacral plates of Neocrinoids." He regards (p. 178) the peripheral portion of the "vault," by which he means the zone between the so-called summit plates and the radials, as generally corresponding to the large interradial of *Cyathocrinus*, and to the single interradial of *Coccocrinus*. As to the plate of *Cyathocrinus* we cannot agree with him for reasons which will be stated further on. That of *Coccocrinus* obviously represents the "calyx interradials" of *Platycrinus*, and not a plate of the peripheral zone.

In referring to *Marsupiocrinus* he says (p. 176), "I have a very strong impression that the so-called vault of this genus is really the strongly plated ventral perisome," and "I cannot see any such essential difference between it and the plated disk of *Pentacrinus wyville-thomsoni* or of many *Antedons* (Pl. XVII, fig. 6; Pl. LV.) as would lead to the supposition that the homologue of the latter is to be sought for beneath the vault of *Marsupiocrinus*." He then alludes to the closure of the mouth, and to the covering pieces proceeding from the perisome, which may have been immovably closed down over the food grooves: "They were thus converted into tunnels, but were still 'external,' in the sense of not being covered by a 'tegmen,' as those were which formed the tubular skeleton beneath the vault of the Actinocrinidae."

We have pointed out before that the covering pieces are exposed not only in the Platycrinidae, but quite frequently also in other families of the Camerata, exceptionally even in the genus *Actinocrinus*. Now, if it were true that in Crinoids in which the calyx ambulacra are entirely subtegminal, and not only the ambulacra but the whole disk is covered in by a structure "*sui generis*," and on the contrary, in forms in which the ambulacra are exposed there is no vault, and the plates in which the ambulacra rest form the disk, it seems to us that the two groups should be distinguished as separate orders; and it would seem to follow that all attempts heretofore made toward classifying the Crinoids would be altogether arbitrary and worthless. It was these considerations which led us to believe that the integuments in both cases must be the same thing, either a vault or a disk, the plates either all vault pieces or all perisomic. The evidence seemed to be conclusive that the disk, at least in some groups, was subtegminal, and this, which was accepted by leading authorities, led us to assume that in all Camerata the true disk was covered in by a vault. In fact this seemed to be corroborated by the nature of the plates, which, although varying considerably in size and number, in all these Crinoids are arranged on the same general principle, forming in all of them a compact rigid test, and in all of them mouth and food grooves being perfectly closed.

We have already stated that in some species of *Platycrinus* the ambulacra make their appearance not at the margins of the summit plates, but at some point between the orals and the arm bases, from beneath the upper ring of interradials. In these species, applying Carpenter's interpretation, the lower interradials would be perisomic for they enclose the ambulacra, and the upper ones vault plates because they do not. In *Pterotocrinus*, the last survivor of the Hexacrinidae, the vault, as Dr. Carpenter admits (p. 177), "seems to have had a closer resemblance to that of *Actinocrinus* than is the case in most Platycrinidae, for it has radial dome plates of the first, second, and even occasionally of the third order." Such radial dome plates, he supposed, existed also in some Platycrinidae, and he asserts "There was a membranous disk, the radial regions of which were traversed by the ciliated food grooves beneath the ambulacral skeleton above; while the inter-palmar regions supported the interradial plates of the vault." In the Actinocrinidae, however, he thought, the tegmen was further extended so as to cover the whole ventral surface.

We never imagined that *Platycrinus* had anything but a membranous disk, but we thought that the disk was continued underneath the interradial plates all the way to the arm bases. Neither did we suppose there were any further plates above the food grooves but the alternating pieces; nor that the latter were true vault plates as Dr. Carpenter on p. 179 seems to have inferred we did. We held that, while in the typical *Actinocrinus* the interradial dome plates meet over the ambulacra, and form more or less elevated ridges upon the surface, the "vault" of the Platycrinidae, by opening out, exposed the covering pieces, and these were gradually incorporated into the test. In a typical Platycrinoid the covering pieces are so modified as to lose almost altogether their original character, being as large and nearly as heavy as the surrounding plates, and they are united with the latter, and with one another, by close suture. In some of the later Platycrinidae the covering pieces even may have been separated from the food grooves, for in the internal casts nothing is found but the impressions of these plates, while in casts of *Actinocrinus*, from the same locality, and in casts of certain Silurian Platycrinidae, probably *Cordylocrinus* or *Culicocrinus*, in which the covering pieces perhaps were less modified, the outlines of the ambulacra are sometimes sharply delineated, and apparently formed solid tubes embracing the ambulacral vessels and food grooves.

It is to be observed, that while Dr. Carpenter regarded the interradial pieces of *Platycrinus* as perisomic plates, he alludes to the ventral covering of that genus as a vault, including the *anambulacral* plates (p. 180); while in speaking of the ventral surface of the Reteocrinidae, Ichthyocrinidae and the genus *Glyptocrinus*, he generally applies the terms "disk" and "interpalmar area." We allude to this fact, as he criticised us on p. 166 for using these terms indiscriminately in our writings. He explains the terms as follows: "The expression 'oral disk' or 'ventral disk' is universally used to denote the upper surface of the visceral mass of a Crinoid, *i. e.*, that in which the mouth is placed with the food grooves radiating outwards from the peristomial area around it." The ventral covering of *Platycrinus*, accordingly, should be called a disk like that of *Glyptocrinus*, if it really is as, he maintains, morphologically in a similar condition.

The ventral structure of the Melocrinidae and Rhodocrinidae, Carpenter probably supposed to have been in the same condition as that of the Actinocrinidae and Platycrinidae, a disk when the ambulacra are exposed, and a vault when they are concealed. He considers *Glyptocrinus* in connection with the Reteocrinidae and Ichthyocrinidae, in all of which the ventral pavement is composed of an immense number of very minute, irregularly arranged pieces, which in the Ichthyocrinidae are traversed by regular rows of alternating pieces passing out from the mouth to the arms; in the other families, however, such alternating plates, if present at all, are found only near the arm bases. Carpenter says in reference to these groups (p. 185), "I venture to think that in the case of *Glyptocrinus*, *Reteocrinus* and *Xenocrinus*, and also of the Ichthyocrinidae, the resemblance to the Pentacrinidae, Apiocrinidae, and Comatulidae is such as to leave no reasonable doubt that the so-called vault of these Palaeocrinoids is homologous with the ventral surface of the body in the Neocrinoids." This is perfectly true as to *Taxocrinus* and *Onycho-*

crinus, and probably the Ichthyocrinidae generally, in which mouth and food grooves are exposed, as we now know from actual observation[1]; but in the case of *Reteocrinus* and *Glyptocrinus* he had no proof beyond a superficial resemblance of the plates. Similar plates occur among species of the Actinocrinidae and Melocrinidae in the same genus, together with species with large plates, and all of these must be perisomic or none of them.

We now take up the Inadunata, which we have sub-divided in Pt. III of the Revision, into Larviformia and Fistulata.

The Inadunata Larviformia were regarded by us as representing the larval state of the Crinoids in a persistent form. The most complex Actinocrinoid or Cyathocrinoid must have passed in early life through a stage in which it closely resembled *Haplocrinus*, when the entire calyx consisted of basals—sometimes underbasals—radials, and orals. To these plates subsequently in *Symbathocrinus* an anal plate was added, but this disappeared in the later *Allagecrinus*. The three stages here alluded to, which are represented phylogenetically by distinct genera or families within the group, recur in the embryonic development of recent Crinoids.

The most characteristic embryonic feature of this group, is the covering of the ventral side by orals only. The plates of *Haplocrinus* were called by us orals in Pt. II of the Revision; but when later on we thought we had discovered centrally within this ring of plates another plate, we regarded this as the representative of the orals (Rev. Pt. III, pp. 31 to 34), and those surrounding it as interradial plates. Subsequently discovering conclusively that such a plate does not exist, we admitted our mistake[2] and recognized the *scheitelplatten* as orals. The Larviformia, therefore, have neither interradial nor interambulacral plates, and that they were in a low state of development is seen also by their arm structure. By far the most of them have but one arm to the ray, and their arm joints are immovably united by suture, but the union between radials and brachials is by articulation. Even in *Haplocrinus*, probably the lowest known form of this group, the radials are perforated. The earliest Larviformia known to us are from the Upper Silurian, but

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[1] Discovery of the Ventral Surface of Taxocrinus and Haplocrinus, and consequent Modifications in the Classification of the Crinoidea, by Charles Wachsmuth and Frank Springer; Proc. Acad. Nat. Sci. Phila., 1888, pp. 337–363.

[2] Ibid., p. 340.

these were evidently preceded by lower forms, which have so far escaped notice, owing perhaps to their diminutive size. We think this the more probable as the species throughout this group are exceedingly small, some of them almost microscopic.

From *Haplocrinus* to *Hybocrinus* and *Heterocrinus* there is but a small step. All three have compound radials, and in the two latter the ventral sac, which represents the best character of the Fistulata, is in its first stage of development. The transitions from *Symbathocrinus* through the Hexacrinidae to the Actinocrinidae are equally gradual, in the latter the orals being carried inward by supplementary plates interposed between radials and orals. *Symbathocrinus* has an anal plate, and its orals had already that asymmetric arrangement—the posterior one larger and interlocking with the four others—which they retain throughout the Camerata. The introduction of a single interradial plate between the proximal brachials transforms *Allagecrinus* into either *Coccocrinus* or *Culicocrinus*.

We formerly arranged among the Larviformia also the Gasterocomidae, but these will have to be removed to the Fistulata or be placed in a new subgroup. We now think that the Larviformia should be restricted to forms in which the radials are directly followed by the orals.

The *Inadunata Fistulata*, like the Inadunata Larviformia, have no interradials in the dorsal cup, the anal piece excepted, but all have interambulacral plates. Four of the interradial spaces of the dome are raised but little above the level of the arm bases, but the posterior area is extended upwards, and formed into a sac or tube of various forms, frequently rising beyond the tips of the arms. This appendage, which in all probability embraced a large portion of the visceral cavity, must not be confounded with the anal tube of the Camerata, which simply contains the rectum. The ventral sac is generally the only part of the ventral pavement preserved in the specimens, and even this in most cases but fragmentarily. It is either tubular, balloon-shaped, spiral or club shaped, and is generally pierced by pores, which, however, do not penetrate the body of the plates but merely enter the edges. The structure of the four other sides is satisfactorily known only in the Cyathocrinidae and Anomalocrinidae, and fragmentarily in the Hybocrinidae, Poteriocrinidae and Encrinidae, enough to indicate that our former definition, giving to all Fistulata but one ring of interradials, was erroneous.

We have recently been fortunate in procuring from Montgomery Co., Indiana, a large number of specimens, some 50 or 60, comprising 7 species of *Cyathocrinus* in which the entire ventral structure is in excellent preservation, in many of them to the very end of the ventral sac. They were obtained by removing the arms in some of the most perfect specimens, a sacrifice for which we were richly rewarded. We have also procured from Sweden, through the kindness of Prof. G. Lindström, careful drawings of some of the types in the Stockholm Museum which, together with the specimens above mentioned, throw a flood of new light upon the ventral structure of this difficult group, and lead to the conclusion that the various species are built on a similar plan, and do not differ so essentially as it appeared to us at first from Angelin's figures. The most aberrant form is probably represented by *Cyathocrinus alutaceus*, of which we give an enlarged figure (Pl. IX, fig. 1). In this species, the greater part of the ventral surface is occupied by 5 large well defined orals which are arranged in the same manner as those of the Camerata; the posterior plate is larger, and its upper end is inserted between the four others. The orals are surrounded by numerous irregular pieces, of which the outer ones abut against the radials. There are no large interradial plates, nor regular rows of side or covering pieces such as we find in *Cyathocrinus laevis*, but alternating with the orals, and resting against them, there is toward each ray a sub-triangular piece, resembling the so-called radial dome plates of *Platycrinus*.

The speimens, Pl. IX, figs. 2–3, both of which Angelin referred to *Cyathocrinus laevis* are either distinct species, or one of them is in a more advanced stage of growth. That represented by fig. 3 (Iconogr. Crin. Suec., Pl. 26, fig. 2) probably at one time had orals like *C. alutaceus*, but these were partly resorbed and replaced by other plates. In fig. 2 (Iconogr. Crin. Suec., Pl. 26, fig. 3*b*), the resorption of the orals was apparently complete, and their place is occupied by irregular covering pieces, which join in the center. Farther out the ambulacra have well defined side pieces, and small covering plates close the food grooves.

A very different structure is seen in the specimen, Revision Palaeocr. Pt. III, Pl. IV, fig. 2, from the Burlington and Keokuk Transition beds; in which it appears as if there had been 5 large interradial plates, leaving a wide open space in the center. The plates meet laterally, and form upon their edges deep grooves for the reception of the ambulacra. In another specimen of the same species, fig. 6, on the same plate, four of the "interradial plates" are almost completely covered by minute, very delicate perisomic pieces, but of the posterior one the greater part of the surface is bare. In *Cyathocrinus iowensis*, Pl. X, figs. 2–3, the larger plates are so closely united that it appears as if they formed a continuous undivided ring around the peristome, and served as a support for the delicate perisomic plates on top. This was the opinion of Wachsmuth, who in 1877 (Amer. Journ. Sc., Vol. XIV, pp. 183 and 184), regarded them as constituting a sort of consolidating apparatus like that described by Roemer in *Cupressocrinus*. We afterwards (Revision Pt. I, p. 12), suggested that the "consolidating plates" of *Cyathocrinus*, and those of *Cupressocrinus*, were structurally identical with the deltoids of the Blastoidea, and both homologous with the orals in the *Antedon* larva. Similar views were expressed by Prof. Zittel, Dr. Carpenter, and lately by Dr. Neumayr who all agreed that those plates in *Cyathocrinus* were orals. This interpretation, which at first seemed most plausible was abandoned by us in 1884, and also by Carpenter, owing to a morphological difficulty which it involved; for the ambulacra would then have to pass *over*, and not *between* the edges of the plates, a combination which seemed to us at variance with the nature of the orals. Since then, until lately, we have regarded these plates as interradials; but with considerable hesitation, for the plates are neither interradial nor interambulacral, but for the greater part *sub*-ambulacral. In their relations to surrounding parts they differ essentially from the interradials of *Platycrinus* or those of any other Camerate genus. Besides in *Platycrinus* the ambulacra rest against the edges of the interradials, and only the covering pieces are exposed on the surface; while in most of the Cyathocrinidae, if not in all, the whole ambulacrum rests on top of them, and the small perisomic plates sustain toward the side and covering pieces the same relations as the interradial plates of *Platycrinus*. That the plates are not orals, is further proved by the fact that there are in *Cyathocrinus iowensis* other large plates covering the peristome, which naturally represent them. The orals, which in *C. alutaceus* are unchanged through life, apparently were wholly or partly resorbed in other species, and their places occupied by large covering plates, of which the proximal ones joined in the center. This is well shown in the specimens Pl. IX, figs. 5, 7, 8, 9, and Pl. X, figs. 1–3, and seems to have been the case in *Cyathocrinus laevis* Pl. IX, figs. 2 and 3, and *Euspirocrinus spiralis*, Pl. IX, figs.

4–5; but while in all of the former species the ambulacra rest between small irregular perisomic plates which pass up from the upper ends of the radials, *Euspirocrinus* has four large "interradial" plates, and the corresponding space of the posterior side is taken up completely by the ventral tube. Whether these four plates were covered like those of *C. iowensis* and *C. gilesi* cannot be ascertained from the specimen, nor can we say whether the Silurian Cyathocrinidae generally had a large plate beneath their smaller ones; but we are convinced that such a plate is present in all Subcarboniferous species of *Cyathocrinus*.

Conceding now that those plates of *Cyathocrinus* are not orals, what are they? Interradial plates? It seems to us the fact that they support the ambulacra and are covered by perisome, proves as completely that they are not interradials as that they are not orals. If they were *calyx interradials*, the "vault" would be placed beneath the disk, while if they were *perisomic* plates there would be two disks on top of one another. Besides, the plates are subtegminal and decidedly subambulacral, and the question arises are they not wholly or in part subambulacral plates.

We have examined the two specimens of *Cyathocrinus iowensis* figured by Meek and Worthen (Geol. Rep. Illinois, Vol. V, Pl. 9, figs. 13 and 14), which are now in the Museum of Comparative Zoology at Cambridge. After comparing with them our specimens from Indiana, and several from Burlington, we became convinced that the consolidating plates, as we had called them, consist not of five but of seven plates, one to each of the four regular interradii, and three to the posterior one. Of the three latter plates, the middle one is larger, and occupies the space between the ambulacra and the ventral tube, the other two being altogether subambulacral. The middle plate, which we find in most excellent preservation in the Indiana specimens, is not covered by other plates, but is throughout profusely perforated, in a somewhat similar manner as the madreporite of other Echinoderms, and in our opinion, must have performed similar functions.

Considering now that in *Cyathocrinus iowensis*, and in the other Subcarboniferous Cyathocrinidae in which the "madreporite" is represented, the tube is imperforate, and that, on the contrary, in *Euspirocrinus spiralis* the whole space which in other forms is occupied by the madreporite, is taken up by the ventral tube, and that this is profusely perforated, it seems natural that the single plate of the former should have performed the functions which in the latter were discharged by the tube. This is further probable, if it is true that the ventral tube is the greatly extended posterior area of the ventral disk, and that the "madreporite" represents not the proximal plate of that area but the distal one. The first row of interradials of the posterior side in all Crinoids in which there is either a ventral sac or proboscis, rests upon the special anal plate, if such is present, and hence this cannot be located in a *Cyathocrinus* at the ventral side of the calyx, but must be looked for at the base of the tube facing the dorsal cup. This, it seems to us, proves conclusively that the perforated plate is a true anambulacral plate, analogous with the perforated limestone particles at the disk of recent Crinoids, and not a first interradial. Neither can we regard the two narrow pieces at either side of the "madreporite" as true interradials, for if they represented, as might be supposed, the posterior interradial split into two halves by the madreporite, they should rest like the middle one against the anal plate. They are strictly subambulacral, supporting one-half of the two posterior ambulacra, the other half resting upon the incurved lateral margins of the adjoining larger plates. This seems to suggest that not only the two smaller plates but possibly also the four larger ones, wholly or in part, are subambulacral plates, and this is not so improbable as it might seem at first sight, if we remember that these parts in all Cyathocrinidae, perhaps with the exception of *Euspirocrinus spiralis*, are covered by other structures.

We have stated before that the "consolidating plates" of *Cyathocrinus* were regarded by us and Dr. Carpenter as closely similar to, if not homologous with, the deltoids of the Blastoidea. In both these groups the plates are laterally connected, and partly covered by the ambulacra so as to be in part subambulacral; but, while in the Cyathocrinidae generally the middle or deltoid part is concealed by perisome, it is more or less exposed in the Blastoids. The similarity that exists in the structure of these plates between the two groups is best observed by a comparison with *Pentremites*. In this genus, the deltoid part is heavy, and differs quite distinctly from the concealed subambulacral portions, which are comparatively delicate.

Pentremites has also an interambulacral integument of small plates overlying the upper portions of the deltoids, which either are spinous themselves or covered with spines,[1] and we cannot help think-

[1] The Summit Plates in Blastoids, Crinoids and Cystids, and their Morphological Relations, by Charles Wachsmuth and Frank Springer (Proc. Acad. Nat. Sci. Phila., 1887, pp. 9 to 11).

ing that these plates represent morphologically the perisomic plates which cover the so-called interradials of *Cyathocrinus*.

Now, is it not possible that the deltoids are compound structures, and the concealed parts were originally separate subambulacral plates, which in palaeontological times became anchylosed with the deltoid part to give more strength to the calyx? This seems quite probable if we consider that a fusion of two or more plates often takes place among Crinoids, and that *interradial* plates, as the term denotes, cannot be *subambulacral*. Such, indeed, also might have been the case in *Euspirocrinus* in which the interambulacral parts are large and apparently not covered by perisome. It is in this regard very significant that in Blastoids with large deltoids, such as *Elaeacrinus* and *Schizoblastus sayi*, it appears from the ornamentation as if the deltoids originally might have consisted of three parts which afterwards had been anchylosed, and Lyon (Kentucky Geol. Rep., p. 489, Pl. V, fig. 1*b*), has actually described interradials in *Elaeacrinus*. In this genus we find generally upon the surface of the deltoids, parallel with the ambulacra, a short distance from them, raised lines, and all striations toward them from the ambulacra are horizontal, while those between the lines take an upward course. This feature is so universal and conspicuous, that it probably is more than mere ornamentation. Such striations upon the plates are more or less the result of growth, and this would seem to indicate, that the growth of the plates took place independently in different directions, and that the parts in question are morphologically distinct. The ambulacra of *Elaeacrinus* are narrow, and it is quite possible that in this genus the "subambulacral" pieces enclosed an interradial in the way we suggested; but that in *Cyathocrinus* they abutted laterally so as to form a support for the disk. This of course is as yet simply hypothesis and has to be substantiated.

The ventral sac of the Cyathocrinidae rarely, if ever, reaches the tips of the arms. It is closed at the upper end, and composed of vertical rows of hexagonal, rather short and solid pieces, which are so arranged that the plates of adjoining rows alternate with one another. The anus is placed near the top facing anteriorly, and closed by a small pyramid of five or six triangular pieces, resembling those of the Cystids and *Stephanocrinus*.

The tegmen of the Hybocrinidae is similar to that of the Cyathocrinidae, but the posterior interambuleral area rises but little above the level of the four others. The ambulacra are tegminal, and apparently rest upon the lateral margins of the five large plates. There are no orals, the median portions of the disk being occupied by large covering plates. The anus is closed by a pyramid of six or more pieces, surrounded by numerous irregular smaller plates.

The ventral pavement of the Anomalocrinidae, which we have observed in a fine specimen from the Museum of Comparative Zoology at Cambridge,[1] is very different from that of the Cyathocrinidae. It consists of rather large, moderately thick, irregular pieces, five or six deep, which decrease in size toward the center and cover the peristome, there being no orals or consolidating plates. The outer plates rest against the large incurved limbs of the radials, which form a wide and deep sinus at the upper face of the calyx for the reception of the ambulacra, which come out *beneath* the irregular calyx plates above, as beautifully shown in the specimen. Not only are the ambulacral plates on a lower level than the disk plates, but they are also of a different shade of color, which makes the case more instructive.

In the Poteriocrinidae, the ventral pavement has never been found in perfect preservation. We have dissected a number of finely preserved specimens, but only in one instance found small fragments of the tegmen *in situ*, which indicate that it consisted of very small delicate pieces. The plates of the ambulacra must have been also extremely fragile, for with the exception of the one instance above mentioned, we never found them preserved either upon the disk or upon the arms, owing probably to the absence of any consolidating apparatus. The form and size of the ventral sac is extremely variable in this group. In some genera it extends beyond the tips of the arms, in others consists merely of a short cone, in some of them it is tubular, in others club-shaped, in some balloon-shaped or coiled up, the sides of the whorls connected or free ; but in all cases, so far as known, the plates are arranged in vertical rows which sometimes diverge at intervals, and in all of them the edges of the plates—not their substance—are perforated by pores or clefts. The anus, wherever it has been observed, is located at the anterior side of the sac, and generally well down toward the bottom.

[1] Prof. Alex. Agassiz has given us the unrestricted use of the magnificent Crinoid collections of the Museum of Comparative Zoology at Cambridge, containing several of the finest original and typical collections ever made from different formations, both in this country and Europe. Only those who are acquainted with the extent and variety of the material thus brought together can appreciate the obligation under which his liberality has laid us.

A similar porous sac is found in the Heterocrinidae and Belemnocrinidae, but nothing is known of the other plates of the disk.

Among the Encrinidae, a ventral pavement has been discovered by Wagner (Zeitschr. d. Deutsch., Gesellsch., 1887, pp. 822 to 828). The pavement, as we infer from his description, rests against the radials, whence it rises to about the height of the third brachials, where it contracts abruptly to one-half its diameter at the base, and is surmounted by a sort of cone. The peripheral part consists of small limestone particles or irregular plates, and is decidedly flexible; while the conical part, which is composed of larger plates, is more or less rigid. Nothing is said about the ambulacra, which probably were not visible in the specimen. That the cone represents a short ventral sac, and that the Encrinidae must be classified with the Fistulata, as we have always maintained, is clearly shown from Wagner's description.

A somewhat similar disk has been observed by De Loriol in *Apiocrinus roissyanus* (Paléont. Française., 1st serie, Anim. Invertebr., Crin., p. 272), a species which is here of especial interest as having plates interposed betweeen the rays. These plates, which are large, extremely heavy, and apparently rigid, were regarded by Carpenter as true "calyx interradials." Upon this we criticised him (Revision, Pt. III, pp. 63, 72 and 137), as it appeared to us the plates must represent morphologically the same thing as the smaller plates between the rays of the Pentacrinidae and Comatulidae. They occupy not only a similar position, but also join with the plates of the ventral disk in a similar manner. A structure parallel to that of *Apiocrinus roissyanus*, we find in most of the Ichthyocrinidae and in *Guettardicrinus*. The interradials are large and heavy, rather regularly arranged, and it was the superficial resemblance that led Dr. Carpenter to regard them as homologous with the calyx interradials of an Actinocrinoid, and as morphologically distinct from the plates between the rays of the Comatulidae. This leads to the question what are "calyx" and what "disk"—interradials? The former term was introduced by Carpenter, but so far as we know, never explained by him.

It has been our impression that in all Crinoids with a vault, *i. e.*, all forms in which we supposed we found a subtegminal disk, or had reason to postulate a disk from analogy, the plates between the rays invariably were "calyx" interradials; and, on the contrary, in those Crinoids in which the disk itself formed the surface, all plates between the rays were perisomic. We arrived at this conclusion after discovering that the interradials of the Camerata are continued into the "vault," and supposed that underneath them there was another system of skeletal plates which, like the former, extended from the *upper margin of the radials up to the orals.* It was upon these grounds that we held the interradial plates of *Apiocrinus* and *Guettardicrinus* to be enormously developed perisomic plates, and upon the same principle we called the corresponding plates in the Ichthyocrinidae perisomic, as soon as we had found an open mouth and a true disk in *Taxocrinus*. The "calyx interradials," we thought, formed an upward prolongation of the dorsal cup, and the perisomic plates a downward extension of the disk, as was practically done by Carpenter in the case of the Pentacrinidae and Comatulidae, and in the Palaeozoic Reteocrinidae and Platycrinidae; while in other groups he seems to have been of the opinion that the "calyx interradials" are followed sometimes by vault—and sometimes by disk plates. In *Thaumatocrinus* he calls the large plates between the radials "calyx" interradials, and the smaller ones above perisomic plates. In *Glyptocrinus* it appears that he regarded the plates between the rays as "calyx" interradials and those of the dome as perisomic. In the Actinocrinidae, however, he thought the "calyx" interradials to be followed by a vault. All this indicates that in these groups Carpenter was influenced largely, if not altogether, by the size of the plates and their regular or irregular arrangement. He regarded the plates as "calyx" interradials and vault pieces, respectively, when large and regularly arranged, but as perisomic plates when small and of ill-formed boundaries. We allude to these facts to show that neither the small size of the plates, nor the presence of ambulacra upon the surface, are good criteria to make them perisomic plates. That there exists, however, a close resemblance in some of these forms with some of the perisomic plates of recent Crinoids, we are quite ready to admit, and in pointing this out, Dr. Carpenter, no doubt, laid the foundation for a better understanding of those structures; but he did not go far enough. He overlooked that among palaeozoic and recent Crinoids are found all intermediate stages from the membranous disk of *Antedon* to the solid vault of an *Actinocrinus* or *Batocrinus*, and this fact has led us to enquire whether all interradial and "vault" plates are not perisomic.

Ever since we discovered that the ventral surface of *Taxocrinus* is a true disk, we became convinced that the views heretofore held by us respecting vault and disk, must be greatly modified or altogether abandoned. We have since given considerable thought to the subject, and in the latter part of last year laid the results before Prof. Alex. Agassiz and Dr. Carpenter, who both encouraged us to continue our researches in that direction. Prof. Agassiz informed us that he had come to quite similar conclusions respecting those plates from his own studies, and Dr. Carpenter with his usual liberality gave us valuable hints and explanations, and now agrees with us on this question in all essential points.

The ventral pavement of the Camerata is composed of interradial plates which, as before explained, form a continuation of the plates from the dorsal cup, and these meet with the orals, where they are represented. Frequently also the covering plates of the ambulacra take part in the pavement, and a set of plates to which we gave the name "radial dome plates." As the latter plates were supposed to form an integral part of the vault, overlying the ambulacra, they deserve especial attention. They were regarded by us, and also by Carpenter, as the actinal representatives of the radials, but later investigations have shown that they are highly differentiated covering pieces. The plates appear in two forms. They are either followed by series of covering pieces, and pass out from between two orals, as in most species of *Platycrinus*; or they are in a certain sense isolated plates, surrounded by other "vault" plates, and succeeded by similar plates of higher rank, as in the case of the Actinocrinidae with subtegminal ambulacra. The former case is quite readily perceived if we examine the Silurian forms, in which, when their ambulacra are exposed, two regular series of alternating plates pass outward directly from the orals. Here either the radial dome plates are wanting, or they must be represented by the proximal covering plates. In the later Platycrinidae, the covering plates throughout lose much of their original character, being, as a rule, more extravagantly developed than in the earlier forms, and the proximal plates of each ambulacrum are larger than the succeeding ones, so as to obscure the alternate arrangement.

The "radial dome plates" of the Actinocrinidae and allied forms are generally larger than any of the surrounding plates, often nodose, and sometimes extended into long spines. They are not followed by covering pieces like those of the Platycrinidae, and, unlike them, are located at some distance from the orals, being placed in the simpler forms, with but two arms to the ray, close to the outer margin of the vault (*Agaricocrinus*), directly over the point at which the bifurcation of the ambulacra takes place. When there are four arms to the ray, they are removed relatively further inward, and are followed by two similar but smaller plates; but when there are three arms to the ray by one plate only, which is directed to the side of the bifurcation.

It is now very interesting to find also that the axillary plates of the covering pieces upon the ambulacra are frequently protuberant. In *Eucladocrinus millebrachiatus* all along the free appendages they are strongly nodose, and their tops, if the ambulacra were subtegminal, would naturally extend into the vault, and be exposed to view. That all calyx plates, and especially the "radial dome plates," were capable of secreting an enormous amount of limestone matter, is well shown by the fact that in some species of *Dorycrinus* the plates are extended to the length of three or four inches, and their ends, if accidentally broken during the life of the Crinoid, were at once replaced. Our explanation that the radial dome plates were developed from the covering plates, seems to us exceedingly probable, and has been favorably received by Dr. Carpenter. If the plates were special structures covering the ambulacra, as heretofore supposed, they would have to be regarded as true vault plates.

In many of the Palaeozoic Crinoids we find upon the tegmen elevations, which sometimes take the form of ridges and pass out from near the center to the arm bases. These ridges which are best preserved and most frequently found in Silurian Camerata, are formed either by the covering plates, or by the so-called smaller vault pieces which pass up from between the rays. Similar ridges occur upon the disk of recent Comatulidae, but these are always formed by the covering pieces, and the plates are movable; while in Palaeozoic forms, in which covering plates enter the surface, these are united by a suture. Ridges of this kind are found in *Actinocrinus quinquangularis* Angl. (Iconogr. Crin. Suec., Pl. XVI, fig. 28), *Habrocrinus ornatus* (Ibid., Pl. XXVII, fig. 5), *Marsupiocrinus depressus* and *M. radiatus* Angl. (Ibid., Pl. X, figs. 16 & 21), and *Platycrinus symmetricus* W. & Sp. (Proc. Acad. Nat. Sci. Phila., 1888, Pl. 18, fig. 15). The mouth in these species is closed either by the orals, or, when these are absent, by the uppermost covering pieces, which interlock with those of adjoining rays. Very prominent ridges occur also upon the disk of the Ichthyocrinoid genus *Taxocrinus*, as shown by our figure in the Proc. Acad. Nat. Sci. Philadelphia, 1888, Pl. 18, fig. 1*e*. In this genus, contrary to the preceding forms, mouth and food grooves are opened out, but otherwise its ventral structure agrees so closely with that of the young *Platycrinus symmetricus* that it seems as if there could be no doubt that the two integuments are composed of the same elements. Indeed, a slight receding outward of the posterior oral, and movable covering pieces, would place the two forms essentially in the same condition. It would seem to suggest further from analogy, that in all other groups in which the ambulacra are exposed very similar conditions prevail, and that in all those forms, as in *Taxocrinus*, the ventral surface is a disk. So far we have met with no serious difficulties, but they arise when we consider those forms in which the ambulacra enter the surface at a point from beneath the interradial plates.

If there was in these forms, as heretofore supposed, a system of skeletal plates distinct from the disk, which cover the ambulacra and the disk generally, it would seem to follow that the upper interradials, which surround the orals and cover the ambulacra, must be vault plates, and all lower ones, so far as the ambulacra are exposed, disk plates.

Cases in which the calyx ambulacra pass out from beneath the interradials before they enter the arms, are found in different families of the Camerata. They occur more frequently among Silurian than among the later Crinoids, and generally in forms in which the ventral surface is paved by small irregular pieces, such as *Glyptocrinus*, *Reteocrinus* and *Archaeocrinus*, but also occasionally among Subcarboniferous forms. A most instructive case of this kind is represented by a rather young specimen of *Megistocrinus nobilis*, in which not only the covering plates, but also well developed side pieces enter the calyx. The ventral side of this species consists of moderately large, irregularly arranged plates, which gradually decrease in size toward the arms. The tegmen is perfectly flat except near its outer margin, where it is distinctly plicated to form the large openings for the ponderous arms. At the flat inner portions the ambulacra are concealed, but along the plicated outer part the covering plates and side pieces are in sight for some distance, and the interradial dome plates extend only to the lateral margins of the ambulacra. It is now quite instructive that in another, more adult specimen of this species, those parts of the ambulacra which in the former specimen were exposed, are roofed over by an extension of the interambulacral plates of subsequent growth. This incidental observation is very important, as it throws much light upon the development of the so-called vault of the Camerata generally. It shows that the same system of plates, which in a young specimen is *inter*-ambulacral only, may gradually become *supra*-ambulacral in another.

A somewhat different structure we observed in a finely preserved adult specimen of *Megistocrinus evansi*, in which in three of its rays two series of large, nodose alternating plates pass out from near the orals in the direction of the ambulacra. The series are frequently interrupted by small, flat pieces, passing out from the interambulacral spaces, and these intermingle with the larger ones. At some places the arrangement of the larger plates, which evidently are covering pieces, is as regular as in any *Platycrinus*, but at others owing to the interference of the smaller plates, quite irregular, especially in the two rays to the right of the anus, in which scarcely any two of these plates are continuous. It is most remarkable that in no two specimens of this species is the arrangement of the covering pieces alike, and in some of them only the five large bifurcating plates, the so-called radial dome pieces, are in view, which are followed by ten others of a second order ; these, however, are always represented. The ventral structure of this species offers not only a most excellent proof that the so-called radial dome plates, as suggested before, are extravagantly developed covering pieces, but indicates also that the "vault" was formed by a gradual extension of the interambulacral pieces toward the ambulacra, either covering the latter entirely, or intruding upon them, leaving the more prominent plates exposed.

In *Glyptocrinus* and *Reteocrinus* the tegmen is essentially in the same condition as in *Megistocrinus nobilis*, but the plates are smaller, and in the absence of orals nearly the whole surface is covered by small granular plates, including the central portions. Toward the periphery there are ridges leading to the arm bases, but these are not found at the middle part, where the surface is evenly convex. Only on top of these ridges, that is, in close proximity to the arm bases, are the covering pieces exposed. They are quite regularly arranged in two rows, and so well defined that we doubt if it is possible that they were continued further up along the surface, as suggested to us by Dr. Carpenter, or they would be recognized in the specimen. It seems to us more probable, and almost certain, that they were exposed only to near the upper ends of the ridges, and then followed the inner floor. If this interpretation is correct, *Glyptocrinus* represents another instance in which a sort of vault is formed by the lateral extension of the interambulacral system of plates.

An examination of the different tegmens which occur in the various families of the Camerata, leads to the conclusion that the ambulacra, as a rule, are subtegminal in specimens with a high dome and bulging at the arm bases; but are generally tegminal, or become tegminal before entering the arms, in species with a flat or depressed surface. They are also exposed in species with high ridges, and in those in which the arm openings are directed upwards, a structure which necessitated a rising of the ambulacra toward the arms. The presence or absence of the ambulacra upon the tegmen, therefore, is not, in our opinion, an essential structural feature in itself, but is rather a consequence of differences in the form and construction of the tegmen in the respective species. This explains in a natural way why the ambulacra are exposed in forms like *Actinocrinus quinquangularis*, *Habrocrinus ornatus*, *Marsupiocrinus depressus* and *Glyptaster ornatus*, all of which have a more or less flattened ventral surface, and conspicuous elevations reaching up to the orals, and why in the typical *Actinocrinus* with a high conical dome the ambulacra are subtegminal, but tegminal in the depressed *Actinocrinus stellaris* which approaches the condition of the Platycrinidae. In *Platycrinus* the tegmen is rather flat in all elongate species, and all have more or less high ridges. The latter we find also in the short discoid species with an elevated dome, owing probably to the shortness of the dorsal cup. The condition of the ambulacra in *Platycrinus* may also be due partly to the extravagant development of the plates.

Comparing the earlier Melocrinidae and Actinocrinidae with those from the Devonian and Subcarboniferous, it is seen that they are built substantially on the same plan. Among the latter the ambulacra occasionally form a part of the solid test; while in by far the majority of their species they are kept below. The plates in all of them occupy relatively the same position to surrounding parts, the only perceivable difference is that those of the later forms are somewhat larger and heavier, which is readily explained by palaeontological development. Why then should their tegmen be composed of a system of plates morphologically distinct from that of the others?

In *Glyptocrinus* and *Megistocrinus*, a sort of vault is formed by the greater development of the interambulacral plates and their gradual fusion along the line of the ambulacra, and from that it would seem to follow that similar modifications took place also in the later forms if it was not for the supposed disk at the inner floor of some species of *Batocrinus*, *Actinocrinus*, *Physetocrinus* etc. As to this structure we have recently made some very important observations.

Through the kindness of Dr. Horace G. Griffith of Burlington, to whom we are indebted for many favors, we obtained a most instructive specimen of *Physetocrinus* showing the structure along the inner floor of the tegmen in a most excellent preservation. This specimen has the great advantage of being free from any silicious coating, such as obscured the structure in all former specimens of this kind. The outer surface of the tegmen is composed of moderately large, smooth pieces of irregular form, closely fitted together at all sides. There are no orals, but near its outer margin there are "radial dome plates" of a first and second order, which are readily recognized by their larger size and greater convexity; but besides these no other covering pieces are visible. Looking at the inner floor, we find the same arrangement of plates, and actually the same plates, but their general aspect is totally different. They appear as sharply delineated stars, with as many rays as there are sides to the plates. There are abrupt depressions between the star-rays, which on meeting the corresponding depressions of adjoining plates, form deep, sometimes cavernous pits, more or less undermining the plates; and there seems to be but little doubt that the pits communicated with one another by imbedded passages all along the tegmen. The star-shaped plates extend over the peristome as well as over the ambulacra, but are occasionally interrupted by small, irregular supplementary pieces, apparently solid. The structure shows plainly that the tegmen of *Physetocrinus* is not composed of two distinct sets of superimposed plates, but of one set only, which are solid externally, and more or less perforated or porous at their inner portions. That there is but one set of plates is further confirmed by the position of the ambulacra which, as shown by the specimen, follow the inner floor. The latter is of the utmost importance, for, if the upper or solid part, as was supposed to be the case in the allied *Batocrinus* and *Actinocrinus*, represented a vault, and the inner part a disk, the ambulacra, if placed beneath the latter, would be covered by two integuments, at first by the overlapping interambulacral plates, and again by a vault, which is exceedingly improbable. The ambulacral skeleton itself is not preserved in the specimen, but the place it occupied is clearly indicated by shallow grooves, which are formed by the thickening of the plates all along the interradial spaces.

The internal structure of *Physetocrinus* gives us the key to that of *Batocrinus*, *Dorycrinus*, *Actinocrinus*, and *Teleiocrinus*, in all of which, we are no longer in doubt, there is but one integument, and the part which we had heretofore regarded as the disk constitutes the poriferous portions of the plates. That in these forms the respective parts are continuous, connected by small surfaces or pillars, was pointed out by us in the Revision (Pt. II, pp. 26–27, and Pt. III, pp. 60 and 61). We gave there a full description of the pores and imbedded passages "evidently for the free circulation of water"; but misunderstood the relations of the ambulacra to surrounding parts. We then supposed that the sharp, slightly overhanging edges of the interradial partitions, along the sides of the ambulacra, were closed beneath them; which proves not to be the case. The ambulacra in all specimens in which they have been preserved, are visible from within the calyx.

The inner structure of these Actinocrinidae always reminded us of the double test in the Clypeasteridae, in which the two parts are connected by similar pillars, and we think it highly probable that we have here among these Crinoids a complex vascular water system, which extended all the way up from the interradial plates of the dorsal cup to the upper end of the ventral disk. Such a complex system was not necessary in recent Crinoids in which the whole ventral surface is perforated, and the water could be brought in contact with any part of the body, but the case is different in the Camerata, in which the tegmen is almost perfectly solid.

There are good reasons to believe that in the Camerata the water was introduced near the arm bases through small openings, described by us (Revision, Pt. II, p. 51), as respiratory pores, and then followed the canals and passages along the test. We have observed such openings not only in the Actinocrinidae, but also in the Melocrinidae, and Rhodocrinidae. In the genus *Dolatocrinus* they are slit-like as in Ophiurids. Like the round openings of *Batocrinus* and *Actinocrinus*, they are located between the rays and their main divisions, a little above the arm region. Some species have from 4 to 6 of these slits to each interradius, and 2 to 4 to each interdistichal space, all arranged horizontally. In *Dolatocrinus* the vascular system probably extended only over the peripheral portions, the upper portions at the inner floor of the tegmen being perfectly smooth. In *Batocrinus* and *Teleiocrinus* it passes up to the outer margins of the orals; while in *Physetocrinus*, in species in which the orals are unrepresented, it extends over the whole inner surface.

The subtegminal anal tube of *Siphonocrinus* is yet unexplained, and we freely admit the structure is still a puzzle to us, but in the absence of specimens showing the test (we know it only from natural casts), we abstain from any speculation respecting it. It should be said, however, that in *Siphonocrinus nobilis* the tube passes out centrally—not anteriorly—which leads to the conclusion that the ventral structure of *Siphonocrinus armosus* cannot have been essentially different from that of the other Camerata. The so-called subtegminal anal tube is probably the extended hind gut, which passed over the mouth and portions of the ambulacra. It appears from the impressions upon the casts that the individual plates, which cover the ambulacra and surrounding parts, extend also over the "proboscis."

From the foregoing facts it appears that *Batocrinus*, *Physetocrinus* and allied forms likewise had but one integument covering the body, that the structure which was supposed to represent the "vault," is composed merely of the outward growth of the plates constituting the disk, and that the plates are thickened and project in "T" shaped extensions.

It will be remembered that it was upon these forms mainly that we postulated the presence of a vault in all Camerata, but now, if it is true that even these have no further integument covering the disk, it seems to us conclusive evidence that a vault as a special structure does not exist in any Crinoids whatever, and that the tegmen in all of them is a greatly modified disk.

A comparison of the earlier with the later Camerata shows that in Silurian forms the ventral surface, as a rule, is covered by small, irregularly arranged plates; that these gradually increase in size in the Devonian, and attain in the Carboniferous that extravagance of form, which in the Batocrinites and Actinocrinites reaches its culmination. With regard to the ambulacra we have observed that in the earlier forms they are much more frequently exposed, their covering pieces are smaller, more regularly arranged, and not so highly differentiated as in the later ones. Their disk generally resembles that of recent Crinoids, and if it were not for the sutural union of the ambulacral and interambulacral plates, and the closure of mouth and food grooves, the conditions of the two structures would be almost identical.

From these observations we conclude that the heavy plated, extravagantly developed integument, the so-called vault, was gradually evolved in geological times from the thinly plated disk of earlier forms. This may have been accomplished in the following way: At first the ambulacra were exposed at the surface, but subsequently became covered over by the great development of interambulacral plates, which encroached upon their space at the surface from each side, and finally closed in above them, crowding the ambulacral skeleton inward. In species in which the ambulacra are not covered but remain external, the covering pieces were stronger and offered greater resistance, so that instead of being crowded inward they became incorporated into the test.

Dr. Carpenter has suggested to us in a note a somewhat similar case—though he thinks the parallel must not be carried too far—in the gradual obliteration of the ambulacral grooves in some arms of *Actinometra*, where the convex perisome gradually encroaches more and more on the sides of the groove, bringing its edges together, and finally closing it. It seems to us that this is a very significant illustration of what may have happened in the evolution of the closed "vault" from the open disk.

Returning again to the *Inadunata*, we find in the Fistulata the palaeontological development essentially different from that of the preceding group. The plates of the ventral side of the calyx at no time attain the rigidity and large size of those in the Camerata. The plates of the dorsal side, with the exception of the anal plates, which we consider afterwards separately, undergo scarcely any changes, and the brachials in all of them are free plates from the radials up. The ventral sac in some of the earliest forms is quite small, but rapidly attains enormous dimensions, constituting the greater part of the calyx; but at the end of the Carboniferous period dwindled down almost as rapidly again to its former insignificance, so as to be represented in *Cromyocrinus*, *Eupachycrinus*, *Erisocrinus*, and *Encrinus* only by a short cone. Respiration was effected directly through the test, but apparently only at the posterior side of the calyx, either by means of pores along the ventral sac, or by a madreporite placed anteriorly to the sac. The ambulacra of all Fistulata, so far as known, are tegminal; they are bordered by side pieces, and the food grooves are roofed over by covering plates, which were apparently immovable. The mouth was probably closed in all of them.

In the recent *Holopus*, *Hyocrinus* and *Bathycrinus*, the ventral sac is further reduced, so as to be a mere proboscis or anal tube. In all of them the interambulacral plates themselves are perforated and not merely their margins, and mouth and food grooves are exposed.

The *Inadunata Larviformia*, as now restricted, have neither interradial nor interambulacral plates, and rarely anals, and their orals cover the ambulacra to the bases of the arms. They have apparently no water pores, in the calyx, and it is very possible that throughout this group water for respiration was introduced through pores at both sides of the arm ambulacra, as suggested already by us (Revision, Pt. III, p. 83).

The *Articulata*, the third great division of the Crinoidea, to which we have heretofore referred only the Ichthyocrinidae, will probably have to be amended so as to include the Comatulidae, Pentacrinidae, Apiocrinidae and Bourgueticrinidae. How closely the Comatulidae are related to the Ichthyocrinidae may be seen by comparing the simpler forms of the latter with the young *Antedon* in its pedunculate state (Chall. Report on Comat., Pl. XIV). The stem in fig. 3 is exactly like that of *Mespilocrinus*, fig. 9 might represent as well a young *Onychocrinus*, and the brachials of fig. 5, in their waving sutures are quite characteristic of the Ichthyocrinidae generally. In all of these families the proximal brachials are incorporated into the calyx, either by supplementary plates, by soft tissues, or by sutural union.[1] In some species of the Apiocrinidæ and Ichthyocrinidae these supplementary pieces are quite large and massive, and some have a sort of regularity in their arrangement, but they are notwithstanding perisomic plates. The ambulacra throughout this group are tegminal, although the plates are frequently not readily

[1] In some specimens of *Millericrinus* it appears in the fossil as if their brachials might have been free from the radials up; but we doubt it, as the capacity of the calyx is too small to have contained the whole of the visceral cavity, and it seems to us more probable that the lower brachials were connected by small plates or soft tissues. A lateral union of the brachials, such as we find frequently in the Apiocrinidae, and which occurs also in the Ichthyocrinidae, has never been observed in any of the Camerata at least not between costals or distichals. In some Actinocrinidae sometimes the higher brachials are laterally connected.

distinguished from the interambulacral plates, and the mouth, so far as known, is exposed.

It thus appears that in the Inadunata and Articulata, as in the Camerata, there is but one integument covering the body, and that the ventral pavement, although undergoing various modifications in geological times, is a true disk. We, therefore, abandon the term "vault" as a morphological term altogether, and consider all plates between the rays and interposed between the ambulacra, as well as those covering the ambulacra when these are subtegminal, as plates of the disk.

We think the plates of a Crinoid fall naturally into two categories, viz. *primary*, and *secondary* or *supplementary* pieces. The primary plates form the fundamental part of a Crinoid, while the supplementary pieces serve to fill up spaces. The primary plates may be separated into two classes: those developed on the right antimer, which in one way or another are related to the axial nerve cords, and those developed on the left antimer, and connected with the mouth or the annular vessel around it. To the first class we refer the stem joints, basals, underbasals, radials, all brachials whether fixed or free, and the plates of the pinnules; to the second the orals and all plates of the ambulacra to the end of the pinnules. The remaining plates, which embrace the various perisomic plates, are supplementary pieces, and in our opinion neither strictly actinal nor abactinal.

Dr. Carpenter, in the July number of the Ann. and Mag. Nat. Hist., p. 12, shows that, in analogy with other Echinoderms, there is fundamentally but one ring of radials in a Crinoid, and that the succeeding plates along the rays are brachials, a view which we have held for some time, and discussed in various parts of our Revision. After correspondence with us and mutual discussion, he brought out special terms for the different orders of brachials. He proposed the term *costals* for the primary brachials, *distichals* for the plates of the second order, *palmars* for those of the third, *post palmars* for those of the next order. To the arm plates after the last bifurcation he applies the term *free brachials.* To the most of this terminology we entirely agreed, but in some particulars it does not quite meet the requirement in dealing with the greater complexity and variety of construction found in the Palaeozoic forms. We find it more convenient to use the term *brachials* in its general sense, to designate all plates of the rays succeeding the radials. They will be *fixed brachials* so far as they are incorporated into the calyx, and *free* *brachials* when they are not. In either case they will also take the special appellation given by Carpenter, viz., *costals, distichals, palmars* etc., which will be either *fixed* or *free* as the case may be. We prefer to use the term *post palmars*, however, for all plates beyond the third bifurcation, whether there be further branching or not, and apply *free* to all brachials that are free from the calyx, so that in the Inadunata all plates beyond the radials are free brachials, whereas, according to Carpenter's idea, in a frequently dichotomizing form like *Cyathocrinus* the term would only be applied to the joints of the last slender branches at the tips of the arms. In the Camerata we will have one or more orders of fixed brachials, as the calyx extends variously to the distichals, palmars, or post palmars. To correspond with these terms and conform to the ideas of the foregoing discussion, it will be advisable to designate the different perisomic plates as follows:

Interradials, all plates interradially disposed in the calyx.

Interbrachials, a general term for all plates between the rays above the radials.

Interdistichals, the plates between the first divisions of the ray.

Interpalmers, those between the second divisions of the ray.

Interambulacrals, the plates between the ambulacra.

Let us now consider the anal plates, which take such an important part in the phylogeny and classification of Palaeozoic Crinoids. The term "anal plate" has been used by some writers indiscriminately for all interradial plates of the posterior area, while others restrict it to the plates directly or indirectly connected with the anus. We apply the term only to the latter plates, and only to those taking part in the dorsal cup. All others are plates of the anal tube or the ventral sac.

The anal plates in all Camerata, when present, occupy the median line of the posterior area so as to divide the interbrachial plates into two equal sets, and in rows containing an odd number splitting the middle plate into two pieces, even in cases when no anal plate is inserted between the segments. The latter is the case in all *Actinocrinites*, in which the first interbrachial row at the posterior side invariably consists of two plates as against one in each of the others; but all have an anal plate between the radials, and a second one in the second interbrachial row. In the *Batocrinites*, and in all other Actinocrinidae and Glyptasteridae, there are two interbrachial pieces above the first anal, which enclose a second anal piece. The Hexacrinidae, like *Cyathocrinus*, have but one large anal plate resting upon the basals. In the Eucalyptocrinidae there are no anal plates in the dorsal cup, and the five interradial areas are perfectly symmetrical. The same is the case in *Dolatocrinus*, *Stereocrinus*, *Centrocrinus*, *Allocrinus* and *Patelliocrinus*; while the typical Melocrinidae have an anal plate in one or more of the upper rows. In the Rhodocrinidae the anal plates are in a similar condition as in the Melocrinidae, their posterior area being undisturbed in some of them, while in others a few anal plates are introduced; but the Rhodocrinidae have at all five sides a plate interposed between the radials, which rests upon the basals. The Platycrinidae have no special anal piece, but the middle plate of the first row at the posterior side is considerably larger, and obviously served throughout this group as anal plate.

It appears from these observations that the distribution and position of the anal plates varies considerably among the families, and that in some of them they are absent altogether. As a general rule, the anal plates are well represented in species with a strong tube or a protruding lateral opening; while in forms in which the anus is central or comparatively small, as in the Eucalyptocrinidae, they are either wanting or but feebly represented. The interposition of the anus affected more or less the whole posterior area. In species with a large anal tube, the increase in width thereby produced necessitated the introduction of special anal plates; while when the tube was small, a mere enlargement of the regular interbrachial plates sufficiently increased the width of the area. This shows that the anal plates of the Camerata do not constitute a primary element, but are supplementary pieces, which were introduced as the case required. This is important as throwing light upon the anal plates in the other groups.

In the Fistulata the anals are the only plates interposed between the rays. They consist of one or two pieces, or are unrepresented altogether, and the ventral sac is supported by the radials. In species with but one anal plate, this rests upon the posterior basal, which is truncated for its reception, and hence is interradial in position. When there are two plates, as in most of the Poteriocrinidae, and in a few Cyathocrinidae, the second, which is actually the first or lowest in point of position, is placed obliquely to the right of the first, so as to encroach more or less upon the lower face of the right posterior radial, its lower angle resting between the upper sloping faces of adjoining basals, its upper face supporting the first plate of the tube, which in some of these genera is partly enclosed in the calyx. To understand the relations of this plate, it is very important to note that throughout the various modifications which the posterior side of the Fistulata undergoes in geological times, this plate retains invariably its alternate arrangement with the basals. The plate, therefore, was radially disposed from the beginning, and always remained so. This shows that the widening of the anal area, which took place in later forms, owing to the increasing width of the ventral sac, was effected by a displacement of the arm-bearing plates. The oblique position, which the radially situated anal plate holds toward the posterior basal and the other anal plate, and this toward the first plate of the tube, gives to these plates a sort of alternate arrangement, which is continuous throughout the whole tube.

The relations of the anal plates in the various groups of the Fistulata were discussed by us at different times, and a comparison of the literature will show that our views underwent some modification in the course of time.[1]

The subject was also discussed by Dr. P. H. Carpenter in his paper "On the Relations of *Hybocrinus*, *Baerocrinus* and *Hybocystites*."[2]

We think it unnecessary to give a review of all these papers, and we can dispense with it more readily, as Mr. F. A. Bather, in an interesting paper "On the British Fossil Crinoids,"[3] has lately given a full history of them. We, therefore, take up the question where we left it in 1885.

Mr. Bather, in the paper above cited, has advanced views respecting the origin of one of the anal plates, from which we regret to be obliged to dissent. He agrees with us and Carpenter that the radial anal plate, the so-called azygous piece, constitutes primarily the lower portion of the right posterior radial, which in the earlier forms occupies a position immediately below the radial; but he differs from us essentially upon the origin of the other anal plate. He seeks to prove that this plate "originated as a plate morphologi-

[1] 1879, Revision, Pt. I, pp. 71 and 72; 1883, Amer. Jour. Sci., Vol XXVI, pp. 365 to 377; 1885, Revision, Pt. III, Sect. I, pp. 11, 12 and 40; and 1886, ibid., Sect. II, pp. 196 and 210.

[2] Quart. Journ. Géol. Soc. London, Vol. XXXVIII, pp. 298–312.

[3] Ann. and Mag. Nat. Hist. (6th ser.), Vol. V, April, 1890, pp. 319–334.

cally corresponding to an ordinary brachial," which gradually in its palaeontological development passed down from above the radials to the basals, and between the radials. To the former plate he gives the name "*radianal*," which we think an excellent one, and we accept it as being more appropriate than azygous plate. To the latter he applies the name "*brachianal*," a term which becomes meaningless if the plate proves to be an interradial. For this plate we retain the name *anal plate*, as we hold it to be the true homologue of the anal plate in the *Antedon* larva, and the homologue of the *first* anal plate of *Actinocrinus*.

In our diagrams we have marked this plate X, and we find it convenient to refer to it as such in this paper. We apply the letter R to the radials, and when these are compound, we distinguish the lower, non-arm-bearing section as R′.

To understand the relations of the anal plates, we must at first direct attention to the structure of the radials of the earlier Fistulata, which in all *Lower* Silurian genera, probably with the exception of *Ottawacrinus*,[1] differ essentially from those of the *Upper* Silurian forms. It is very curious that in the former the radials in from one to three of their rays are compound, *i. e.*, constructed of two segments or parts, which are closely united by a horizontal suture, and in the organization of the Crinoid count as one plate. Compound radials are found in the Heterocrinidae, Anomalocrinidae, Hybocrinidae, and in the earliest Cyathocrinidae. In some of these families they are restricted to the right posterior ray, in others one or two of the other rays also may have compound radials. But we know of no case in which the compound structure extends to all five rays, at least two of the plates being always simple. Among the Heterocrinidae, as a rule, the right posterior and the right and left antero-lateral radials are compound—exceptionally the anterior one in place of the left antero-lateral—while *Anomalocrinus* and *Ohiocrinus* have but two, and *Iocrinus*, *Merocrinus*, *Hybocrinus* and *Hoplocrinus* only one. It is further worthy of note that when there are several compound radials, the corresponding parts are of nearly equal size; while the segments vary considerably among themselves in the

[1] *Carabocrinus*, which also we had referred to the Fistulata, is possibly a Cystid. We were recently informed by Mr. Walter R. Billings that it may have hydrospires. He was kind enough to send us carefully prepared diagrams of this genus and of *Hybocrinus*, showing the structure of the ventral disk, for which he has our hearty thanks.

different genera. In *Heterocrinus*, *Ohiocrinus*, *Iocrinus*, *Merocrinus*, *Hybocrinus* and *Hybocystis*, the lower portions are considerably larger than the upper; in *Anomalocrinus* and *Dendrocrinus* the two are of nearly equal size; while in *Ectenocrinus (Heterocrinus) simplex* the upper ones are three to four times as large as the lower.

Now, what does this gradual increase of the upper portions, and the disappearance of compound plates in other rays than the posterior, tell us? Does it not indicate that in these Crinoids there is a gradual development from three to one compound plate, and from the compound to the simple radial? It certainly looks like it. The idea is further confirmed by the fact that true compound radials do not exist among any of the later Fistulata, in which, as we shall presently show, the lower portion of the right posterior radial, more or less, serves as an anal plate. But what preceded the compound radials? What else, but forms in which the arm-bearing portion was still smaller, and, primarily, those in which it was absent altogether, that is to say, was as yet undeveloped. This, indeed, seems to have been the structure of *Baerocrinus*. As we understand this genus, it has three well developed radials, and two are in a transition state, only their lower or non-arm-bearing segments being represented. This is further corroborated by the fact that the non-arm-bearing radials occur in the same rays as the compound radials of *Anomalocrinus*, for if we take the third plate of our diagram (Pl. X, fig. 6) to represent the posterior ray, the other non-arm-bearing plate must represent the antero-lateral one. This would make *Baerocrinus* the ancestral form, lower in its development than either *Anomalocrinus*, *Hoplocrinus*, or *Iocrinus*.

We now pass to the genera in which the lower segment of the right posterior radial serves as an anal plate. In all these forms, as may be seen in Bather's diagrams, the four other radials are simple, and in all of them the anal plate (X) is represented, and *invariably rests upon the basals*. The size of the ventral sac had rapidly increased at the close of the Lower Silurian, and the sloping upper faces of the radials were insufficient to support it. This required certain modifications in the structure of the dorsal cup. The posterior radials, which theretofore had been in contact laterally, now separated, the posterior basal increased its width, and the plate X was introduced to fill the space between the radials. While these modifications were going on, the radianal, or lower segment of the radial, retained its position between the upper sloping faces of two basals, only changing its form enough to fit in between adjoining plates. Later on, as the ventral sac grew still larger, and the brachials came to occupy the entire upper face of the radials, leaving no surfaces for an attachment of anal plates, the right posterior radial was gradually shifted to the right, and finally attained a position directly above the right postero-lateral basal, and obliquely above the radianal. Toward the end of the Carboniferous, when the size of the anal tube was again reduced to a minimum, both anal plates gradually disappeared, and the five radials resumed their normal position.

Mr. Bather assumes, as before stated, that the anal plate, the plate X, is derived primitively from a brachial, which gradually in geological times passed downward into the dorsal cup. He regards (p. 329) "those forms as primitive in which the radianal is more of a radial and less of an anal, in which it is not in an asymmetrical position but corresponds to the other lower radial plates. Such forms are *Iocrinus*, *Heterocrinus*, *Ectenocrinus*, *Anomalocrinus* and *Merocrinus*. Now in all these forms X is supported by R and does not touch R′. Obviously then X is not derived from R′, but originates above R, and on its left side. By parity of reasoning we assume the next stage to be represented in such forms as *Hybocrinus* (?), *Ottawacrinus*, *Dendrocrinus* and *Homocrinus* since in them R′ is rather more asymmetrical. In these X has passed down from above R, and now rests with its lower half between the right and left posterior radials, being supported partly by R′ and partly by the basal.[1] *Carabocrinus*, *Botryocrinus*, and similar forms are, as all acknowledge, the next stages in the shifting of the radianal; in these X has sunk still lower into the dorsal cup, and is now entirely in a line with the radials." "In *Parisocrinus* and *Euspirocrinus* among pinnuless forms, and in the Poteriocrinites, another change has taken place; the radianal has passed through a revolution of 90°, and the lowest plate of the ventral sac (t) has sunk down between R and X."

Before we enquire into the merits of this argument, we must ascertain whether the plates of the different genera which Bather marked X are structurally alike, for any mistake in this regard, naturally upsets the whole theory. The question is, is his plate X in *Iocrinus* and *Merocrinus* which rests upon that marked by him R or C, and that upon R′ in *Hybocrinus* and *Anomalocrinus*, homologous with the plate of *Dendrocrinus*, *Homocrinus*, etc. supported by

[1] The latter is not the case in *Hybocrinus*, in which there is no anal plate supported by the basal.

R' and partly by the basals, and homologous with the plate of *Poterio-crinus* which rests upon the basals and against the radianal? Bather did not discuss this question at all, notwithstanding we had expressed different views respecting his plate X in *Iocrinus* and *Merocrinus*. In both genera (in *Iocrinus*, as early as 1879, Revision I, p. 65), we called that plate a plate of the tube, and, so far as we know, never made any statement from which he might have inferred that we thought it represented the plate X in the other genera; yet Mr. Bather quotes us in his diagrams as if we had done so in 1879. We must also protest against his statement on p. 324. There, in summarizing our position on the anal question, he says under *Iocrinus*: "Radial growing larger at expense of Azygos, and here has *absorbed* X"; while the fact is we have always held, and have said so, that this plate X was *unrepresented* in *Iocrinus* and was as yet *undeveloped*.

Instead of commencing, as Bather did, with the earliest form, we prefer to begin with the simplest, and select as a starting point the genus *Cyathocrinus*, which is well known to every palaeontologist. *Cyathocrinus* has simple radials and but one anal plate, and this, as all writers agree, represents the plate X, and is the homologue of the first anal of the Actinocrinidae. Like the anal plate of the latter, it rests upon the truncated upper face of the posterior basal and between two radials, and supports generally three plates of the tube (Pl. X, fig. 4). The plate to the right sometimes rests against, or rather upon, the left sloping upper face of the adjoining radial, almost as in *Poteriocrinus*, but is here unsupported by a radianal. In *Graphiocrinus* also only the plate X is represented, but this is angular above, and supports two plates t, of which neither one is connected with the radials, but both are free plates.

In the preceding genera all radials, including the right posterior, are simple. In *Dendrocrinus*, however, the latter is compound. The anal structure of *Dendrocrinus* is most instructive as forming a sort of link between that of the earlier and later Palaeozoic Crinoids. Looking at *Dendrocrinus casei* (Pl. IX, fig. 12), it is obvious that the plate X holds the same relation to the compound radial, as X in *Cyathocrinus* to the simple one. It abuts against both segments of the plate, and is also supported by a truncate basal. In both, the plate X is succeeded by three plates in the tube, but in *Dendrocrinus* their arrangement is less regular, owing to the asymmetry of the radials. The plate to the right is placed at a higher level than the one to the left, and does not touch X, nor does it touch the adjoining brachial, and is therefore a plate of the tube; while that to the left, which is laterally connected with the adjoining radial, actually forms a part of the dorsal cup. Both plates rest by their lower faces upon the sloping upper sides of adjacent radials, and each of them, as well as the middle plate—resting upon the truncate upper face of X—supports a vertical row of plates in the tube. These plates are not represented in Bather's diagram of *Dendrocrinus*, but are shown by our figure.

Now, if it is true that the plate which rests upon the left upper sloping side of the compound radial, represents morphologically the plate t in *Poteriocrinus*, and we think Bather will have to admit this, what then is his plate X in *Iocrinus* and *Merocrinus?* This plate, like t in *Dendrocrinus*, rests upon the left upper sloping face of the compound radial. Like that it is a free plate of the ventral tube, and like that it supports a vertical row of tube plates upon its upper face. The only real difference between these plates in the two genera is that the facet of the radial in *Dendrocrinus* is horse-shoe-shaped, and that of *Iocrinus* straight. This structure was evidently not understood by Bather, or he would never have called the radial of *Iocrinus* an axillary plate. There would be just as much propriety in calling the radials of an *Actinocrinus* axillary plates, for they support in a similar manner upon their upper sloping faces the first interbrachials.

Admitting that the plate X of Bather in *Iocrinus* and *Merocrinus* is a plate of the ventral tube, where is the anal plate? It seems to us there cannot be the least doubt that in both of them, and in most of the earlier Fistulata, the anal plate X is unrepresented. Their radials are in contact laterally, and the tube does not extend into the dorsal cup, but rests upon it. To satisfy ourselves that the plate t forms no part of the dorsal cup, we have examined and dissected a number of the most perfect specimens of *Iocrinus subcrassus*, and can state positively that it is a free plate of the tube. It is even perforated by lateral slits, such as occur frequently in the plates of the tube, but never in the true anal plate. The tube is club-shaped, narrow at the base, and its posterior side is composed of large, heavy plates, which are formed into a conspicuous ridge. From this narrow, arm-like ridge, as it appears from the outside of the specimens, one gets no idea of the real nature of the tube, which is quite deep and capacious.

After determining the structure of *Dendrocrinus* and *Iocrinus* the other genera are readily understood. *Anomalocrinus* is in a similar condition to *Iocrinus*, but has two compound radials in place of one. As in the case of *Iocrinus* the plate X is unrepresented. Its tube, which is narrow, rests within a notch formed by the sloping upper faces of the two posterior radials, the lower plate touching the first costal. Almost the same structure we find again in *Heterocrinus* and *Ectenocrinus* with three compound radials, and in *Hybocrinus* with but one. We cannot understand how Bather on p. 330 of his paper could conclude from the structure of *Ectenocrinus*, which he has regarded as one of the most "primitive forms," that X "originated as a plate morphologically corresponding to an ordinary brachial." His own diagram shows that his plate X in *Ectenocrinus* is placed symmetrically between the two posterior radials, resting as much on the one plate as on the other. In his diagram of *Heterocrinus bellevillensis* the plate is not correctly represented. A comparison with Walter Billings' figures (Trans. Ottawa Field Naturalist's Club, 1883), and ours (Pl. X, fig. 8), shows that it resembles in form and position that of *Ectenocrinus*, (fig. 9). Like that it rests upon the sloping upper faces of both posterior radials, and not on the plate to the right only. The plate in *Hybocrinus* occupies almost the same position, and we confess we fail to see how the structure of either of these genera helps to prove that the plate is a modified brachial. We think the evidence derived from them shows conclusively that it is an interradial plate. If the ventral sac represented a modified arm, we should like to know to which ray the plate in *Heterocrinus* and *Ectenocrinus* belongs, whether to the right or to the left? In *Dendrocrinus casei*, in which the case is somewhat complicated, we would have three modified arms, one to the right, one to the left, and one supported by the plate X. *Dendrocrinus caduceus* (Pl. X, fig. 11) would have variously two or three such arms, two resting upon the upper sloping faces of adjoining radials, and both supported by the plate X. Still more inconceivable would be the case of *Hybocrinus* in which the so-called "brachianal" supports numerous small, irregularly arranged pieces forming a short protuberance.

In alluding to the anal structure of the Camerata, it has been pointed out that in the Actinocrinidae the first anal plate rests between the radials, contrary to the Melocrinidae, in which the lowest anal plate rests within the second row of interradial plates, and all the radials are in lateral contact. The anal plate of *Actinocrinus* thus occupies a position toward the radials similar to that of the plate X in *Cyathocrinus*, and the anal plate of *Melocrinus* to that of the plate t (X of Bather) in *Hybocrinus*. We have not the least doubt that the plates of the two former genera are homologous with one another, and also those of the two latter among themselves, but we go no further. We believe that in *Melocrinus* and *Hybocrinus* the plate X is unrepresented, and the structural changes that took place afterwards in *Actinocrinus* and *Cyathocrinus* were not effected by a sinking of the tube, but by the introduction of an additional plate.

We now return to *Dendrocrinus*, and take up those forms in which the lower section of the posterior radial turns into a supplementary anal piece. The first step in this direction is shown by *Homocrinus*, *Botryocrinus*, *Oncocrinus* and *Barycrinus*, in all of which the upper or arm-bearing portion of the radial has shifted slightly to the right, and is connected with the lower by an oblique suture. Here the plate X is comparatively large, occupying the whole space between the two posterior radials, and as no part of the ventral tube, as yet, is introduced into the dorsal cup, the plate R′ is physiologically and morphologically a radial, and not an anal plate.

Bather explains the evolution that took place in these forms by "the shifting of the radianal," and that "X has sunk still lower into the dorsal cup and is now on a line with the radials," in which we cannot agree with him. We have already pointed out that the radianal throughout this group retains the same position which it held when constituting a part of the radial. It always rests with its lower angle between the two basals, and only changes its outlines so as to conform to the adjacent plates. The widening of the anal area was effected by the shifting of the radials, which in *Dendrocrinus* and *Homocrinus* opened out for the insertion of the plate X, and by the increase in width which took place in the posterior basal simultaneously. There was no shifting of the radianal, nor any sinking of the plate X, but the latter retained the position which it held in *Dendrocrinus*.

In *Parisocrinus*, *Atelestocrinus*, *Euspirocrinus*, and in most of the Poteriocrinidae, the width of the anal area is increased again. In these genera, the arm-bearing section of the right posterior radial moved away from the lower section so as to be placed almost directly upon the right postero-lateral basal, and a new plate was introduced between the radial and the plate X, supported by the radianal—the former R′.

The derivation of the Poteriocrinidae, etc. was explained by Bather as follows: "in the Poteriocrinites another change has taken place; the radianal has passed through a revolution of 90°, and the lowest plate of the ventral sac (t) has sunk down between R and X." We are somewhat in doubt what Mr. Bather means by "revolution of 90°," but suppose it refers to the change in the position of the radianal toward the right posterior radial. If he means that here the radial moved away from the radianal, we agree with him; but if it implies the radianal shifted away from beneath the radial, we cannot follow him, for that plate, as already stated, retains its position throughout the different phases of its development, and only undergoes modifications in size and form, until it disappears entirely. That the lower part of the tube "sunk down between R and X" appears to us doubtful. It is more probable that a new plate was introduced beneath the other, a sort of third anal, and this is partly confirmed by the fact that the plate is imperforate.

This explains the anal structure of all Poteriocrinidae except that of *Ulocrinus*, *Graphiocrinus*, *Ceriocrinus* and *Erisocrinus*, which we regard as transition forms toward *Encrinus*. The ventral tube, which through these forms dwindles down again to a short cone, no longer necessitated the same representation in the dorsal cup, and as the anal plates gradually diappeared, the posterior radials assumed a symmetrical position. In the new genus *Ulocrinus* of S. A. Miller the plate X ceased to be represented, and its place was taken by the radianal; while in *Graphiocrinus* and *Ceriocrinus* only the plate X is represented. In *Graphiocrinus*, in which the ventral tube is quite capacious, the plate X is comparatively large; while in *Ceriocrinus*, with a small tube, it is reduced to a very narrow piece, which rests upon the greatly extended posterior basal. In *Erisocrinus*, *Stemmatocrinus* and *Encrinus* the latter plate also disappeared, and the tube came to rest upon the edges of the radials, where it started in *Hybocrinus*, *Ectenocrinus* and allied forms.

From the above considerations it appears to us that Bather's theory respecting the "brachianal" is based upon a misinterpretation of the plates. If it were true that the plate resting to the left of the radial of *Iocrinus*, passed in later forms down to the basals, it would mean nothing less than a partial revolution of the entire tube to the left. Consulting the specimens it will be found that in this genus and in the Fistulata generally, the plate alluded to is succeeded by a vertical row of plates in the tube, and that the anal plate (X), where it exists, is followed by another row of plates, arranged in the same way, and placed aside of the first row. Moreover, how can that plate on the separation of the radials sink to the bottom of the dorsal cup, when the anterior side of the tube rests upon the ventral disk? It would be practically impossible unless this side was lowered also. Is not the evolution that here took place more reasonably explained if we assume that on the separation of the radials the space between them was filled by an additional plate?

We hold that the Fistulata have but one true anal plate—the plate X—and that the radianal is a sort of supplementary radial, which in some genera performed the functions of an anal plate. The anal plate of the Camerata, when present, as before stated, invariably occupies the middle line of the posterior area, so as to separate the interbrachial plates into two equal divisions, even splitting the plates in rows in which there is an uneven number. Under such circumstances it seems unreasonable to assume that the plate X is a brachial, and the anal tube a modified arm. This suggestion was made at first by us, but given up in 1883, finding it not sustained by the phylogeny of the group. If it was a modified arm, the arm structure should be indicated in *Hybocrinus*, one of the *earliest* known Crinoids; but, unfortunately for Bather's theory, the ventral sac in this genus consists of only a small protuberance, composed of irregularly arranged pieces. Nor do we find anything among Cystids to support this hypothesis, and certainly not among Blastoids. The theory is based wholly on a superficial resemblance between the tube and arm-plates in *Iocrinus*, and a misconception of the right posterior radial which Bather took to be an axillary plate. But even this apparent resemblance fades away on examining the tube with the arms removed and the outer wings of the tube visible.

Bather made no comparison with the anal plates of the Camerata. He obviously regarded them as morphologically distinct from those of the Fistulata, for on p. 319 he says: "it may be pointed out that, as interradials do not enter into the composition of the dorsal cup in any Fistulata, none of these plates can well be homologues of interradials: in many of the Camerata actual interradials are present in the anal area, but in the Fistulata at least we must look elsewhere for the origin of the so-called 'anal' plates." To this we reply, there are "interradial plates" in the Fistulata as well as in the Camerata, but they are in the former interambulacral and not interbrachial, owing to the fact that the arms are free from the radials. All plates between the rays, those between the ambulacra, and all the plates of the ventral sac, those supporting it, and the plates of the anal tube, are parts of the same element.

The symmetry of the Crinoids, as a rule, is bilateral, and the anal area occupies the median axis. The asymmetry, which occurs in so many Fistulata and certain Ichthyocrinidae, is caused by irregularities in the radials. Wherever these have attained a regular form, the plate X takes its median position, and the plates of the ventral tube also are arranged on a strictly bilateral plan. Whether the symmetrical form, as represented in the Silurian Cyathocrinidae, was evolved from the asymmetrical form, we are unable to ascertain. It is possible that the two had a common symmetrical ancestor, but it seems to us more probable that all were at first asymmetrical, and that the lower section of the posterior radial became early resorbed in some cases. Against the former theory it may be said that in the Lower Silurian Fistulata, so far as known without exception, the right posterior radial is compound, and that we find the symmetrical form along with the other in the same families; against the latter, that the symmetrical form is already well represented in the Upper Silurian.

We have made no reference to the Calceocrinidae, as we have not at present the material to study the older forms, but we are quite certain that their structure is in conformity with that of the other Fistulata. The statement, that "*Castrocrinus* shows a series of anal plates supported by the first costal of the left posterior radius, which is exactly comparable to the arm-bearing costal of the right posterior radius," leads us to suspect that there is also here a misinterpretation of the plates.

In the Ichthyocrinidae the anal structure resembles that of the Fistulata. In some of them both anal plates are represented, in others only the plate X; while in the genus *Ichthyocrinus*, both plates are absent. The following table shows the distribution of the anal plates in the different genera, and the representation of interbrachial plates.

	Ichthyocrinus.	*Taxocrinus.*	*Forbesiocrinus.*	*Culpiocrinus.*	*Mespilocrinus.*	*Sagenocrinus.*	*Pycnosaccus.*	*Gnorimocrinus.*	*Lecanocrinus.*
Plate X represented.	...	X	X	X	X	X	X	X	X
Radianal represented.	...	...	...	...	...	X	X	X	X
Interbrachials present at all five sides.	...	X	X	X	...	X	...	X	...

In *Taxocrinus* and *Onychocrinus*, the plate X is followed by a vertical row of additional pieces forming a lateral tube; in *Calpiocrinus* by one or two large plates longitudinally arranged, resting between the radials; in *Forbesiocrinus* by a great number of large interbrachial plates; in *Mespilocrinus* by one plate only. The anal area of *Sagenocrinus* is similar to that of *Forbesiocrinus*, that of *Lecanocrinus* and *Pycnosaccus* like that of *Mespilocrinus*, the presence of the radianal excepted; and *Gnorimocrinus* in its anal structure resembles closely *Taxocrinus*, but the tube of the former rests obliquely, and not vertically, upon the plate X, and partly upon the radianal.

There has been considerable doubt as to the row of plates in the anal interradius of *Onychocrinus* and *Taxocrinus*, whether they are incorporated into the calyx, as the anal plates of *Reteocrinus*, or form a free tube. We can now state from actual observation that the latter is the case, at least in some species. At the special request of Dr. Carpenter, we dissected some fine specimens, and in *Onychocrinus exculptus*, *O. ulrichi*, and in a large species of *Taxocrinus*, succeeded in laying bare the tube at all sides. The posterior side consists of a vertical series of eight or nine large subquadrangular plates, loosely connected, and sometimes separated by very minute pieces. The anterior side is composed of a large number of quite small perisomic plates, forming a sort of pouch, wider at the proximal end. In all of those species, the tube at its anterior side leans considerably to the right, and we suggest from this structure that both genera were derived from the asymmetrical *Gnorimocrinus*, which occurs in the Upper Silurian contemporaneously. The tube at its distal end is rounded, composed of irregular pieces, pierced by a small aperture, which opens out somewhat anteriorly and evidently served as anus. The structure indicates clearly, that this tube is quite different from the solid conical protuberance which occurs in the recent genus. *Thaumatocrinus*, with which it has been compared. The latter we regard as a most remarkable instance of atavism. The projection consists of a vertical row of fourteen or more plates rising to the height of the anal tube, placed in front of it. It recalls the ventral sac of the Fistulata, among which also apparently the anus sometimes is placed in front of the tube. In *Coeliocrinus* with a balloon-shaped sac, which is sometimes found detached so it can be examined from all sides, we have searched in vain for an opening, and we have no doubt that in this genus, and probably in many others, the anus was located near the mouth as in *Thaumatocrinus*.

No other genus among the Crinoids has so wide a range, and undergoes so few modifications as *Ichthyocrinus*. We find it already in the Lower Silurian, and it lived through to the time of the Upper Coal Measures, and was quite probably the ancestor of the Apiocrinidae, Pentacrinidae and Comatulidae of our present seas.

There are in the paper of Mr. Bather several inaccurate references to our previous writings, to some of which we are compelled to direct attention, as much as we regret it, else it would appear that we had actually made such inconsistent and irrational statements.

On p. 322, he says that in our paper on *Hybocrinus*, *Hoplocrinus* and *Baerocrinus*, we considered the "Azygos plate to be an independent morphological element of the dorsal cup, *not* a modified radial," and on p. 323, he alludes to our "previous view that the Azygos plate was a primitive fundamental element of the dorsal cup." We know of no passage in that paper from which Bather would be entitled to draw any such inferences. As he lays so much stress upon this in his criticism, he should have quoted the exact language, and give the page where it occurs.

On p. 324, in summing up the position which we held in 1886, he makes the following astonishing statement:

"(1.) Azygos plate (Az) a primitive element of the dorsal cup.

(2.) Anal (x) and right posterior radial derived from Azygos plate.

(3.) Anal of *Antedon* not homologous with any plate of the Fistulata, but an embryonic interradial."

A careful examination of both sections of Pt. III of the Revision, will show nothing to justify Bather in assuming that we regarded the Azygos as a "primitive element." We only stated on p. 11: "the lower segments (of the compound radials) are probably embryonic plates, which were resorbed by the upper segments." We admit that the expression "resorbed by" was badly chosen, we should have stated: were resorbed *and occupied* by the upper segments, but that is not the issue here.

Bather's second statement is equally inaccurate. If he had said that we regarded the anal plate (X) and right posterior radial as derived from the *undivided Azygos in Baerocrinus*, he would have expressed our views.

His third statement is more faulty yet. To agree with Pt. III of the Revision it should be amended as follows: Anal plate of *Antedon* larva *homologous* with plate X of the Fistulata, and interradial in position. At that time we thought it even possible, and said so on pp. 39 and 40, that the anal plate of *Antedon* was developed from an "Azygos plate," and that: "Possibly the undivided Azygos plate, *as represented in Baerocrinus*, has been overlooked in the larva." We stated further on the same page "that at least in *Cyathocrinus* the latter (Azygos) plate was entirely removed, and the anal plate took the position of that in the larva of *Antedon*," thus showing conclusively that we regarded the two plates as structurally identical.

Another incorrect statement we find on p. 323. There Bather asserts that we stated "the 'anal' of *Antedon* larva is an interradial with special function, while the Azygos plate is as much radial as interradial." The fact is we said the Azygos plate "*in Baerocrinus*," and not the Azygos generally, is as much radial as interradial. In a supplementary note to his paper, in the June number of the Annals, on p. 486, he alludes to this omission, stating that he left out the words purposely, "since they (we) in the very next sentence imply that *Baerocrinus* is an ancestral stage," and "that a simple and exact quotation would have tended to confuse the issues." This is taking altogether too great liberty with the text. We stated correctly that the "Azygos of *Baerocrinus* is neither radial nor interradial," for it rests between two radials and alternates with the basals; but to say the same thing of *Homocrinus*, *Dendrocrinus*, etc. would be ridiculous.

PLATE IX.

Fig. 1. VENTRAL DISK OF CYATHOCRINUS ALUTACEUS Angl.
The orals in lateral contact, and covering nearly the whole ventral surface. Refigured from the type specimen in the Zoöl. Riks Muset at Stockholm (Iconogr. Crin. Suec. Pl. XXIII, fig. 11).

Figs. 2 and 3. VENTRAL DISK OF CYATHOCRINUS LAEVIS Angl.
Fig. 2, specimen in which the orals are partly resorbed.
Fig. 3, another specimen, in which the orals are replaced by large covering pieces.
From the same Museum (Iconogr. Pl. XXVI figs. 2 and 3b).

Figs. 4 and 5. VENTRAL DISK OF EUSPIROCRINUS SPIRALIS Angl.
The orals replaced by large ambulacral plates uniting in the center.
(Same Museum, Iconogr., Pl. IV, figs. 7d and 7e).

Fig. 6. VENTRAL ASPECT OF A SPECIMEN OF CYATHOCRINUS GILESI W. and Sp.
The "consolidating plates" in part covered by small perisomic pieces; the ambulacra not preserved.
(Collection of Wachsmuth and Springer).

Fig 7. VENTRAL DISK OF CYATHOCRINUS BREVISACCULUS W. and Sp. (n. spec.).
Showing the "madreporite." The oral center closed by the fused covering and side pieces; the "consolidating plates" partly exposed.
(Same collection).

Fig. 8. VENTRAL DISK OF CYATHOCRINUS NODOSUS W. and Sp. (n. spec.).
Showing the "madreporite," the ambulacral and interambulacral plates.
(Same collection).

Fig. 9. VENTRAL ASPECT OF A VERY YOUNG SPECIMEN OF CYATHOCRINUS BREVISACCULUS.
The orals partly intact.
(Same collection).

Fig. 10. VENTRAL ASPECT OF THE TYPE OF MARSUPIOCRINUS DEPRESSUS Angl.
Specimen in the Zoöl. Riks Muset at Stockholm (Iconograph. Pl. X, fig. 16).

Fig. 11. Inner floor of the tegmen in Physetocrinus.
Showing the cavernous pits and passages. The braces represent the thickened interradial portions, which form the galleries for the reception of the ambulacral skeleton.
(Collection of Wachsmuth and Springer.)

Fig. 12. Posterior or anal side of Dendrocrinus casei Meek.
From a specimen in the collection of Wachsmuth and Springer.
(All figures are enlarged two diameters, except fig. 9 which is enlarged four times, and fig. 11 which is but one-half larger).

PLATE X.

Fig. 1. Ventral disk of Cyathocrinus harrodi W. and Sp.
Showing the structure of the ambulacra, and the ventral sac to its full length.
(Collection of Wachsmuth and Springer).

Figs. 2 and 3. Cyathocrinus iowensis O. and Shum.
Fig. 2. Specimen in which only the "consolidating plates" are *in situ*.
Fig. 3. Another specimen, in which the "consolidating plates" are covered over by ambulacral and interambulacral plates; the orals are partly resorbed.
(Same collection).

Fig. 4. Cyathocrinus longimanus Angl.
Showing the arrangement of plates in the tube. (After Angl.).

Figs. 5a, b. Iocrinus sub-crassus Meek and Worthen.
a, posterior aspect; b, portion of the ventral tube enlarged.

Figs. 6 to 14. Diagrams showing the relations of the anal plates to surrounding parts.
Fig. 6, in *Baerocrinus*; fig. 7, *Hybocrinus*; fig. 8, *Heterocrinus bellevillensis*; fig. 9, *Ectenocrinus simplex*; fig. 10, *Anomalocrinus*; fig. 11, *Dendrocrinus caduceus*; fig. 12, *Poteriocrinus*; fig. 13, *Ceriocrinus*; fig. 14, *Ulocrinus*.

Explanation of Lettering.

R. Radial.

R′. Lower half of a compound Radial.

R^x. The latter assuming anal functions=Radianal.

X. The true anal plate.

t. Plates of the ventral tube.

THE EOCENE MOLLUSCA OF THE STATE OF TEXAS.

BY PROFESSOR ANGELO HEILPRIN.

The following list embraces, so far as I know, all the Eocene Mollusca that have thus far been noted to occur in the Gulf deposits of the State of Texas. For my data I have used the type series of Gabb and Conrad, the major portion of which is in the possession of the Academy of Natural Sciences of Philadelphia, the extensive collection of the State Geological Survey, and minor collections which have from time to time reached the Academy and been reported upon in its publications. The collections of the State Geological Survey (for the use of which I am indebted to the Director, Mr. E. T. Dumble, and to Dr. R. A. F. Penrose, Jr., the geologist of the Tertiary areas of the State) are by far the most extensive, and they serve to definitely locate the formations whence the fossils were obtained in their true position in the geological scale. Of some 145 species here enumerated (including a few doubtfully determined forms) about 61 (or upwards of 40 per cent.) are also members of the Claiborne fauna of Alabama; these I have indicated by prefixing an asterisk. A few others occur in some of the older deposits of Alabama, while a very few are members of the Mississippi (newer) fauna. The recurrence of a large number of the species in various counties and localities indicates that the horizon is a common one, namely: the Clairbornian, or typical Middle Eocene of the Gulf slope, the equivalent of the Calcaire Grossier of the Paris Basin.

The principal localities whence the fossils were obtained are: Cherokee Co., near Alto and McBee's School; Palestine, in Anderson Co.; Robertson Co., near Wheelock; Milam Bluff in Milam Co.; Burleson Shell Bluff in Burleson Co.; Smithville, Devil's Eye, Bombshell Bluff and "Camp Disaster," in Bastrop Co.; Caldwell Co.; Atascosa Co.; Laredo, in Webb Co.; and Stations 1–5 on the Rio Grande River, included between Carrizo and "Cardita Bluff," in the northwestern corner of Webb Co.

In my references to Conrad's descriptions I have intentionally referred in some cases to the first edition of the "Fossil Shells of the Tertiary Formations" (abridged F. S. T.), and in others by preference to the second edition, where many of the forms are more completely diagnosed or illustrated than in the original edition.

CEPHALOPODA.

Belosepia ungula, Gabb. Jour. Acad. Nat. Sci., 2d Ser., iv. p. 376.
Wheelock, Smithville.

Nautilus sp.?
Milam Bluff, Brazos R.

GASTEROPODA.

* **Conus sauridens**, Conr. F. S. T., 2d ed., p. 38.
? *Conus gyratus* Morton.—Org. Rem. Cret. Group, p. 49 (from a cast.)
Devil's Eye; San Antonio F.; Smithville; Caldwell.

Pleurotoma alveata, Conr.
? *P. persa*, Whitfield.—A. J. Conch., I, p. 262.

P. capax, Whitf. A. J. Conch., 1, p. 261, Alabama.

* **P. denticula**, Basterot. Descrip. Géol. Bass. Ter. Sud-ouest de la France, 1825, p. 63.
P. nodo-carinata, Gabb (in part.)

* **P. (Moniliopsis) elaborata**, Conr. F. S. T., 2d ed., p. 52.
P. cancellata, H. C. Lea.—A. J. Science. XL, p. 98.
? *Turris retifera*, Gabb.—Jour. Acad. Nat. Sci. Phila., 2d ser., IV, p. 379.
Wheelock.

P. platysoma, Heilpr. Proc. U. S. National Museum, 1880, p. 150.
Atascosa Co.

P. Tuomeyi, Aldrich. Bulletin Geol. Survey Alabama, 1, p. 31.
Devil's Eye.

Drillia Texana, Conr. A. J. Conch., 1, p. 143.
Wheelock.

* **Surcula Desnoyersii**, Lea. Contrib., p. 135.
Smithville.

S. Gabbii, Conr. A. J. Conch., 1. p. 142.
Smithville, San Antonio F.

S. Kelloggii, Gabb. Jour. Acad. Nat. Sci. Phila., 2d ser., IV, p. 379.
Wheelock.

* **S. lintea**, Conr. A. J. Conch., 1, p. 142.

S. Moorei, Gabb. Jour. Acad. Nat. Sci. Phila., 2d ser. IV, p. 379.
Smithville, Wheelock.

* **S. nodo-carinata**, Gabb. Jour. Acad. Nat. Sci. Phila., 2d ser., IV, p. 379.
Devil's Eye, Wheelock.

S. Texana, Gabb. Jour. Acad. Nat. Sci. Phila., 2d ser., IV, p. 379.

Turris Moorei, Gabb. Jour. Acad. Nat. Sci. Phila., 2d ser., IV, p. 378.
Smithville, Caldwell.

Exilia pergracilis, Conr. Jour. Acad. Nat. Sci. Phila., 2d ser., IV, p. 291.

Cochlespira engonata, Conr. A. J. Conch., 1, p. 112.
Turris cristata, Gabb (*non* Conrad), Jour. Acad. Nat. Sci. Phila., 2d ser., IV, p. 378.
Caldwell.

C. bella, Conr. A. J. Conch., 1, p. 210.

Cordiera Texana, Conr.
Smithville, Ala.

Eucheilodon reticulata, Gabb. Jour. Acad. Nat. Sci. Phila., 2d ser., IV, p. 380.
? *Scobinella* (!) *laeviplicata,* Gabb. Jour. Acad. Nat. Sci. Phila., 2d ser., IV, p. 380 (imperfect specimen).
Wheelock; Caldwell.

Scobinella crassiplicata, Gabb. Jour. Acad. Nat. Sci. Phila. 2d ser., IV, p. 380.
Wheelock.

* **Murex Vanuxemi** Conr. A. J. Conch. 1, p. 210.
Smithville.

? **M.** (**Odontopolys**) **compsorhytis,** Gabb. Jour. Acad. Nat. Sci. Phila. 2d ser., IV, p. 377.
Wheelock.

I have seen no specimen of this poorly figured species, and am unable to pronounce upon its generic position.

* **Rostellaria** (**Calyptrophorus**) **velata,** Conr. F. S. T., 2d ed., p. 38.
Rostellaria staminea, Conr.—Proc. Acad. Nat. Sci. Phila., VII, p. 260.
R. Lamarckii, Lea.—Contrib., p. 158. *Et ead. R. eburnea?* Conr.
Near Alto.

Persona (**Distorsio**) **septemdentata,** Gabb. Jour. Acad. Nat. Sci. Phila., 2d ser., IV, p. 380.
Devil's Eye; Caldwell; Wheelock; Lee.

Clavella Penrosei Heilpr. Proc. Acad. Nat. Sci. Phila., 1890, p. 405.
Station 2.

Clavella ? enterogramma Gabb. Jour. Acad. Nat. Sci. Phila., 2d ser., IV, p. 378, as *Neptunea.* Aldrich, Bulletin Geol. Survey, Alabama, 1, p. 24.
Alabama.

* **Fusus salebrosus,** Conr. F. S. T., 2d ed. p. 56. (*Turrispira.*)
Smithville.

* **F. trabeatus,** Conr. F. S. T., 2d ed., p. 53 (*Levifusus*).
F. bicarinatus, Lea.—Contrib. p. 146.
Caldwell; San Antonio F.

F. (**Strepsidura ?**) **Marnochi** Heilpr. Proc. U. S. National Museum, 1880, p. 151.
Atascosa Co.

Fusus pagodæformis, Heilpr. Proc. Acad. Nat. Sci. Phila., p. 375.
Smithville.

Fusus Mortoniopsis, Gabb. Jour. Acad. Nat. Sci. Phila., 2d ser., IV, p. 377.
Wheelock; Caldwell.

* ? **Strepsidura (Muricidea?) bella**, Conr. F. S. T., 2d ed., p 56.
Fusus crebrissimus, Lea.—Contrib., p. 147.
Smithville.

* ? **Bulbifusus inauratus**, Conr. F. S. T., 2d ed., p. 53.
Fusus Fittonii, Lea.—Contrib., p. 150.
F. parvus, Lea.—Contrib., p. 151.
F. minor, Lea.—Contrib., p. 151.
Alum Creek Bluff.

Only a fragment, which shows a partial costation; in this character it agrees more closely with the *B. ficulneus* of Lamarck, which the species may prove to be.

Latirus (Cordiera) Moorei, Gabb. Jour. Acad. Nat. Sci. Phila., 2d ser., IV, p. 382.
Wheelock; Caldwell.

? **L. (Cordiera) Texana**, Conr.
Specimen in Museum—description?
? *Cordiera gracilis* of Smithsonian Check List.

This species differs from the above in the prominence of its revolving lines; the type is, however, founded on a single imperfect specimen, which scarcely permits of characterization.

Fusimitra polita, Gabb. Jour. Acad. Nat. Sci. Phila., 2d ser., IV, p. 382, as *Fasciolaria*.
Caldwell.

Differs from *Mitra minima*, of Lea (Contr. p. 168) in being much more elevated and slender.

F. exilis, Gabb. Jour. Acad. Nat. Sci. Phila., 2d ser., IV, p. 383.
Wheelock.

Mitra sp?
Devil's Eye.

* **Fusimitra lineata**, Lea. Contrib., p. 168.
Wheelock.

Lapparia dumosa, Conr. Proc. Acad. Nat. Sci. Phila., VII, p. 260.
Lapparia Mooreana, Gabb.—Jour. Acad. Nat. Sci. Phila., 2d ser., IV, p. 383.
Smithville; Caldwell; Wheelock; Mississippi.

This species is distinct from *Lapparia pactilis*, Conr., from Claiborne, Ala.

Caricella reticulata, Aldrich. Journ. Cincinnati Soc. Nat. History, July, 1885.
Smithville, Ala.

Volutilithes petrosa, Conr. F. S. T., 2d ed., p. 41.
Voluta Vanuxemi, Lea.—Contrib., p. 173.
V. impressa, Conr.—A. J. Conch., 1, p. 144.
V. indenta, Conr.—A. J. Conch., 1, p. 144.
V. symmetrica, Conr.—Proc. Acad. Nat. Sci. Phila., VII, p. 260.
V. dumosa, Conr.—Wailes' Geol. Rept. Mississippi, pl. XVI, fig. 1.

Devil's Eye; Alum Creek B.; San Antonio F.; Smithville; Lee Co.; Miss.

* **V. Sayana**, Conr. F. S. T., 2d ed., p. 41.
Voluta Defrancii, Lea.—Contr., p. 171.
V. gracilis, Lea.—Contr., p. 172.
Well at Palestine, Anderson Co.

V. precursor, Dall. Trans. Wagner Free Ins. Science, Phila., III, p. 84.
Wheelock.

* **Marginella semen**, Lea. Contr., p. 178.
Marginella (Erato) seminoides, Gabb.—Jour. Acad. Nat. Sci. Phila., 2d ser., IV, p. 383.
Oliva minima, Lea.—Contr. p. 184.
Wheelock; Caldwell.

I see no character by which to separate *M. seminoides* from *M. semen*. The species is not, as Conrad assumed, the young of *M. larvata*.

Cancellaria (Admete ?) ellapsa, Conr. A. J. Conch., 1, p. 212.

* **Cancellaria tortiplica**, Conr. A. J. Conch., 1, p. 145.
Smithville.

This species is probably identical with Brander's *C. (Buccinum) evulsa*, from the Barton (Upper Eocene) deposits of England (*C. evulsa*, Sowerby—Min. Conch., IV, p. 84.—See my "Contributions to the Tertiary Geology and Palæontology of the United States," p. 93, 1884.)

C. impressa, Conr. A. J. Conch., 1, p. 145.
Smithville; Alabama.

* **C. plicata**, Lea. Contr., p. 139.
Cancellaria lirata, Conr., A. J. Conch., 1. p. 145.
Caldwell.

The occurrence of this species in Texas rests on Gabb's identification; his label still remains in the Academy collection, but the specimen belonging to it is lost. The same is true of the species following.

* **C. gemmata**, Conr. F. S. T., 2d ed., p. 144.
Cancellaria Babylonica, Lea.—Contr., p. 138.
Caldwell.

* **Oliva bombylis**, Conr. F. S. T., 2d ed., p. 42.
Oliva constricta, Lea.—Contr., p. 182.
Caldwell.

* **? O. gracilis**, Lea. Contr., p. 182.
I suspect that this is the young of *Oliva Alabamensis* of Conrad, F. S. T., 2d ed., p. 41.

* **Olivula staminea**, Conr. F. S. T., 1st ed., p. 25 as *Ancillaria*.
Smithville.

O. punctulifera, Gabb. Jour. Acad. Nat. Sci. Phila., 2d ser., IV, p. 381.
Wheelock.
Also at Claiborne, Ala., according to Gabb.

? **O. Texana**, Conr. A. J. Conch., I, p. 143, as *Tortoliva.*
I have seen no specimen of this species, and am in doubt as to its true position.

Monoptygma crassiplica, Gabb. Jour. Acad. Nat. Sci. Phila., 2d ser. IV, p. 384, from Conrad's Mss.
Wheelock.

Ancillaria ancillops, Heilpr. Proc. Acad. Nat. Sci. Phila., 1890, p. 406.
Smithville; Alum Creek B.

Pseudoliva carinata, Gabb. Jour. Acad. Nat. Sci. Phila., 2d ser., IV, p. 381, from Conrad's Mss.
San Antonio F.; Caldwell; Wheelock.

P. fusiformis, Gabb. Jour. Acad. Nat. Sci. Phila., 2d ser., IV, p. 381 from Conrad's Mss.
Pseudoliva filiformis? Conr., of Smithsonian Check List.
Smithville; Wheelock.

* **P. sulcata**, Lea. Contr., p. 163, as *Monoceros.*
Pseudoliva linosa. Gabb.—Jour. Acad. Nat. Sci. Phila., 2d ser., IV, p. 381, from Conrad's Mss.

* **P. venusta**, Conr. F. S. T., 2d ed., p. 37.
Monoceros pyruloides. Lea.—Contr., p. 161.
M. fusiformis, Lea.—Contr., p. 162.
Station 3; White Marl B.

P. perspectiva, Gabb. Jour. Acad. Nat. Sci. Phila., 2d ser., IV, p. 381, from Conrad's Mss.
Gastridium vetustum, Conr., in Wailes' Rept. Geol. Mississippi, pl. 17, fig. 4.
Smithville; Mississippi.

* **Lacinia alveata**, Conr. A. J. Science, XXIII, p. 344.
Melongena alveata, Conr. F. S. T., 2d ed., p. 37.
Pyrula Smithii, Lea.—Contr., p. 155.

* **Euthria (Lævibuccinum) prorsum**, Conr. F. S. T., 1st ed., p. 45.
Buccinanops prorsum, D'Orb., Prodrome, II, p. 369.
Station 2.

* **Terebra venusta**, Lea. Contr., p. 167.
Terebra perlata, Conr.
Smithville.

T. plicifera, Heilpr. Proc. U. S. National Museum, 1880, p. 151.

* **F. polygyra**, Conr.
Labelled specimen.—Description?

* **Terebrifusus amœnus**, Conr. F. S. T., 1st ed., p. 45.
Terebra gracilis, Lea.—Contr. p. 166.
Buccinanops amœnum, D'Orb., Prodrome, II, p. 369.
Terebra multiplicata. H. C. Lea.—A. J. Science, XL, p. 101.
Smithville.

This genus or group, of whose exact position I am ignorant, recalls both *Buccinum* and *Terebra*; it is seemingly closely related to, if not identical with, *Genea* of Bellardi (*Molluschi Terreni Terziari del Piemonte*, 1873, part 1, p. 205.)

Buccitriton Texanum, Gabb. Jour. Acad. Nat. Sci. Phila., 2d ser., IV, p. 381, as *Phos*.
Buccitriton altum, Conr.—A. J. Conch., i. p. 211.
? *Rageneila Texana*, Conr.—A. J. Conch., 1, p. 21.
Sta. 3; Caldwell; Wheelock; St. Augustine.

B. scalatum, Heilpr. Proc. Acad. Nat. Sci. Phila., 1890, p. 405.
Smithville.

Dr. Dall, in his report on the "Tertiary Mollusks of Florida" (Trans. Wagner Free Inst. Science, III, 1890, pp. 134–35), refers *Buccitriton sagena*, Conr. to *Phos* and *B. altum*, Conr. and *B. Texanum*, Gabb, to *Nassa*. I see no good reason for generically separating the species. The group appears to me to be neither *Phos* nor *Nassa*.

* **Pyrula nexilis**, Lam. Anim. Sans. Vertèbr., 2d ed., III, p. 688.
Pyrula penita, Conr.—F. S. T., 1st. ed., p. 32.
P. cancellata, Lea.—Contr., p. 154.
P. elegantissima, Lea.—Contr. p. 155.
Ficopsis penitus, Conr.—Smithsonian Check List, 1866.
Smithville.

Natica (Neverita) arata, Gabb. Jour. Acad. Nat. Sci. Phila., 2d ser., IV, p. 384.
Alum Creek; Caldwell; Wheelock.

? **N. Moorei**, Gabb. Jour. Acad. Nat. Sci. Phila., 2d ser. IV, p. 384.
Caldwell.

I have seen no specimen answering to Gabb's figure or description; the specimen marked in his hand-writing as the "type" of this species is *Natica minor*, of Lea.

N. Dumblei, Heilpr. Proc. Acad. Nat. Sci. Phila., 1890, p.
Station 2.

* **N. minor**, Lea. Contr., p. 107.

Natica minima, Lea.—Contr., p. 107.
N. semilunata, Lea.—Contr., p. 108.
Smithville.

* **Natica limula**, Conr. F. S. T., 1st ed., p. 46.
Natica mamma, Lea.—Contr., p. 109.
Smithville.

* **Sigaretus canaliculatus**, Sowerby. Mineral Conchology, IV, p. 115.
Sigaretus bilix, Conr.—A. J. Science, XXIII, p. 344.
S. declivus, Conr.—F. S. T., 1st ed., p. 45.
S. declivus, Conr.—A. J. Conch., VI, p. 314.

S. Mississippiensis, Conr.—Jour. Acad. Nat. Sci. Phila., 2d ser., 1, p. 113.
Smithville.

Xenophora confusa, Deshayes. Coquilles Fossiles Envir. de Paris, II, p. 243 as *Trochus*.
Devil's Eye.

Solarium Meekanum, Gabb. Jour. Acad. Nat. Sci. Phila., 2d ser., IV, p. 385.
Wheelock ; Caldwell.

S. Texanum, Gabb. Jour. Acad. Nat. Sci. Phila., 2d ser., IV, p. 384.
Wheelock.

S. vespertinum, Gabb. Jour. Acad. Nat. Sci. Phila., 2d ser., IV, p. 384.
Caldwell.

* **S. alveatum**, Conr. F. S. T., 2d ed., p. 47.
Solarium bilineatum, Lea.—Contr., p. 119.
Caldwell.

* **Tuba (Littorina) antiquata**, Conr. F. S. T., 1st ed., p. 35.
Tuba alternata, Lea.—Contr., p. 128.
T. striata, Lea.—Contr., p. 128.
T. sulcata, Lea.—Contr., p. 129. (Worn fragment.)
Smithville.

Scalaria staminea, Conr. Jour. Acad. Nat. Sci. Phila., 2d ser., IV, p. 294.
Smithville.

Turritella nasuta, Gabb. Jour. Acad. Nat. Sci. Phila., 2d ser., IV, p. 385.
Smithville ; Caldwell ; Wheelock.

* **Turritella carinata**, Lea. Contr., p. 129.
? *Turritella monilifera*, H. C. Lea.—A. J. Science, XL, p. 97.
Laredo ; well at Palestine, Anderson Co.

* **T. (Mesalia) Claibornensis**, Conr.
Labelled specimen—description ?
San Antonio F.

* **T. (Mesalia) obruta**, Conr. F. S. T., 2d ed., p. 40.
Turritella lineata, Lea.—Contr., p. 130.

* **T. (Mesalia) venusta**, Conr. F. S. T., 2d ed., p. 40.
Cerithium ? striatum, Lea.—Contr., p. 131.
Caldwell.

Eulima exilis, Gabb. Jour. Acad. Nat. Sci. Phila., 2d ser., IV, p. 385.
Caldwell.

E. tenua, Gabb. Jour. Acad. Nat. Sci. Phila., 2d ser., IV, p. 386.

E. Texana, Gabb. Jour. Acad. Nat. Sci. Phila., 2d ser., IV, p. 386.

* **Pyramimitra costata**, Lea. Contr., p. 166, as *Terebra*.
Smithville.

I believe that the group or genus to which Conrad, in 1865 (A. J. Conch., 1, p. 28), applied the name *Pyramimitra* has never been characterized. It may stand thus :

Shell elevated, terebriform, and having the general ornamentation of *Cerithium*, or of closely related forms—i. e., longitudinal costæ and revolving lines ; aperture comparatively short and contracted anteriorly into a twisted canal ; columella considerably twisted (but not reflected posteriorly, as in *Vertagus*), with two folds, the upper of which is the longest ; outer lip dentate interiorly.

* **Cerithium Whitfieldi**, Heilpr. Proc. Acad. Nat. Sci. Phila., 1879, p. 216, as *Rostellaria*.
McBee School.

Cerithium Texanum, Heilpr. Proc. Acad. Nat. Sci. Phila., 1890, p. 404.
Station 5.

Crepidula sp ?
Station 4.

* **Cylichna galba**, Conr. F. S. T., 2d ed., p. 40.
Bulla St. Hilairii, Lea.—Contr., p. 98.
B. Kelloggii, Gabb.—Jour. Acad. Nat. Sci. Phila., 2d ser., IV, p. 386.
Smithville ; Caldwell ; Wheelock.

Volvula minutissima, Gabb. Jour. Acad. Nat. Sci. Phila., 2d ser., IV, p. 386.
Caldwell ; Wheelock.

V. Conradiana, Gabb. Jour. Acad. Nat. Sci. Phila., 2d ser., IV, p. 386.
Caldwell ; Wheelock.

* **Helcion Leanus**, Gabb. Jour. Acad. Nat. Sci. Phila., 2d ser., IV, p. 387.
Caldwell.

This species is, I believe, Lea's *Hipponyx* (*Concholepas*) *pygmæa* (Contr., p. 95.)

Dentalium minutistriatum, Gabb. Jour. Acad. Nat. Sci. Phila., 2d ser., IV, p. 386.
Smithville ; Wheelock.

Gadus subcoarctatus, Gabb. Jour. Acad. Nat. Sci. Phila., 2d ser., IV, p. 386, as *Ditrupa*.
Wheelock.

ACEPHALA.

* **Corbula rugosa**, Lamarck. Anim. sans Vertèbr., 2d ed., VI, p. 141 ; Deshayes Anim. sans Vertebr., Bassin de Paris, I, p. 226.
Corbula oniscus, Conr.—A. J. Science, XXIII, p. 341.
C. Murchisonii, Lea.—Contr., p. 46.
C. gibbosa, Lea. var.—Contr., p. 47.
? *C. bicostata*, Nyst.
Smithville ; St. Augustine Co.

C. Texana, Gabb. Jour. Acad. Nat. Sci. Phil., 2d. ser., IV, p. 387.
Smithville.

Tellina Mooreana, Gabb. Jour. Acad. Nat. Sci. Phila., 2d ser., IV, p. 387.
Caldwell.

* **Donax limatula**, Conr. F. S. T., 1st ed., p. 12.
Egeria Bucklandii, Lea.—Contr., p. 52.
E. triangulata, Lea.—Contr., p. 51.
Colorado R.

Cytherea Yoakumii, Gabb. Proc. Acad. Nat. Sci. Phila., 1861, p. 370, (*Meretrix*.)

Cytherea sp.?
Station 5.

* **C.** (**Dione**) **discoidalis**, Conr. F. S. T., 1st ed., p. 36.
Cytherea subcrassa, Lea.—Contr., p. 67.
C. Hatchetigbeensis, Aldrich.—Bull. Geol. Surv. Alabama, 1, p. 39.
Station 3, Ala.

* **C. Nuttallii**, Conr. Jour. Acad. Nat. Sci. Phila., VII, p. 149.
Station 1.

C. Nuttalliopsis, Heilpr. Proc. Acad. Nat. Sci. Phila., 1880, p. 270.
Devil's Eye, Ala.

* **Grateloupia Moulinsii**, Lea. Contr., p. 59, as *Cytheriopsis*.
Cytherea Hydana, Conr.—F. S. T., 1st ed., p. 36.
Cytheriopsis Hydana, Conr.—A. J. Conch., 1, p, 146.

Protocardium Gambrinum Gabb. Proc. Acad. Nat. Sci. Phila., 1861, p. 371.
? *Cardium diversum*, Conr., from Vicksburg (Jour. Acad. Nat. Sci. Phila., 2d ser., 1, p. 122).

* **Lucina alveata**, Conr. F. S. T., 1st ed., p. 40.
Lucina lunata, Lea.—Contr., p. 58.
Station 1.

* **? Mysia ungulina** Conr.
Astarte ungulina, Conr.—A. J. Science, XXIII, p. 342.
Egeria rotunda, Lea. Contr., p. 50.
Devil's Eye.

* **Astarte tellinoides**, Conr. A. J. Science, XXIII, p. 342.
Astarte Nicklinii, Lea.—Contr. p., 61.
A. sulcata, Lea.—Contr., p. 62.
Smithville; Devil's Eye.

* **Cardita planicosta**, Lamarck. Anim. sans Vertèbr., 2d ed., VI, p. 381; Deshayes, Anim. sans Vertèbr., Bassin de Paris, I, p. 756.
Cardita densata, Conr.—Jour. Acad. Nat. Sci. Phila., 2d ser., 1, p. 130.
C. regia, Conr.—A. J. Conch., 1, p. 8.
Venericardia ascia, Rogers.—Trans. Am. Philos. Soc. new ser., VI, p. 374.
et V. Mooreana, Conr.?
Laredo; Lee; Co.; well at Palestine, Anderson Co.

C. Mooreana, Conr. A. J. Conch., III, p. 190, as *Venericardia*.
Lee Co.

I think it not unlikely that this species is only a varietal form of *C. planicosta*.

* **C. alticosta**, Conr. A. J. Science, XXIII, p. 342.
Cardita Blandingi, Conr.—Jour. Acad. Nat. Sci. Phila., VI, p. 229.
Venericardia transversa, Lea.—Contr., p. 68.
Camp Disaster, Colorado River; St. Augustine Co.

Cardita tetrica, Conr.
Labelled specimen—description?
Smithville; Devil's Eye; Mississippi.

* **C. rotunda,** Lea. Contr., p. 70, as *Venericardia.*
Smithville.

Crassatella antestriata, Gabb. Jour. Acad. Nat. Sci. Phila., 2d ser., IV, p. 388.
Wheelock.

C. Texana, Heilpr. Proc. Acad. Nat. Sci. Phila., 1890, p. 406.
Smithville; McBee's School; near Alto; St. Augustine Co.

* **Nucula magnifica,** Conr. F. S. T., 1st ed., p. 37.
Nucula Sedgwickii, Lea.—Contr., p. 79.
Caldwell; Devil's Eye.

* **Leda bella,** Conr. A. J. Science, XXIII, p. 343.
Nucula plicata, Lea.—Contr., p. 85.
Smithville.

Leda compsa, Gabb. Jour. Acad. Nat. Sci. Phila., 2d ser., IV, p. 387.
Caldwell.

* **? Yoldia eborea,** Conr. Jour. Acad. Nat. Sci. Phila., 2d ser., IV, p. 295.
Smithville.

Pectunculus intercostatus, Gabb. Jour. Acad. Nat. Sci. Phila., 2d ser., IV, p. 402.
Axinæa bellasculpta, Conr.—Jour. Acad. Nat. Sci. Phila., 2d ser., IV, p. 295.

* **? Limopsis corbuloides,** Conr. F. S. T., 1st ed., p. 40, as *Pectunculus.*
Devil's Eye.

Limopsis pulcher, Gabb. Jour. Acad. Nat. Sci. Phila., 2d ser., IV, p. 388, as *Noetia.*
Wheelock; Caldwell.

Arca (Cibota) Mississippiensis, Conr. Jour. Acad. Nat. Sci. Phila., 2d ser., IV, p. 125 (Vicksburg). Jour. Acad. Nat. Sci. Phila., 2d ser., IV, p. (Gabb.)
Arca lima (juv.)
Caldwell; Wheelock; near Alto.

Modiola Texana, Gabb. Proc. Acad. Nat. Sci. Phila., 1861, p. 371, as *Perna.*

Pinna sp.?
Smithville.

Pecten sp.?
Station 4.

* **P. Deshayesii,** Lea. Contr., p. 87.
Pecten Lyelli, Lea.—Contr., p. 88.
Burleson Shell B.; St. Augustine Co.

This species must not be confounded with *Pecten Deshayesii* of Nyst (Coqu. et Polyp. Foss., p. 288.)

* **P. (Camptonectes) Claibornensis,** Conr. Labelled specimen—description?
St. Augustine Co.

Plicatula filamentosa, Conr. F. S. T., 1st. ed., p. 38.
Plicatula Mantelli, Lea.—Contr., p. 89.
Near Alto.

Spondylus sp.?

* **Ostrea Alabamensis**, Lea. Contr., p. 91.
Ostrea lingua-canis, Lea.—Contr., p. 92.
O. pincerna, Lea.—Contr., p. 92.
O. semilunata, Lea.—Contr., p. 90.
Near Alto; Burleson Shell B.; St. Augustine Co.; Station 5; Station 1, below Carrizo; Smithville.

* **O. sellæformis**, Conr. F. S. T., 1st ed., p. 27.
Ostrea radians, Conr.—F. S. T., 1st ed., p. 27.
Smithville; Cherokee Co.; St. Augustine Co.

* **O. divaricata**, Lea. Contr., p. 91.
? *Ostrea flabellula*, Lamarck.
St. Augustine Co.

Anomia ephippioides, Gabb. Jour. Acad. Nat. Sci. Phila., 2d ser., IV, p. 388.
Station 2; McBee's; near Jacksonville; near Alto.

Natica Dumblei, n. sp. Plate XI, fig. 3.

Shell globular, smooth; whorls about five, moderately convex, and flattened slightly on the shoulder; suture impressed; aperture about two-thirds the length of shell; columellar surface flattened; umbilicus probably wanting.

Length (height), 2·3 inches; greatest width, about the same.

Station 2, Rio Grande; one specimen, filled with matrix.

This species seems closely allied to *Natica crassatina*, Lamarck, from the Paris Basin, and may prove to be that form. It is the largest of our Eocene *Naticas;* named after the State Geologist of Texas.

Cerithium Texanum, n. sp. Pl. XI, fig. 2.

Shell turreted, of the type of the well-known *Cerithium giganteum* and *C. Parisiense* of the Paris Basin, but more rapidly tapering; whorls? in number, smooth, moderately convex, and ornamented with obtuse, widely placed, and slightly diagonal ribs, which completely traverse the whorls; aperture?

Station 5, Rio Grande. Two fragments, lacking both apex and aperture, and measuring about one and a half inches in height. Although thus imperfect, I have thought best to describe the form, as it represents a well-recognized type from the European Eocene deposits which has not heretofore been generally recognized as occurring in the United States. The species is most nearly related to *Cerithium Parisiense*, of Deshayes, from which it differs in the rapidly-tapering spire.

Clavella (Fusus ?) Penrosei, n. sp. Pl. XI, fig. 1.

Shell large, turbinate, with a greatly elongated canal; whorls scalariform, depressed, broadly flattened and slightly hollowed on the shoulder; no revolving lines, but wrinkles of growth faintly indicated; beak nearly (or fully ?) the length of the spire, and twisted at about its middle somewhat as in *Fulgur*; canal narrow, tortuous in its upper half.

Length of full-grown specimen probably 8–10 inches.

Station 2, Rio Grande. Fragments of two specimens. The species is manifestly of the type to which *Fusus longævus*, of Brander (Sowerby), belongs, although in that species the canal and columella are nearly straight; to the same type also belongs *Clavella humerosa*, of Conrad, from the Alabama Eocene. I cannot tell from my specimens whether a posterior canal is present or not, but the general similarity of the shell to the forms first referred to, in which such a canal is present, leads me to infer that it also exists in this species.

The species differs from *Fusus longævus*, apart from the character presented by the columellar arcuation, in the broader and more depressed whorls, and in the very considerable inferior flattening of the body-whorl. I have compared it with Sowerby's type (Mineral Conchology, 1, p. 141, table LXIII), which is contained in the collections of the Academy.

Named after Dr. R. A. F. Penrose, Jr., to whom I owe most of the material which has been submitted to me for examination.

Buccitriton scalatum, n. sp. Pl. XI, fig. 5.

Shell small but robust; spire of about seven volutions, prominently turreted or scalariform; whorls only feebly convex, flattened on the shoulder and carrying a considerable number of sharp, diagonally directed ribs, which become obsolete on the body-whorl; revolving lines well-defined on the base of the body-whorl, elsewhere almost obsolete; the flat shoulders with two impressed lines, the upper of which is the most prominent. Aperture bucciniform (or columbellæform), about one-half the length of shell; outer lip thickened near the border.

Length, one-half inch.

Smithville, Bastrop Co.

This species differs from the *Buccitriton sagena*, of Conrad, in its high and flat shoulder, in the less prominence of the revolving lines, and in the obliteration of the longitudial folds on the body-whorl.

Ancillaria ancillops, n. sp. Pl. XI, fig. 4.

Shell smooth, fusiform, having much the appearance of *Oliva Alabamensis;* whorls strongly convex, the first four or five prominently ribbed; sub-sutural band, with sigmoidal lines of growth, well marked; aperture broad, about one-half the length of shell; columellar surface markedly concave, with a pseud-umbilicus; basal notch profound.

Length somewhat more than an inch.

Smithville, Bastrop Co.

The reverse of this shell has much the aspect of *Oliva Alabamensis.*

Crassatella Texana, n. sp. Pl. XI, fig. 6.

Shell irregularly rhomboidal; valves prominently angulated posteriorly, with the post-umbonal slope broad and slightly concave; umbones prominent, well incurved; hinge powerful; exterior surface ornamented with strong and closely set lines of growth, which traverse the entire shell, becoming, however, less prominent on the umbonal slope.

Length of shell about an inch and a quarter, slightly exceeding the height. Smithville; McBee's School; near Alto; St. Augustine Co.

This species is comparatively more elongated than *Crassatella antestriata,* of Gabb, which in some respects it closely resembles. The ornamentation, too, is carried completely across the shell, and is not restricted to the anterior moiety of the valves.

NOVEMBER 4.

Mr. JOHN H. REDFIELD in the chair.

Fifty-seven persons present.

The functions and histology of the yolk-sack of the young Toad-fish.—PROF. J. A. RYDER presented verbally some observations upon the microscopic anatomy of the yolk-sack of the young Toad-fish or *Batrachus tau*. Unlike the larvæ of other fishes, the young of this form do not at once escape from the egg-membrane when the latter is ruptured at the time of hatching but continue to adhere for a long period by means of an adhesive discoidal area on the under side of the yolk-sack to the inner side of a similar area of the egg-membrane which in turn is adherent by its external surface to some foreign object such as the under side of a stone, which forms the roof of the tiny cavern excavated by the parent at the time of oviposition.

The origin of the adhesive matter which causes the eggs to adhere to foreign bodies was well understood to be ovarian, but the origin of the adhesive matter covering the discoidal area on the under side of the yolk-sack has not until now been explained. If the cellular membrane covering the inferior pole of the yolk-sack be carefully dissected off, it is found to be much thickened as compared with the rest of the outer wall of the yolk. This thickening is found upon making vertical sections of the adherent area, to be due to the vertical lengthening and modification of the substance of the outer cells of the epidermis of this region, The peripheral ends of the cells of the epidermis are in fact here seen to be much prolonged in the form of a homogeneous, almost vitreous, looking material, which shows, by the way in which the ends of these cells are roughened or fractured, that they effect the adhesion of the yolk to the egg-membrane before alluded to by the speaker.

The whole of the free surface of the epidermis covering the yolk-sack is studded with scattered goblet or mucous secreting cells. At the edge of the adherent area of the epidermis there seems to be some evidence of the fact that these goblet cells are multiplied so as to completely cover the adherent area of the yolk-sack. If this is the case, which seems very probable, the cells causing the adhesion, for a time, of the yolk-sack and consequently the whole embryo, to the inner side of the egg-membrane, have originated from a multiplication and modification of the mucous or goblet cells completely covering the adherent area referred to.

Another remarkable peculiarity of the yolk-sack of the young Toad-fish is the presence of a layer of smooth muscular fibres underneath the epidermis and apparently originating from the splanchnic mesoblast. This muscular layer consists of two layers of spindle-shaped muscular fibres. One of these layers has its fibres running equatorially round the pyriform yolk-bag, and the other, which is closely adherent to the first-named, has its fibres running at right angles to the latter, and consequently corresponding in direction with the greatest elongation of the yolk-sack. As far as the speaker is aware, nothing similar in the form of an involuntary muscular coat covering the yolk is known in any other embryo fish. Whether its function is to increase the strength of the yolk membrane under the peculiar conditions of tension or whether it served to force the contents of the yolk-bag within the abdominal parietes, as happens during the disappearance of the yolk, the speaker did not attempt to decide.

The statement in Jordan and Gilbert's *Synopsis of the Fishes of North America*, p. 750 that: "the young of some or all the species (of the Batrachidæ) fasten themselves to rocks by means of an adhesive ventral disk which soon disaappears," must accordingly be qualified as incorrect so far as it carries the implication that the act of adhesion is a voluntary one on the part of the young fishes themselves. The researches of the speaker show very conclusively that the adhesion of young toad-fishes is effected in the first place, at the time of oviposition, by a mucous secretion covering the outer surface of the eggs, and this is supplemented at a later period, or after hatching, by the development, through a modification of certain cells at the surface of the yolk-sack, of an adhesive disk, produced by the modification of the substance of the peripheral or free portions of the cells of such an area which adheres to the inside of the egg-membrane. The embryo is thus left enchained for a period at the same place where the eggs were originally deposited but in such a way as to be free to respire the surrounding water and to freely vibrate the fins and tail. It is, therefore, clear that the fixation of young toad-fishes is a very complex process some of the steps of which are effected by the parent at the time of oviposition, while others are effected during the process of the development of the embryo itself, so that it is clear that such a fixation is not voluntary and has nothing in common with the voluntary and momentary adhesion, by means of modified fins such as is witnessed in the cases of the *Gobiesocidæ* and *Cyclopteridæ*.

NOVEMBER 11.

The President, Dr. JOSEPH LEIDY, in the chair.

Forty-eight persons present.

Remarks on Velella.—PROF. LEIDY exhibited specimens of *Velella mutica*, which with many others, where cast on shore at Beach Haven, N. J., in the early part of last August. The living ones were of a deep blue color and ranged from an inch and a half to three inches in the greater breadth. From them there were detached multitudes of gonophores; minute jelly fishes, measuring 0·44 mm. long by 0·32 mm. broad.

NOVEMBER 18.

Mr. CHAS. P. PEROT in the chair.

Forty-seven persons present.

NOVEMRER 25.

Mr. CHAS. P. PEROT in the chair.

Fifty-eight persons present.

Papers under the following titles were presented for publication:—

"Researches on Respiration, No. 1." By Henry C. Chapman, M. D. and Albert P. Brubaker, M. D.

"New Species of Fungi from Various Localities." By J. B. Ellis and B. M. Everhart.

Albert P. Brubaker, M. D. and Miss Virginia Maitland were elected members.

The following were elected Correspondents:—

Alfred Giard of Paris, C. Hart Merriam, M. D. of Washington, R. W. Shufeldt of Washington, and Florentino Ameghino of Buenos Ayres.

The following were ordered to be printed:—

NOTICES OF ENTOZOA.

BY JOSEPH LEIDY, M. D.

1. Ascaris lumbricoides Linné.

2. Trichocephalus dispar Rudolphi.

3. ? Filaria primana n. s.

In the dissection of an Orang, *Simia satyrus*, which died in our Zoological Garden, Dr. H. C. Chapman found in the intestines several worms (Proc. 1880, 166), which were submitted to my examination. Three seem in no respect to differ from the ordinary *Ascaris lumbricoides*; one of the specimens being 18 centimeters long. One from the cæcum seems to be *Trichocephalus dispar*. The occurrence of these parasites of man in a near relative outside the genus is an interesting fact.

Three other worms are unknown to me and I am in doubt as to their generic character. They are females, and measure up to 26 centimeters long by 2·75 millimeters thick. They are more robust than species of *Filaria* commonly are, and in this respect are more like *Eustrongylus gigas*. Although neither of these usually live in the intestine, I provisionally refer the worms to the former genus. The body is nearly uniformly cylindrical, being 2·5 mm. thick one centimeter back of the cephalic end, gradually increasing to 2·75 mm. and behind, slightly tapering to 2 mm. one centimeter from the tail end. The head is rounded conical, with the mouth as a central pore enclosing a minute papilla and unarmed. The tail is blunt conical. An anal aperture was not detected; but the genital aperture appears near the cephalic end. The species may be distinguished as *Filaria primana*.

4. Ascaris osculata Rudolphi.

Body cylindroid, tapering in advance; mouth with prominent lips; caudal end incurved; tail short, as wide as long, conical, obtuse.

Ten females from 25 mm. long and 1 mm. thick to 60 mm. long by 2 mm. thick.

From the Elephant Seal, *Macrorhinus angustirostris*, which died at the Zoological Garden. Submitted by Dr. Chapman.

5. Ascaris transfuga Rudolphi.

Body cylindrical, moderately and nearly equally tapering at both ends; head with narrow lateral alae and prominent lips.

A female 6 inches long and a male 4 inches.

From the Polar Bear, *Ursus maritimus*, of the Zoological Garden. Submitted by Dr. Chapman.

6. Ascaris simplex Rudolphi.

Body cylindrical, tail short, conical, straight, with a minute mucro.

One female 4 inches long by 1·5 mm. thick; a multitude of young, with no males, generally from 20 to 50 mm. long by 0·3 to 0·5 mm. thick.

From the stomach of *Mesoplodon sowerbiensis*. Submitted by Dr. Cooper Curtice, Washington.

6. Ascaris spiculigera Rudolphi.

Females to 45 mm. long by 2 mm. thick; tail short, acute. Males 30 mm. long by 1 mm. thick; tail short, incurved, acute. A pair of curved spicules exserted from the genital aperture.

Numerous specimens from the stomach of *Pelecanus fuscus*, Florida. Submitted by Mr. F. C. Baker.

8. Ascaris diacis n. s.

Body cylindrical, spirally rolled, pinkish-white, translucent, with the brown intestine shining through, smooth, about equally tapering at the ends. Head without appendages; mouth trilobed, with lobes large and rounded. Tail straight conical, acute, without papillae.

A female 70 mm. long, by 1·25 mm. thick. Obtained by Dr. B. H. Warren, from the body cavity, in the vicinity of the cloaca, of the Purple Grackle, *Quiscalus quiscala*, Chester Co. Submitted by Dr. Warren.

9. Atractis (Ascaris) opeatura n. s.

Body fusiform, most tapering and subulate behind; head rounded and tripapillate. Female broader; tail long, straight, acute, without appendages; vulva slightly tumid, situated a short distance in advance of the anus. Tail of male shorter incurved, with a mucronate point about one-third its length, with two pairs of tubercles ventrally near the middle and a pair opposite dorsally. Genital spicules curved; one twice the length of the other.

Oesophagus cylindrical, bounded by chitinous rods; pharynx about as long, slightly narrower and expanded below; intestine dilated at commencement but quickly narrowing: rectum short.

Length of females to 5 mm. by ·33 mm. thick at the middle; tail 7 mm. long. Length of males nearly as in the former by ·2 mm thick; tail ·375 mm. long. About an ounce measure of the worms obtained from the intestine of an Iguana, *Cyclura baeolopha*, Cope, from the island of New Providence.

10. Trichocephalus affinis Rudolphi.

About a pint measure of this worm was taken from the large intestine of a camel, *Camelus bactrianus*, which died at the Zoological Garden and was dissected at the Biological Department of the University, in the museum of which the worms are preserved.

11. Filaria horrida Diesing.

A dozen females and as many males were taken from the body cavity of an American Ostrich, *Rhea americana;* from the Zoological Garden, dissected at the Biological Department of the University. Preserved in the museum.

12. Filaria obtusa Rudolphi.

Body pinkish-white, cylindrical; cephalic end rounded, smooth; caudal end obtuse. About a dozen specimens, female and male, from the abdominal cavity of the Barn Swallow, *Chelidon erythrogaster*. Obtained by Dr. B. H. Warren, Chester Co.

The mouth organs consist of a pair of trilobate, elongated clavate appendages. Dujardin figures them as conjoined in loops. Length of the organs 0·12 mm. long. Spicules of penis 0·75 mm. long. Ova 0·04 mm. long, 0·032 mm. broad.

13. Cheilospirura uncinipenis Diesing.
Spiroptera uncinipenis Molin.

Body cylindrical, nearly equally tapering at the extremities; head naked. Caudal extremity of the female obtuse; of the male spiral, alate; alae longitudinally corrugated. Penis long, curved and acuminate; sheath hooked at the extremity, narrowly bialate.

Several dozen from the gizzard of the *Rhea americana*. Collection of the Biological Department of the University. Females 25 to 32 mm. long; males 20 mm. long.

14. Physaloptera retusa Rudolphi.

Body cylindrical, most tapering in advance; mouth retractile, with six papillae; caudal end acute; in the male bialate, with the alae supported by four ribs. Four males from 10 to 12 mm. long and a female 24 mm. long, from the intestine of *Varanus*——? Submitted by Dr. H. C. Chapman.

15. Trichosomum ? tenuissimum n. s.

In a mature male Brown Rat, *Mus decumanus*, embedded in the liver, were a number of irregular milk-white bodies, some appearing as spots and others as interrupted lines. These proved to be exceedingly slender thread worms more or less coiled up in the substance of the liver. They were so delicate that I failed to detach one of them entire. One specimen teased out but broken into half a dozen pieces was estimated to be two inches long and was only one-tenth of a millimeter thick. The anterior extremity is much attenuated, with the head acuminate; the posterior extremity thicker, straight and without papillae. Mouth minutely papillate, unarmed. Tail very short, blunt conical. Generative aperture at the fore part of the body and conspicuously swollen. The specimen, a female, contained numerous immature eggs. In some fragments of another worm, a third of a millimeter thick, the uterus was distended with mature eggs. These are white, oval, 0·04 mm. long and 0·032 mm. broad. They have a thick striated shell with a cylindrical aperture at both poles.

16. Echinorhynchus pellucidus Leuckart.

Body cylindrical, slightly wider at the extremities; anterior extremity barrel-shaped and armed with two zones of short, conical, recurved spines; posterior extremity obtusely rounded. Proboscis clavate, with extremity oval and armed with about a dozen rows of strong hooks; neck conical, smooth.

A dozen females, attached to the lining membrane of the intestine of *Mesoplodon sowerbiensis*, ranging from 10 to 18 mm. long by 0·6 to 1· mm. broad. Submitted by Dr. Cooper Curtice, Washington.

17. Echinorhynchus paucihamatus n. s.

Body cylindroid, widest in front and tapering behind, annularly constricted, truncate at the caudal end. Proboscis cylindrical, about three times the length of the thickness, clavate at the extremity and furnished with a single row of six, large, abruptly bent, hooks, succeeded by two rows of small ones about half the length of the former. Length 4 to 12 mm.; thickness at the fore part 0·5 mm.; behind 0·25 mm.; proboscis 0·5 mm. long; large hooks 0·625 mm.

Frequent and abundant in the small intestine of the Black Bass, *Micropterus nigricans;* usually found loose and with the proboscis retracted.

18. Amphistomum fabaceum Diesing.

Body hemiovoid, convex dorsally, flat ventrally. Numerous specimens, from 7 to 9 mm. long by 3·4 to 5 mm. broad, from the large intestine of a Sea-cow, *Manatus latirostris,* which died in the Zoological Garden in 1875. Submitted by Dr. H. C. Chapman. Numerous specimens, many of larger size, up to 11 mm. long by 9 mm. broad, were obtained from the nasal passages of another Sea-cow and were presented to the Academy by Jacob Geismar.

19. Distomum trapezium n. s.

Body ovate lanceolate, flat, smooth, narrowest in front; mouth subterminal, transverse oval, unarmed; ventral acetabulum situated a short distance behind the former, about twice the size. Color brown, darker laterally and thicker due to the vitelline glands which extend from the ventral disk to the posterior extremity of the body. Testes just behind the ventral disk; uterus dendritic and occupying the interspaces of the vitelline glands. Genital aperture back of the oral disk. Length 21 mm., breadth 6 mm. A single specimen from the American osprey, *Pandion carolinensis.* Submitted by Dr. H. C. Chapman.

20. Distomum aniarum n. s.

Body elliptical, flat, translucent white with a median brown streak, smooth. Oral acetabulum subterminal, circular; mouth transverse oval, unarmed. Ventral acetabulum larger, sessile, situated just in advance of the middle of the body. Genital aperture close to the oral acetabulum; uterus median, tortuous filled with brown ova; testes two, situated one on each side immediately behind the ventral acetabulum. Length from 1·875 to 3 mm; breadth 0·875 to 1 mm. Diameter of oral acetabulum 0·375 mm.; of ventral acetabulum 0·5 mm. Ova oval yellowish-brown, 0·032 by 0·02 mm. Six specimens obtained from the mouth of the Water-snake, *Tropidonotus sipedon.* Submitted by Dr. H. C. Chapman.

21. Distomum incommodum.

? *Monostomum incommodum* Leidy, Pr. A. N. S. 1856, 43.
Distoma oricola Leidy, Ibid. 1884, 47.

22. Distomum gastrocolum n. s.

Body elongated elliptical, flattened, smooth, translucent reddish, with brown intestine and yellowish genitals; cephalic extremity narrower, posterior extremity obtusely rounded, or somewhat abruptly prolonged and truncate and with a large contractile vesicle opening externally; ventral acetabulum spherical, nearly as broad as the body; oral acetabulum about half the size of the former. Pharynx immediately succeeding; forks of the intestine capacious, distant from the end of the body. Uterus coiled along the middle of the body and filled with yellowish ova; testicles paired, spherical, situated behind the ventral acetabulum; genital apertures behind the oral acetabulum. Length from 2 to 3 mm. by 0·5 to 0·75 mm.; in movement elongated to twice the length and most narrowed in advance of the ventral disk; the latter to 0·5 mm. Ova 0·02 by 0·016 mm.

Several hundred attached to the lining of the stomach from its commencement to the end of its cœcal extremity. From the Skip-jack, *Trichiurus lepturus.*

23. Distomum ischnum n. s.

Body long, narrow band-like with the ventral disk at the anterior fourth; smooth, translucent, brownish with lateral black lines due to the long tortuous and sacculated forks of the intestine; anterior extremity slightly narrower, with rounded head and unarmed; posterior extremity transversely corrugated, with parallel sides and rounded truncate, emarginate end; ventral disk about half the width of the body; oral disk smaller; uterus coiled along the middle of the body and distended with ova. Length 8 mm. by 0·875 mm. wide; ventral disk 0·625 mm. Ova 0·02 by 0·012 mm.

A dozen specimens from the mouth, throat and gills of the Sand-pike, *Saurus foetens.* Beach Haven, N. J.

24. Distomum lasium n. s.

Larval form. Body fusiform, widest at the ventral disk, which is situated near or a little in advance of the middle, finely annulate and minutely echinate; anterior extremity wider, rounded at the end; posterior extremity moderately tapering, truncate and emarginate at the end. Ventral disk large; oral disk nearly as large, with a style inserted in the upper lip. Interior organs, except the posterior contractile sac of the vascular system, indistinct. Sporocyst, simple, elliptical with from few to numerous larval distomas.

Larva 0·2 to 0·33 mm. long, by 0·08 to 0·1 mm. wide; elongating to 0·4 long by 0·04 mm. wide. Oral disk 0·048 mm.; ventral disk 0·06 mm.; style 0·016 mm. Sporocyst 0·375 by 0·15 mm. to 0·875 by 0·25 mm.

Very common and numerous in the liver of *Ilyanassa obsoleta*, Beach Haven, N. J. *Ilyanassa* oçcurs in great abundance at Beach Haven, the mud flats of the neighboring sounds, at low tide, being covered in dense patches. Covered with dirt, the ordinary observer takes them for pebbles. In dissecting a number I found that about one in five or six was infested with the larval distomas enclosed in sporocysts, often in large number, embedded in the liver and associated genital gland. The larvae always appeared in the distoma-form and never as a cercaria. They exhibited no trace of genital organs, and were all provided with a conspicuous style, in the forehead as it were, ready for penetration into their as yet unknown future host.

25. Distomum céntrappendiculatum.

Distoma appendiculata Leidy, Proc. A. N. S. 1877, 202; not *Distomum appendiculatum* Rudolphi.

26. Tetracotyle typica Diesing.

Body flattened obpyriform, with an oral, a ventral central and an anterior lateral pair of bothria. Length 1·125 to 1·25 mm. long by 0·95 to 1·125 mm. broad.

Encysted in the liver and genital gland of *Lymnaea catascopium* and *Physa heterostropha*. Sixty-five specimens were obtained from a single *Physa*.

27. Cercaria platyura n. s.

Body elongated hemielliptical, widest and truncate behind; head rounded; oral acetabulum large and spherical, with a strong style in the upper lip; ventral acetabulum central, smaller than the former. Tail nearly as long as the body, stout, tapering, corrugated and with a broad, costate, lateral membrane. Length 0·8 mm.; body 0·4 by 0·12 mm.; tail 0·36 by 0·06 mm. at base, breadth with membranous alae 0·14 mm.; oral acetabulum 0·08 mm.; ventral acetabulum 0·06 mm.

Found free in a pool, with *Lymneus*, at Fort Bridger, Wyoming.

28. Cysticercus tenuicollis Rudolphi.—The Larva of *Taenia marginata* Batsch.

1. A specimen enclosed in a spherical cyst an inch in diameter attached to the paunch of a young sheep, *Ovis aries*. *Cysticercus* 3 inches long with terminal cyst an inch in diameter; the retracted head and neck an additional inch in length. Submitted by Dr. J. Cheston Morris.

2. A specimen from the vagina of a Sheep, measured 5½ inches in length with the terminal cyst over an inch in diameter.

3. A specimen enclosed in a sac an inch in diameter attached by a pedicle two inches in length to the liver of a Monkey, *Semnopithecus entellus*. The worm was 22 mm. long; the body 8 mm; the terminal cyst 14 mm. in diameter. The retracted head 1 mm. broad;

the bothria 0·375 mm.; the rostrum with its double circle of hooks 0·375 mm. Submitted by Dr. H. C. Chapman.

29. Cysticercus pisiformis Zeder.=Larva of *Taenia serrata* Goeze.

Numerous sacs simple and compound, ranging from 2 to 3 centimeters in diameter, with worms isolated and in groups in various stages of development. One large sac contained a dozen groups adherent to the inner surface; the groups with from 6 to 30 worms, opaque yellowish, obconic from 4 to 6 mm. long by 1·5 mm. thick; with head and neck retracted nearly the length of the rest of the body which is transversely corrugated. Bothria 0·225 mm.; rostrum 0·3 mm. broad; upper hooks 0·14 mm. long, lower ones 0·1 mm. long.

From the peritoneal cavity of the Jack Rabbit, *Lepus palustris*, from northern Minnesota. Submitted by Mr. Horatio C. Wood.

30. Taenia nematosoma n. s.

Head rounded quadrate, unarmed, with equidistant hemispherical bothria and a small central papilla; neck short or none; fore part of body linear; anterior segments much wider than long; posterior segments gradually becoming proportionally longer, quadrate or barrel-shaped; genital apertures marginal and alternating irregularly. Length to 9 inches, contracting to about one half. Breadth of head 0·375 to 0·5 mm.; bothria 0·175 wide; neck 0·25 wide; anterior segment an inch from the head 0·175 mm. long by 2 mm. broad; posterior segments 0·75 mm. long by 2 mm. broad and when contracted, widening to 2·5 mm. Ova spherical, 0·028 to 0·032 mm.

A half dozen specimens in the stomach of two Pickerels, *Esox reticulatus*.

31. Tetrabothrium triangulare Diesing?

Head large, oblate spheroidal and formed by four large bothria; neck short or none; anterior segments of the body transverse linear, then oblong square, the posterior segments short companulate; genital apertures marginal.

Several inches in length; described from fragments of several individuals. Head 0·55 mm. long by 0·75 mm. broad; bothria 0·5; neck 0·3 wide; body 15 mm. behind the head indistinctly segmented and 0·125 mm. wide. In a fragment without the head, about an inch long, the anterior segments are oblong square with prominent marginal genital apertures and 0·3 mm. long by 0·25 mm. wide; the posterior segments 0·175 mm. long and 0·2 mm. wide. In a posterior segment of half an inch, the segments readily separable are short compamulate, 0·175 mm. long and 0·375 mm. wide. From the intestine of *Mesoplodon sowerbiensis.* Submitted by Dr. Cooper Curtice, Washington.

32. Tetrabothrium loliginis.

Taenia loliginis Leidy. Proc. A. N. S. 1887, 24.

The Scolex of *Tetrabothrium* Rudolphi, or *Phyllobothrium* Van Beneden. A dozen specimens in alcohol, obtained from the Squid, *Ommastrephes illecebrosa*, at Bar Harbor, Me. In their present condition they are an inch in length or less and from 2 to 3 mm. wide, linear lanceolate, posteriorly acute and unsegmented. The head is prominent, spheroidal and consists of four much folded rosette-like lobes with hemispherical bothria. Submitted by Dr. H. C. Chapman.

33. Phyllobothrium inchoatum n. s.

Ten specimens, taken from the blubber in the vicinity of the vent of *Mesoplodon sowerbiensis*, preserved in alcohol, appear as depressed fusiform bodies from 14 to 18 mm. long and 3 or 4 mm. broad. The retracted head is globose quadrate and is provided with four larger globose and plicated bothria. Submitted by Dr. Cooper Curtice, Washington.

34. Pentastomum proboscideum Rudolphi.

Cylindrical, slightly narrowing behind and ending obtusely; head marked by a constriction, spherical, fore and aft flattened and wider than the body.

Two females 100 mm. long with the head 5 mm. broad and the body 3 mm. A male 35 mm. long, the head 4 mm. broad and the body 2·5 mm., marked with about forty-eight rings. In the females the fore part of the body is distinctly annulated, but indistinctly behind. From the lung of a Black Snake, *Coluber constrictor*, Florida. Submitted by Mr. F. C. Baker.

A male *Pentastomum*, obtained by the same gentlemen, from a Skunk, *Mephitis mephitica*, is like the one above indicated. It is 30 mm. long and distinctly annulated with about forty-eight rings. The head is cap-like, orbicular, convex dorsally and concave ventrally.

CO-OSIFICATION OF AXIS VERTEBRA WITH THIRD CERVICAL.

BY EDWARD BANCROFT.

Last summer, while in the neighborhood of Media, I found the the skeleton of a young dog. It was in excellent condition, being cleansed by the rain and bleached by the sun. The epiphyses on the distal end of the femur were present and the sutures were well defined in the skull. I secured the head together with the axis and atlas vertebrae. On reaching home and carefully examining the bones, my attention was first called to what seemed to be an abnormally long axis vertebra with four transverse processes. On closer examination I found the supposed anomaly to consist of the normal axis vertebra firmly and inseparably ossified with the third cervical which may be thus described in detail :—

Centrum normal, anterior end firmly ossified to posterior end of axis ; transverse processes normal, also foramen for intervertebral artery ; neural arch divided, antero-posterior on the summit, division passing to right of neural spine of which a mere rudiment, 1 mm. high, is left ; postzygapophyses normal ; prezygapophyses, especially on the right side, firmly ossified to the postzygapophyses of the axis. On the left side ossification is complete but not so prominently marked as on the right side where the corresponding zygapophyses are obliterated.

The case is probably one of abnormal development, as an injury to the animal tending to produce such effect would have resulted in death.

PENNSYLVANIA AND NEW JERSEY SPIDERS OF THE FAMILY LYCOSIDAE.

BY WITMER STONE.

The Lycosidae comprise the largest spiders of the northern United States. They are all ground species, and are found running among grass and dead leaves or hiding beneath stones and logs. Some of the species dig tube-like holes in the ground. These spiders spin no regular web, though *Dolomedes* and *Ocyale* make a rough web on weeds or bushes for their young. The eggs are encased in a tough silken bag, which is carried about by the female. When they have hatched, the bag splits open around the middle, apparently cut by the jaws of the female, and the young swarm out and cling to her body. In this way they are carried about for a time until able to shift for themselves. In Pennsylvania the eggs of most of the species are deposited about the middle of August.

The male spiders are about the same size as the females, and in their markings differ but little from them, being usually somewhat brighter.

The species of Lycosidæ are usually marked with various shades of brown, gray, buff and black. They are thickly covered with hairs, and as many of the markings are due to patches of different colored hairs they often present quite a different appearance when dry and when wet with alcohol.

The Lycosidae have well-developed legs. The fourth pair are the longest, the third pair shortest, and the first and second pairs about equal in length. The thorax and abdomen are rather elongated and the jaws are well developed. The eyes are in three rows: four small ones in a slightly-curved row on the front of the head, above the jaws, and four large ones arranged in two rows on the top of the head, forming a quadrilateral (except in *Dolomedes* and *Ocyale*, where the posterior row is nearly on a line with the middle one.)

Authors differ somewhat in the number of genera in which they arrange the species of Lycosidae. Dr. Marx, in his recent "Catalogue of the Described Araneae of Temperate North America," divides the family into eight genera, while Emerton (Lycosidæ of New England, Trans. Connecticut Acad., Vol. VI, p. 481) recognizes but six, considering *Trochosa* and *Tarentula* as identical with

Lycosa. The three are certainly very closely allied. *Trochosa*, however, with its low, rounded cephalothorax, seems sufficiently distinct; but *Tarentula*, at least as far as our one species, *T. kochii*, is concerned, does not seem to me distinct from *Lycosa*.

The genera which occur in our fauna can be distinguished by the following key. I have included *Aulonia*, as *A. aurantiaca* has been found both north and south of Pennsylvania, though I have not been able to find it here.

Family LYCOSIDAE.

I. Eyes in three horizontal rows.

- *a*. Upper spinnerets not longer than the lower.
  - *b*. Length of dorsal eye-area more than one-quarter of the length of the cephalothorax. Spiders small. PARDOSA.
  - *bb*. Length of the dorsal eye-area less than a quarter of the length of the cephalothorax. Spiders large, or of medium size.
    - *c*. Head low in front, and sloping obliquely on the sides. TROCHOSA.
    - *cc*. Head high in front; sides more nearly perpendicular. LYCOSA.
- *aa*. Upper spinnerets longer than the lower.
  - *b*. Dorsal eye-area very large, occupying fully one-third of the top of the cephalothorax. AULONIA.
  - *bb*. Dorsal eye-area occupying much less than a third of the cephalothorax. PIRATA.

II. Eyes apparently in two horizontal rows, which are convex anteriorly (i. e., posterior eyes so far forward as to be nearly on a line with those of the middle row.)

- *a*. Front row of eyes equidistant from the second row and the anterior edge of the cephalothorax. OCYALE.
- *aa*. Front row of eyes much nearer to the second row than to the anterior edge of the cephalothorax. DOLOMEDES.

Genus LYCOSA.

The spiders of this genus are usually large, with well-developed jaws and strong legs. The front row of eyes is straight, or slightly curved upwards in the middle; the central pair are somewhat larger than the others. The eyes of the second row are the largest, and are separated by about their diameter from one another. The dorsal eyes are somewhat smaller and are a little farther apart.

The following key will serve to distinguish the species which I have found in eastern Pennsylvania and New Jersey:—

I. Abdomen with a distinct median brown band running its *entire* length, and bordered on each side by a buff band. Thorax buff, with brown stripes.

a. Median band with edges entire. *L. punctulata.*

aa. Median band with edges notched anteriorly, and including several pairs of buff spots posteriorly. *L. scutulata.*

II. Abdomen never with a median brown band running its entire length (except *L. arenicola,* in which case the thorax is not banded buff and brown.)

a. Cephalothorax not banded, or with a narrow light median band not nearly as broad as the eye-area.

b. Cephalothorax polished and shining, with a few scattered hairs.

c. Abdomen light gray, sometimes nearly white, with a median notched brown band. *L. arenicola.*

cc. Abdomen mottled with black and buff; no distinct figure. *L. polita.*

bb. Cephalothorax covered with short hairs, not polished.

c. Femora strongly banded above and below. *L. tigrina.*

cc. Femora not banded.

d. Intensely black beneath; band on the cephalothorax obsolete. *L. carolinensis.*

dd. Brown beneath, with a few black dots; band on the cephalothorax distinct. *L. nidicola.*

aa. Cephalothorax with a light median band as broad anteriorly as the eye-area.

b. Abdomen with a central light band running its entire length, and which contains a short dark band.

c. Under side of abdomen uniform light buff. *L. ocreata.*

cc. Under side of abdomen with a semi-circular black mark, or black, with two central light spots. *L. communis.*

bb. Abdomen gray, with two dark spots at the anterior end, often with several small dorsal spots on a line with these, and sometimes a short median band.

c. Band on the cephalothorax deeply notched in front of the dorsal groove. *L. kochii.*

cc. Band on the cephalothorax with the margins entire. *L. frondicola.*

bbb. Abdomen very light gray, with a dark central-toothed band running its entire length. *L. arenicola.*

bbbb. Abdomen black, mottled with buff; no distinct figure. *L. polita.*

The median band of the cephalothorax is often obsolete in *L. polita* and *arenicola*, so they are inserted twice.

L. carolinensis, Walck. (Pl. XV, figs. 6, 6a.)

Gray or dark brown above, without any distinct pattern on the cephalothorax. A short black median band on the forepart of the abdomen. Under side of abdomen, sternum and coxae, deep black. The male has two rows of light dots on the abdomen reaching from the middle of the black central stripe to the posterior extremity. Length of female, 25 mm.

The deep black color of the under surface, and the unbanded legs, serve to distinguish this species from the next, while its large size separates it from the other members of the genus.

I have occasionally found this spider under stones, but most frequently at the bottom of the tube-like holes which it digs in meadows or on the edges of woodland. Females with egg-bags have been taken in their burrows during the last week of August; while others, apparently full sized, had not deposited their eggs by the middle of September. Males have been taken running on the ground in grass fields. This species has been observed in Philadelphia and Chester County, Penn., and also in Mercer County, in the western part of the State.

L. tigrina, (McCook.) (Pl. XV, figs. 7, 7a, 7b, 7c.)

McCook, Trans. Am. Ent. Soc., VII (Proceedings), p. XI.
L. vulpina, Emerton, Trans. Conn. Acad., VI, p. 487, pl. 47, fig. 2.
McCook, Amer. Spiders and their Spinning Work, Vol. I, p. 323, II, p. 404.

Cephalothorax brown above, with a light median stripe, very narrow between the eyes, becoming wider in the middle, and two light lateral bands. The abdomen is dark brown, sometimes with indications of black markings; beneath brown. The abdomen marked with black dots, and usually with three dark bands uniting towards the posterior extremity. The legs are brown; the femur, patella and tibia with light and dark bands. The male is much lighter colored, and the bands on the thorax are very prominent. The under side of the abdomen in one specimen has the black bands very well marked, while in another it is uniform buff with a few black dots. Length of adult female, 25 mm.

This species, especially the light-colored male, somewhat resembles *Dolomedes tenebrosus* at first sight.

Adult males and females were collected under stones in woodland during the last week of August. The eggs had not yet been deposited. Two adult females were collected in a similar locality in York County, Penna., June, 1890. One of them had constructed a nest by hollowing out the earth under the center of the stone. From this a tunnel ran out to the edge of the stone, and at the mouth of this tunnel the spider probably watched for her prey. The whole floor of the nest was strewn with portions of beetles, mainly of the green *Cicindela sexguttata*.

L. nidicola, Emerton.

Above dark brown, with a narrow light band on the cephalothorax, and a submarginal light band on each side. There is a light band on the anterior part of the abdomen, in which is a shorter dark band. The abdominal markings, however, are often very obscure in the females. Beneath the abdomen is brown, with small black dots. Legs uniform brown. The male is lighter, and the markings are more distinct, and there are traces of two light lines from behind the dorsal eyes. Length of female, 18 mm.

This is the commonest species in the vicinity of Philadelphia. I have frequently found it under stones in woodland, and also inhabiting burrows similar to those of *L. carolinensis*. Nearly adult females have been taken in these holes as early as April 14th. While digging one of them out of its burrow some years ago I was bitten on the end of the finger. The pain was rather more intense than that experienced from the sting of a bee, and extended through the whole forearm. It did not last, however, more than half an hour, though the finger remained swollen for some time. I have taken this species in Philadelphia, Chester and York Counties, Penna., and at Pt. Pleasant, Ocean County, N. J.

L. arenicola, Scudder.

Scudder, Psyche II, p. 2.
McCook, Proc. Acad. Nat. Sci., Phila., p. 333.
Marx, Amer. Naturalist 1881, p. 396.

Above light gray, quite silvery in young specimens. The cephalothorax has a wide central band, which, however, is often indistinct, as the hairs rub off very easily, leaving the cephalothorax shining reddish-brown. The abdomen has a dark median band running its entire length, much cut or toothed on the edges, and including several pairs of small gray spots behind. The legs are gray, the front ones darkest and blackish beneath. The under side of the abdomen is gray, with a black spot around the spinnerets. Length of female, 17 mm.

This species I have met with only in the sandy districts of New Jersey, especially near the coast. Here they make tube-like burrows in the sand, usually lining them with silk. Numerous specimens were collected at Pt. Pleasant August 13th, 1888. Both males and females were found in the holes, but only one spider in each. The females were not fully grown, and had not yet deposited their eggs. The tubes were made in the loose sand, and were eight to ten inches deep, with a slight silky lining inside, but no collection of sticks or rubbish around the opening. My friend, Mr. A. P. Brown, made a careful study of these spiders at the same locality some years before, and states that most of the burrows examined by him had silky linings which extended out from the mouth of the hole, and the sand adhering to them formed flaps. These flaps, he noticed, were always drawn over the hole during rain or high wind, nearly covering the mouth of it, and serving as a protection to the spider within. Burrows situated in grassy localities some distance from the beach often had a few pieces of grass or small sticks collected around the mouth, but nothing like the turrets found by Dr. Marx, Dr. McCook, or Mr. Scudder. (For interesting accounts of these turrets see references above.)

The spiders inhabiting the sand-hills had the opening situated at the top of a slight mound, which seemed to serve as an additional protection from the particles of drifting sand. Adult females covered with young were taken from the holes in September.

L. polita, Emerton.

Above, cephalothorax smooth and shining, dark reddish-brown, with an indistinct lighter area extending from the eyes to the dorsal groove. The abdomen is mottled with black and yellowish; there is usually a light median stripe containing a shorter dark stripe, and several light spots on the sides, but these markings are not at all distinct. Beneath there is a median black band on the abdomen. The legs are shining like the cephalothorax, and are short. Length of female, 10 mm.

This species I have taken only in York County, Penn. It is found under stones, but does not seem to be common.

L. frondicola Emerton. (Pl. XV, figs. 2, 2a, 2b.)

Above, cephalothorax brown with a broad gray central band as wide as the posterior pair of eyes. Abdomen gray with two dark spots on the anterior end, which are prolonged into bands on the sides. There are two black dorsal spots and sometimes a short median stripe as shown in Emerton's figure (Trans. Conn. Acad., vol. VI, pl. XLVI, fig. 3.) but in nearly all my specimens this stripe is obsolete. The under side of the abdomen is marked with a broad black band. Length of female 14 mm.

This species I have usually found running among dead leaves in woods, it is rather common about Philadelphia and has also been taken in York Co., Penn.

L. kochii Keys. (Pl. XV, figs. 3, 3a 3b.)

Above, cephalothorax brown with a gray median stripe as broad as the eye area, strongly indented on each side just in front of the dorsal groove. There are also indistinct submarginal bands. Abdomen gray with two black spots on the anterior end which are followed by several pairs of irregular dorsal spots and occasionally a short median stripe. Beneath gray with minute black dots usually arranged in four longitudinal lines converging at the spinnerets. Legs gray slightly banded on the femora. Length of female 14 mm.

This species closely resembles the preceding but may be distinguished by the band on the cephalothorax being incised about the middle.

It is common in the vicinity of Philadelphia being found under stones in woods. It has also been taken in Chester Co., Penn., and at several localities in New Jersey.

L. communis Emerton.

Above brown, cephalothorax with a light central band as broad as the eyes, and light lateral bands. Abdomen with a broad light median band coming to a point at the posterior extremity just above the spinnerets. On the fore part of this band is a dark stripe edged with black ending in a point about the middle of the abdomen. There are also some black spots on the edges of the light stripe posteriorly. The under side of the abdomen is light buff with a black mark, shaped like a horse-shoe, open towards the front; sometimes the front ends of this mark are joined and there is a black median stripe, leaving only two buff spots. The markings above and below are very distinct. Length of female 12 mm.

I have found this species under stones and logs. It is not common about Philadelphia but is very abundant in York Co. along the Susquehanna River. I have also taken it in Chester Co., Penn. and at Pt. Pleasaant, N. J.

L. ocreata Hentz.

Above, cephalothorax brown with a broad central and narrow lateral band. Region around the eyes black. Abdomen brown on the sides with a light central band indistinctly barred with brown on the posterior portion and with a central brown band reaching to about the middle. Under side of the abdomen uniform buff. Legs light with long spines, the first pair in the male thickly covered with black bristly hairs which stand out horizontally forming a conspicuous tuft.

I have taken this species near Philadelphia and in York Co., Penn. Length of male 7 mm.

L. punctulata Hentz.

Above, cephalothorax light buff with two longitudinal brown bands extending back from the eyes leaving a central buff band of about equal width. There is also a very narrow line of brown on the margin and traces of a submarginal line. The abdomen has a dark median band edged with black running its entire length and on each side of this, a buff band, while the sides are brown. The under side is buff, the abdomen usually with a few black dots. Legs buff. Length of female 15 mm.

I have taken this species in Philadelphia, Chester and Lancaster Counties, Penn. and at Point Pleasant, N. J. It is found running among grass but is not nearly as common as the next.

L. scutulata Hentz.

Similar to *L. punctulata*. Cephalothorax buff with two wide brown bands and a narrower buff one between them. Marginal line black, submarginal line brown, indistinct. The abdomen has a broad dark median band with a narrow buff band on each side. The edges of the median band are cut or toothed anteriorly and it contains several pairs of buff spots in the posterior portion. The sides of the abdomen are dark brown; beneath it is uniform buff. Legs buff, the front pair in the male have the femur, patella, tibia and part of the tarsus dark brown. Length of female 16 mm.

This species is very common running in grass fields. The female makes a nest under stones when carrying her egg bag. The eggs are deposited during the latter part of August. Adult males were collected during the first week in August. I have taken this species in Philadelphia, Chester, Lancaster and York Counties, Penn.

Genus **TROCHOSA**.

This genus is quite similar to Lycosa but the cephalothorax is lower and the sides of the head much more oblique.

T. cinerea (Fab.)

General color very light gray nearly white (yellowish in alcohol). Cephalothorax with a number of irregular radiating brown markings. Eyes surrounded with black in alcohol but when dry the white hairs conceal the black patch. Abdomen marked in the center with a number of brown dots and patches of yellow hairs, with four short narrow brown lines on the anterior part, and some irregular brown lines on the dorsum. Beneath white. In alcohol there appears to be an irregular brown median band with two rows of white spots surrounded with brown. Legs white with black spines. Length of female 15 mm.

I have found this species only on the coast of New Jersey. Nearly adult females were collected under boards and rubbish near the beach on April 30th. On the night of Aug. 12th, 1889 while catching Amphipods and other small crustacea which abound on the beach after dark, I caught a number of these spiders which appeared to run down after the retreating waves in search of food. Some of these were females that had already deposited their eggs while others were not more than half grown.

Genus **PIRATA**.

The spiders of this genus are of rather small size. They bear considerable resemblance to *Lycosa* but the upper spinnerets are longer than the lower and the eyes of the middle row are very large and prominent and are usually separated from each other by less than their diameter. The posterior eyes are somewhat farther forward than in *Lycosa*. There are usually three longitudinal lines on the cephalothorax which unite near the dorsal groove.

P. piratica Clerk.

Cephalothorax brown with three buff lines running back from the eyes and uniting into one at the dorsal groove, also a submarginal band on each side.

Abdomen with a median light stripe bordered with black, on the anterior portion, and outside of this, several pairs of yellowish spots becoming smaller and united by cross lines posteriorly, (when dry there are two longitudinal rows of small white dots on the back and some white markings on the sides and anterior margin) rest of abdomen blackish. Below buff with three black lines from the epigynum to the spinnerets, the side ones more or less contiguous with the dark coloring of the sides of the abdomen. Legs yellowish; the femora obscurely banded. Length of female 5 mm.

This species is very common about Philadelphia in damp fields and swamps. Females with egg bags have been collected about the middle of August.

P. elegans nov. sp. (Pl. XV, figs. 5, 5a.)

Cephalothorax brown with a light median band partially divided into three anteriorly by two narrow brown lines. No submarginal bands, but a very narrow whitish marginal line (only seen when dry). Abdomen reddish-brown with several pairs of black dots in a median row, the posterior ones smaller and connected by transverse lines. Beneath brown. Legs uniform yellowish. The peculiar shape of the epigynum can best be seen in the figure. It is usually quite prominent. Length of female 6 mm., 4th leg 8 mm., 1st leg 7 mm.

This species is rather abundant in damp woods in York Co., Penn., in June.

P. marxi nov. sp. (Pl. XV, figs. 1, 1a.)

General color reddish-brown. Cephalothorax with an indistinct buff median line with traces of side branches in front from the dorsal groove to the eyes. Lateral submarginal bands broken and indistinct. Abdomen with a light median band in the anterior portion of which is a shorter dark band terminating about the middle. On the posterior portion are two longitudinal rows of four buff dots. Legs reddish brown, lower side of abdomen uniform, somewhat lighter than above. When dry the markings on the cephalothorax are very indistinct and it appears nearly uniform reddish-brown. The epigynum has a triangular depression on the posterior margin, the edges of which are horny, somewhat swollen and dark colored. Length of female 9 mm., 1st leg 10 mm., 2nd leg 11 mm., 3rd leg 9 mm., 4th leg 13 mm.

It gives me great pleasure to dedicate this species to Dr. George Marx, of Washington, D. C., who has greatly assisted me in my study of the Araneae.

This spider was collected in York Co, Penn., only one specimen was secured.

Genus **PARDOSA**.

The species of Pardosa are all small. The legs are long and slender, armed with long spines. The dorsal eye area occupies about one quarter of the cephalothorax and the eyes are large for the size of the spider. The following key will serve to separate the species that I have found in Pennsylvania and New Jersey.

I. Cephalothorax uniform black, shining. *P. nigra*

II. Cephalothorax with a light median band.

- *a.* Band contracted just before the dorsal groove.
  - *b.* A distinct light median band on the abdomen.
    - *c.* Several distinct transverse light bands on the posterior part of the abdomen, male palpus black. *P. nigropalpis.*
    - *cc.* Transverse bands obsolete, male palpus with the patella white. *P. albopatella.*
  - *bb.* No distinct median band on the abdomen. *P. lapidicina.*
- *aa.* Band not contracted. *P. bilineata.*

P. nigropalpis Emerton.

Female. Cephalothorax brown with a broad gray central band, broadest just behind the eyes then contracted and widened again around the dorsal groove and narrowed posteriorly. There are two narrow gray submarginal bands. The region around the eyes is black.

Abdomen dark brown with a median gray stripe reaching nearly to the middle and followed by several transverse gray stripes, becoming shorter posteriorly. Legs gray, indistinctly banded. The male is similar but darker with the markings more obscure. The palpi are deep black and are very prominent. In alcohol the light markings appear yellowish. Length of female 5 mm.

This is one of our most common spiders and is abundant running on the ground in fields and gardens. Females have been taken with egg bags and some covered with young, during the early part of August.

P. albopatella Emerton.

Female. Cephalothorax similar to *P. nigropalpis.* Abdomen with a median light band reaching to the middle, the rest of the abdomen mottled but without any distinct cross stripes.

The male according to Emerton has the lateral bands of the cephalothorax broader and brighter than in *P. nigropalpis* while the patella of the palpus is white. Length of female 4 mm.

I have found only the female of this species and it does not seem to be very common about Philadelphia.

P. bilineata Emerton.

Female, cephalothorax dark brown with a distinct broad buff median band slightly wider at the anterior end, and on each side a light marginal band with a dark line down the middle of it. Eye region black. Abdomen brown with a bright yellowish central band in the anterior portion of which is a brown stripe, the posterior part has several black dots along the margin. Beneath the abdomen is light with four longitudinal lines converging near the spinnerets. The two median lines are sometimes indistinct. Length of female 7 mm.

This species is not very abundant but has been taken near Philadelphia.

P. lapidicina Emerton.

Cephalothorax brown, the central light band deeply incised in front of the dorsal groove and the anterior portion more or less obliterated, widest around the dorsal groove and suddenly narrowed posteriorly. Lateral bands broken and irregular. Abdomen brown with irregular yellowish spots arranged in two longitudinal rows and more or less connected transversely and longitudinally. Legs light, distinctly banded with brown. Length of female 7 mm.

This species I have taken only among the Susquehanna hills in York county, Penn.

P. nigra nov. sp. (Pl. XV, fig. 4, 4a.)

Cephalothorax smooth and shining, uniform black with a reddish brown luster, no stripes whatever. Sternum and coxae similar, somewhat lighter. Abdomen black, indistinctly mottled with olive brown or gray, without any distinct pattern, though there is a more or less distinct light median stripe on the anterior part reaching nearly to the middle. The sides of the abdomen are black, thickly speckled with small gray dots. Beneath brownish, with no distinct markings. Mandibles and palpi shining dark reddish brown, front edge of cephalothorax just below the first row of eyes, yellowish. Legs, femur dark shining like the cephalothorax, patella white; the first and second pairs have the other joints entirely yellowish white, the third pair are similar but with prominent black spines while the fourth pair have the tarsus banded with brown at the ends. Two females with egg bags were taken running in a pasture field in Chester Co., Penna., in the latter part of August. Length of female 5 mm. 1st leg 5½ mm. 4th leg 9 mm.

Genus OCYALE.

The cephalothorax and abdomen are rather more elongated than in Dolomedes or Lycosa. The hind row of eyes is nearly on a line with the second, and the front row is equidistant between the second row and the front of the cephalothorax.

O. undata (Hentz).

Cephalothorax light buff with a broad, brown median band as wide as the eye area. Abdomen with a central band, somewhat scalloped on the edges. Legs buff. Old specimens have the legs darker and the abdominal markings less distinct. Length of female 12 mm.

This spider is quite common, being found on bushes or among grass where it spins a loose mass of web and deposits its egg bag. I have sometimes noticed it make its nest in the folds of a window curtain inside the house. I have taken specimens at Philadelphia and in Chester Co., Penna.

Genus DOLOMEDES.

The cephalothorax in this genus is very broad, the second and third rows of eyes are nearly as in Ocyale but the front row is much nearer to the second than to the edge of the cephalothorax. The species live about water.

D. tenebrosus Hentz. (Pl. XV, fig. 8.)

Cephalothorax brown with a broad light marginal band and a light one behind the eyes terminating in a point in front of the dorsal groove. There are also several dark radiating lines. The abdomen is gray and brown with several transverse black angular marks resembling the letter W, across the posterior portion. On the anterior part are two longitudinal black bands enclosing a lighter space between them, all these black bands are bordered with light buff. Beneath uniform brown. The coloration varies considerably in different individuals especially with age. Legs banded with brown and gray. Length of female 25 mm. from tip to tip of legs stretched longitudinally 90 mm.

This species is abundant about water, often inhabiting spring houses and boat houses. The female carries her bag of eggs in August and the young have been observed in a rough web on weeds early in September. This spider runs over the surface of water readily and frequently goes beneath when pursued. The male I have not seen.

D. sexpunctatus Hentz.

Cephalothorax reddish-brown with a bright silvery white band on each side. Abdomen brown with a similar band on each side and two rows of white dots down the back. Beneath brown. Legs uniform brown. The white markings do not show when the spider is wet with alcohol. From the note in Dr. Marx's Catalogue there seems to be some confusion about the male of this species and the preceding. I have a specimen from York Co., Penna., which I think is undoubtedly the male of *D. sexpunctatus* as it is just like the female except that the ground color is lighter, it having just cast its skin, and the white spots are all surrounded with black. Length of female 11 mm.

I have taken the female at Pt. Pleasant, N. J. near the beach. Dr. McCook has taken it at Philadelphia.

Explanation of Plate XV.

Fig. 1. *Pirata marxi*, female.
Fig. 1a. Epigynum of same.
Fig. 2. *Lycosa frondicola*, female.
Fig. 2a. Same, under side of abdomen.
Fig. 2b. Same, epigynum.
Fig. 3. *Lycosa kochii*, female.

Fig. 3a. Same, under side of abdomen.
Fig. 3b. Same, epigynum.
Fig. 4. *Pardosa nigra*, female.
Fig. 4a. Epigynum of same.
Fig. 5. *Pirata elegans*, cephalothorax.
Fig. 5a. Epigynum of same.
Fig. 6. *Lycosa carolinensis*, under side of abdomen.
Fig. 6a. Epigynum of same.
Fig. 7. *Lycosa tigrina*, female.
Fig. 7a. Same, under side of abdomen.
Fig. 7b. Epigynum of same.
Fig. 7c. Male palpus of same.
Fig. 8. *Dolomedes tenebrosus*, female.

DECEMBER 2.

Mr. THEODORE D. RAND in the chair.

Sixty-eight persons present.

A paper entitled "Description of a new Japanese Scalpellum," by Henry A. Pilsbry, was presented for publication.

The death of Samuel Lewis, M. D., a member, was announced.

Geology of the South (Chester) Valley Hill.—MR. THEO. D. RAND remarked that in a paper on the serpentines he had called attention to the fact that northwest of West Chester there appeared to be an outcrop of Laurentian rock on the north side of Black Horse Run or Taylor's Run apparently enclosing a mica schist valley. He had expressed doubt as to whether it was really Laurentian.

A further study of this region convinced him that these gneisses extend several miles at least, and certainly from the east branch of the Brandywine to the High Street Road near Taylor's Mill, and that they belong properly to the mica schist formation of Cream Valley which bounds the serpentine on the north and further that these schists, often garnetiferous, compose the greater mass of this part of the South (Chester) Valley Hill, which has, he believed, been heretofore universally regarded as wholly of the hydromica schist of which it is composed a few miles to the northeast. It is true that in some places it is extremely difficult to tell one rock from the other, but where largely exposed the separation is clear. Small hand specimens often look alike, rock masses do not.

Where garnets occur they are a distinguishing feature, as he believed they are not found in the true hydromica schist. When garnets are absent, the most characteristic feature is the occurrence of the quartz, which, in the hydromica, is in lenticular masses closely covered with the hydromica which adheres strongly, while in the mica schists the quartz is either disseminated, or interlaminated in sheets frequently very thin. The fracture too is characteristic, the hydromica breaks into more or less lenticular masses, the tendency being towards very thin flat plates with very smooth surfaces, or more usually into elongated roughly oval masses on which parallel faces are almost entirely absent but still with an even smooth surface. The mica schist on the contrary is more massive, has a more or less regular lamination, breaking into masses with two nearly parallel sides, the other fractures irregular but without the tendency to come to a thin edge prevalent in the hydromica. The surfaces are rougher and somewhat corrugated. The mica schist occasionally contains feldspar, the hydromica probably never.

There is in some places at least, a marked change of dip, that of the hydromicas being almost invariably 80° and upwards and not regular, while the garnetiferous schists dip less steeply and invariably to the southeast. The garnets are frequently absent over large areas; again they are abundant, but as a rule less so as we approach the hydromica. On the East Branch of the Brandywine, and on the adjacent affluent, Valley Creek, the mica schists appear to be between two and three miles wide, while the hydromica narrows to probably less than three quarters of a mile.

This is in marked contrast to the exposure in Radnor, twelve miles to the northeast, where the mica schists are not over 200′ wide while the hydromicas extend two miles. On the East Branch the contact is near Hawley's Mill. The actual contact cannot be observed but the change of dip and in the character of the rock is well marked.

In these schists northwest of West Chester near Taylor's Mill, fragments, apparently of Potsdam sandstone, were found similar to the occurrence in Cream Valley and in them or next to them also occurs the limestone of this region.

In the discussions of the geology of this section it seems to have been taken for granted that the topographical South Valley Hill was wholly of hydromica schists which widened westward. The fact that the mica schists in question are not of the same age as the hydromica schists may explain in part the want of agreement between different geologists on this region. It was his intention to study this farther and present the facts more fully hereafter.

DECEMBER 9.

Dr. GEO. H. HORN in the chair.

Thirty persons present.

DECEMBER 16.

Dr. BENJAMIN SHARP in the chair.

Thirty-seven persons present.

Trichia proximella Karst.—DR. GEO. A. REX presented specimens of *Trichia proximella* Karst. and described its specific characters, history, and geographical distribution.

This species is not rare in the United States, having been found in many localities, its range, as far as yet known, extending from Canada to North Carolina and as far west as Iowa.

It occurs, however, less frequently than *Trichia chrysosperma* Rost. growing usually in small, scattered clusters of minute, closely aggregated, sessile sporangia of a golden brown color.

In the Journal of Mycology for August, 1886, the speaker had published a paper giving an analysis of the results of an examination of a large number of specimens of sessile, aggregate Trichias from widely separated localities.

Exclusive of those referred to *Trichia chrysosperma* Rost. the specimens there described, were all of one specific type possessing some of the diagnostic characters of *T. affinis* De By. and *T. Jackii* Rost. and yet properly referable to neither species.

Since that paper was written, however, a type specimen of *T. proximella* Karst. was obtained from Dr. Karsten by Mr. Harold Wingate, through whose courtesy the speaker was enabled by comparison with that type, to refer the above series of undetermined specimens to *T. proximella* with certainty.

More recently he has examined over fifty additional specimens, principally from Fairmount Park, Philadelphia, which would be issued in a forthcoming century of the North Am. Fungi, E and E.

In these he had found the same specific characters as before, the elaters morphologically similar in all specimens, but the spores showing a great variety of epispore sculpturing in the same cluster of sporangia and even in the same sporangium.

Using the figures of the spores of *T. affinis* and *T. Jackii* in Rostafinski's Monograph, as convenient type illustrations, it may be said that the spores in some of the sporangia of *T. proximella* show raised bands or markings largely of the *T. affinis* type; in others, largely of the *T. Jackii* type; in others, a commingling of both types, in all cases these type markings being more or less associated with a bewildering variety of sculptures of irregular form or of forms, suggesting the outlines of the Arabic numerals or various letters of the alphabet.

These bands are perforated through their thickness with one, two or three rows, or a cluster of minute cylindrical openings or pits, or are sculptured into intricate plexuses of minute reticulations with quadrilateral interspaces.

In the type specimen of *T. proximella*, the spore markings approach the *T. Jackii* type.

The elaters or threads are 4·5 μ thick and provided usually with four spirals which are closely and minutely spinulose, and connected with each other by well marked and numerous interspiral filaments.

The elaters in all the American specimens correspond morphologically with the type, differing only in a coarser growth in some cases due probably to local conditions.

The speaker further illustrated with the microscope the relations of *T. proximella* to *T. Jackii*, its nearest allied species.

Through the kindness of Prof. W. G. Farlow he was enabled to exhibit a type slide of *T. Jackii* prepared by Dr. Farlow from a portion of the type specimen of Rostafinski. Considering the great variability of the spore sculpturing in the two species, the spores of *T. Jackii* do not differ specifically from those of *T. proximella*.

The elaters, however, are more slender and otherwise not so strongly developed, having few and poorly developed interspiral filaments. Nevertheless these filaments can be determined beyond a doubt, by a sufficiently high power lens.

Under these circumstances the speaker believed that the difference between the two species is that of development only.

Note on Stemonitis maxima Sz.—MR. WINGATE remarked that he had carefully examined the type of this *Stemonitis* in the Schweintiz collection in the herbarium of the Academy, and although the specimen is very old and has not been handled with the care which is now bestowed upon these delicate forms of the Mycetozoa, the speaker was gratified to find a remnant of capillitium which contained spores enough to identify the species with one of the commonest forms found in this vicinity. This very common species will probably be found in most herbaria under the name of *Stemonitis fusca* (Roth) Rost. but on comparing it with an authentic specimen of the latter species the distinctness of the two species is very apparent. Mr. J. B. Ellis has sufficient material at present of *Stemonitis maxima* Sz. and proposes to issue it shortly in Ellis & Everhart's "North Amer. Fungi." The speaker was indebted to Mr. Geo. Massee of Kew Gardens, London, for authentic specimens of several species of *Stemonitis*, and hoped with this aid to be able to identify our American species and make the same the subject of a future communication.

DECEMBER 23.

MR. CHAS. P. PEROT in the chair.

Thirty-one persons present.

A paper entitled "Palæosyops and Allied Genera," by C. Earle was presented for publication.

The Development of Bacillus tuberculosis.—DR. SAMUEL G. DIXON made the following summary report of his work in the Bacteriological Laboratory of the Academy with special reference to investigations on the tubercle bacillus. The communication was read at the meeting of the 18th ult., publication being deferred in consequence of the author's immediate departure for Europe:—

Our experiments show that the *Bacillus tuberculosis* is capable of changing from its commonly recognized rod form to that of a more compound one. Some of the rods assume a club shape, while further on in the cycle of life, they become branched, many organisms showing at least one distinct branch.

When these forms, including some ordinary shapes, are placed on a pabulum, rich in glycerine and poor in pepton, yet suited to their existence, the culture medium within a few weeks shows an increase of foreign matter. This includes not only a few of the complex forms but many ordinary rod bacilli. Time, however, produces an increase of the more complex micro-organisms, which may be a degenerate form of the bacillus.

There would appear to be in this homogeneous mass something other than the bodies of the micro-organisms. This may be the residue of the pabulum remaining after the bacilli have selected what was necessary for their existence, or a digestive secretion, or again it may be an excretion of the live organism. Let this be as it may, I hope to find a changed functional action in the organism in its secretion or excretion, that would combat tuberculosis in animal life, either by stimulating the cells or by causing a chemical reaction in the tissues that were susceptible to the digestive secretion of the tubercle bacillus.

An attempt to explain its probable action appears in an article I wrote for the "Medical News" of October 19th, 1889, and also in the "Medical and Surgical Reporter," and the "Times and Register" of this year. The views expressed are, however, purely hypothetical.

When the mass that I have already spoken of as being found on the pabulum was subjected for a considerable length of time to various degrees of heat and injected into the guinea pig, the animal seemed to sicken, yet only for a short time. The animals so treated appear to resist injections of virulent bacilli. Whether this would produce immunity for any length of time, provided we discontinue the administration of the remedy, I am not sure. Some animals injected with virulent matter after the treatment with the changed mass had been discontinued, appear to be immune; and experiments on animals suffering with tuberculosis have resulted most satisfactorily.

From the fact that I believe an inorganic matter would be less dangerous in the treatment of tuberculosis than organic matter, work on the following lines is being carried out.

First of all, we have tried the subcutaneous injection of Trypsin into tuberculous animals. The rationale of this will be patent to all.

Then again we have introduced the respective bile constituents into the blood of tuberculous animals. This was suggested by the condition of liver and bile found in them.

Another method we have employed has been to introduce germicides directly into the spleen, thereby bringing the drug in contact with the blood corpuscles when in, probably, a susceptible state.

We have also introduced germicides into the intestinal tract, accompanied with predigested food stuff. In this method, we have the germicide in contact with the intestinal glands, when the latter are in an inactive state of absorbing.

The animals have been kept under strictly hygienic surroundings. The results have varied much. While one has been unsatisfactory, another has been promising.

At this stage, a cablegram from Berlin has informed us that Prof. Koch of that city, has succeeded in producing a lymph that does combat tuberculosis in man. Believing the reports, I feel convinced that he has brought his researches to a higher degree of refinement than that accomplished at this time in our laboratory. I intend, therefore, to sail for Berlin in the interest of humanity, as well as in the interest of the Academy and the Jefferson Medical College and Hospital.

My fervent wish is that those who have had hope of cure breathed into them by the Hon. Prof. Koch will enjoy a full realization and that I may return better understanding micro-organic life and armed with that which will hereafter check the tubercle bacillus in its devastations in the animal economy.

December 30.

Mr. Thomas Meehan, Vice-President, in the chair.

Thirty-one persons present.

The following were ordered to be printed:—

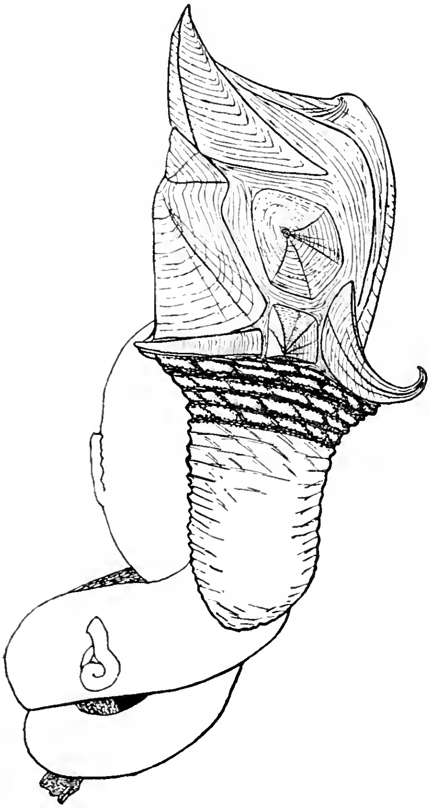
DESCRIPTION OF A NEW JAPANESE SCALPELLUM.

BY HENRY A. PILSBRY.

In a collection of Japanese Mollusca and Cirripedia recently sent the writer for determination, numerous specimens of a very large *Scalpellum*, which proves to be of a new species, were found. The specimens were collected by Mr. Frederick Stearns, of Detroit, Michigan, and it seems but just to connect his name with this form, in recognition of the value of his additions to the Japanese fauna.

Scalpellum Stearnsii sp. nov.

Valves fourteen, wholly calcified; carina distinctly bent near the the middle, with the umbo at a considerable distance from the apex; upper latus pentagonal; infra-median latus much smaller than the upper latus, subquadrangular, its altitude scarcely exceeding its breadth; carinal latus narrow, crescent shaped, projecting below the carina in a strong recurved hook; rostral latus narrow, lanceolate. Rostrum short, triangular.



Capitulum rhomboidal, compressed.

Scutum large, longer than broad, its apex projecting a trifle over the tergum.

The tergum is large, triangular; occludent and scutal margins slightly convex, carinal margin concave; apex erect, a trifle recurved.

Carina much curved, strongly angled at the umbo, the distance of which from the apex is a little over one-third the length of the valve; the sides are well developed, the roof in the lower part nearly flat or slightly convex.

The upper latus is pentagonal-oval, its umbo subcentral, having riblets radiating to the four lower angles; the tergal and scutal margins are about equal in length.

Rostrum very small and short, triangular, its three sides equal.

Rostral latus narrowly cuneiform, basal and scutal margins subparallel, converging anteriorly, of equal length.

Infra-median latus quadrangular, about as broad as high, the rostral margin a trifle longer than the carinal; umbo on the basal margin.

Carinal latus narrow, sickle-shaped, recurved, longitudinally ribbed, the free projecting portion about half the length of the plate.

The peduncle is long, elliptical in section. Length of capitulum of the largest specimens 46 mm., width (in the middle) 32 mm.

This species belongs to the group of *S. vulgare* Linn., *S. magnum* Darwin, *S. Pfeifferi* Weithofer,—species with fourteen valves, the carinal latus and rostral latus narrow, compressed, with outward-projecting umbones; carina strongly angularly bent near the middle, its umbo situated nearer to the middle than to its upper termination; rostrum short, inconspicuous.

Compared with *S. magnum* (coralline Crag, etc.), the present species has the umbo of the carina more curved inward; roof flatter, broader. The scutum is not so narrow above, nor is the upper latus so elongated. The rostral latus is truncated on its inner margin, not rounded as in *S. magnum.*

The triangular shape of the rostrum will separate *S. Stearnsii* from *S. vulgare;* compare also the shape of the inferior latus and the carinal latus, which are quite different. This is the only recent species at all approaching *S. Stearnsii.*

The species described by Weithofer as *S. Pfeifferi* has a decided resemblance to the Japanese form. It differs in the more robust carina, higher, more oblique inferior latus, and in the sculpture of many of the valves. *S. Pfeifferi* is from the miocene of Austria. It is a much smaller species than *S. Stearnsii*, but not much reliance is to be placed on this character.

The principal works consulted on *Scalpellum* are Darwin's "Monograph on the fossil Lepadidæ," in the publications of the Palæontological Society, 1851, and his "Monograph on the Cirripedia" Ray Society, 1851. "Report on the Cirripedia collected by H. M. S. Challenger," by Dr. P. P. C. Hoek, 1883, and "Bemerkungen ueber eine fossile Scalpellum Art aus dem Schlier von Ottnang u. Krems-Münster" etc., in Jahrb. k.-k. geol. Reichsanstalt 1887, p. 371, by A. Weithofer.

The figure represents a specimen of natural size on a *Vermetus* shell. All of the specimens collected were attached to shells.

The following species of Cirripedia were included in the collection made by Mr. Stearns in Japan:—

LEPADIDÆ.

Pollicipes mitella L. Abundant at Enoshima.

Lepas anatifera L. East coast near Yokohama.

Scalpellum stearnsii Pilsbry. East coast of Tokyo, 6 to 10 fms.

BALANIDÆ.

Balanus tintinnabulum L. (typical). Awaji coast.

Balanus amphitrite Darwin. Akashi coast.

Balanus amaryllis Darwin (mixed with *B. amphitrite*). Inland Sea.

Balanus cepa Darwin. Inland Sea; growing on *Cancellaria nodulifera.*

Tetraclita porosa Gmel. Inland Sea; three only found.

GEOLOGY OF ARTESIAN WELLS, ATLANTIC CITY, N. J.

BY LEWIS WOOLMAN.

Additional Species of Diatomaceæ.—In the list of species identified by C. Henry Kain and E. A. Schultze, (pages 136 to 140 of this volume) there was accidentally omitted the entire enumeration of of species of the genus *Navicula*. The list is as follows:

NAVICULA CRABRO Ehr.
NAVICULA DIDYMA Ehr.
NAVICULA DEWITTIANA Kain & Schultze.
NAVICULA ELLIPTICA Kutz.
NAVICULA ENTOMON Ehr.
NAVICULA FORCIPATA Grev.
NAVICULA GRACILIS (Ehr.) Kutz.
NAVICULA HENNEDYI W. Sow.
NAVICULA LEWISIANA Grev.
NAVICULA LYRA Ehr.
NAVICULA MACILENTA Ehr. Rare.
NAVICULA (PINNULARIA) MAJOR Kutz. Rare.
NAVICULA PERMAGNA Bail.
NAVICULA PRAETEXTA Ehr.
NAVICULA SMITHII Breb.
NAVICULA VIRIDIS Kutz. Rare.

THE GEOLOGY AND PALEONTOLOGY OF THE CRETACEOUS DEPOSITS OF MEXICO.

BY PROFESSOR ANGELO HEILPRIN.

In the following pages I have attempted to present, so far as they are known to me, all the leading facts touching the geological and paleontological relations of the Cretaceous deposits of Mexico. It is true these are still far from sufficient to permit us to analyze with satisfaction the minor details of the geology of so vast a region as the Mexican Republic, but they serve to clearly mark out its more salient geognostic features, and to establish its relationship with the great continental mass lying to the north and with the oceans which bound it on the east and on the west. My own observations were made in the spring of the present year (1890), when, as chief of the scientific expedition organized under the auspices of the Academy of Natural Sciences of Philadelphia, I traversed much of the south-central region of the Republic, from the Atlantic nearly to the Pacific, at the same time that I enjoyed the opportunity of studying special collections which had been previously made at points not reached by our party.

The conclusions stated in the present paper are the following:

1. Cretaceous deposits cover, or are scattered over, the greater part of Mexico, from the Atlantic plains to the Pacific, and from the Rio Grande to (or through) the States of Colima, Michoacan, Guerero and Oaxaca. These deposits are continuous with the Cretaceous area of the interior basin of the United States, and are largely the equivalents in age of the deposits which are represented in Texas and in the other Gulf States.

2. The Mexican Cretaceous deposits that have thus far been identified by fossil remains represent a horizon not lower than the Cenomanian, while the greater bulk of the formation is of Turonian or Senonian age. The deposits are thus a part of the Middle (?) and Upper Cretaceous series of the true geological scale.

3. No unequivocal deposits of Lower Cretaceous age—as equivalents of the Gault, Neocomian, etc.—have yet been discovered in the Republic, although some such may exist intermingled with, or underlying, the newer series.

4. The great central plateau of Mexico consists in greater part of nuclear Cretaceous strata, over whose uneven summits a more or

less even surface has been prepared through aqueous erosion (and sedimentation) and long-continued volcanic discharges, principally the latter. Along the southern margin of the plateau the Cretaceous strata (emerging from the plateau) rise to an absolute elevation (above the sea) of upwards of 8,000 feet.

5. The Cretaceous rocks, which form the nucleus of the plateau, are projected (with little diminution in height) in more or less parallel ridges southward from the southern scarp of the plateau, proving that the plateau uplift is not due to faulting on the east and west line which marks the positions of the principal volcanic summits of the Republic.

6. The Gulf plain of Mexico has been largely formed through down-wash from the interior heights, but low-level limestones (with little doubt of Cretaceous age) appear in places beneath the capping of volcanic sand and boulders. Marine Tertiary strata seem to be restricted to the northern portion of the Gulf plain, and to point off rapidly after leaving the Rio Grande. No marine Tertiary strata are known from the plateau region.

7. The Cretaceous sea swept continuously across the Republic from what is now the Gulf border to the Pacific, but strips or islands of Azoic and Palæozoic rock probably projected from this sea, much as the peninsula of Lower California and the neighboring islands to-day project from the Mexican Pacific.

9. No true Lower Cretaceous beds exist (or have been so far identified) in either Texas or Arkansas, the Lower Cretaceous, so-called (Comanche series, etc.), being not older than the Cenomanian (Middle or Upper Cretaceous).

9. No marine deposits of unequivocally Lower Cretaceous age have thus far been determined in the United States east of the Rocky Mountains.

The earliest recognition of the existence of Cretaceous deposits in Mexico is, I believe, contained in Galeotti's paper "Notice sur le calcaire crétacé des environs de Jalapa au Mexique," published in the tenth volume of the Bulletin de la Société Géologique de France (pp. 31–39, 1839). Remarkably enough, this paper, although prepared with much care and considerable detail, has been very generally overlooked by geologists, but in it the author strikes the keynote to the geology of the greater part of the Republic. Galeotti's researches cover various outcrops ("islets") of white, cream and blue limestones, which he locates as follows:—of Songuantla, at the elevated base of the Cofre de Perote, two and a half leagues from Jalapa; the *barranca* (ravine) of Gilotepec, 4 leagues N. N. E. of Jalapa; the *hacienda* of Tusamapa; the *barranca* of Jalcomulco, S. S. E. of Jalapa. These various outcrops, which in a general way are said to trend W. N. W.—E. S. E. or W. by N.—E. by S., with a steep pitch southward or southwestward, are on paleontological grounds referred to a single horizon, which is considered to be the partial equivalent of Dufrénoy's Cretaceous of southern France. This determination rests on the discovery in the rocks of fragments of *Ammonites*, *Ostrea*, *Pecten*, *Cardium* and *Lucina*, and of various foraminiferal forms (*Miliola*, *Nodosaria*, *Nummulina*).

I strongly suspect that what are here referred to as fragments of oysters are in part, at least, the remains of *Hippuritidæ*. These are abundant in the limestone of Coatepec, of the same region, which I examined, but I failed to find in that rock any true oysters; however, this is only negative testimony. The Hippuritidæ there occurring are sufficient evidence of the correctness of Galeotti's reference. Less reliable, probably, is Galeotti's determination of his assumed Nummulite, which he describes as *Nummulina Songuantlæ* (p. 35.) No undoubted member of this group of organisms has thus far been found in any Cretaceous deposit, and it is likely that the present reference rests on an erroneous interpretation of the fossil in question. Galeotti's figure (Bulletin, Plate X, fig. 6) can scarcely represent a Nummulite, and, indeed, he himself compares it with *Nummulina lenticula*, presumably of Defrance, which is now known to be an *Amphistegina*. D'Archiac is probably correct in referring the species to the genus *Cristellaria*.[1]

In the year following the publication of the paper above mentioned appeared a joint paper by Nyst and Galeotti "Sur quelques fossiles du calcaire jurassique de Tehuacan, au Mexique.[2]" The authors describe a number of fossils from a locality in the "Cordillère d'Anahuac," some 12 leagues W. N. W. of Tehuacan, and from an elevation of some 4000–7000 feet above the sea. The region is one of gray and brown limestones, and said to be exceedingly rich in organic remains. Indeed, it is questioned whether there exists another region

[1] Description des Animaux Fossiles du Groupe Nummulitique de l'Inde, pp. 36 and 163.

[2] Bulletin de l'Académie Royale des Sciences de Bruxelles, VII, 1840, pp. 212–21.

on the earth's surface which in an equal area abounds so largely in fossil remains (p. 220). The abundance of fragments of large Ammonites, supposed to measure from 50 to 60 centimetres in diameter, is especially commented upon.

With due deference to the learning and experience of the authors, I am constrained to believe that the formation in question is not of Jurassic age, but Cretaceous, and I may add, late Cretaceous. It is true, I have not been in the precise region described by Nyst and Galeotti, but my observations extend around and about it in various directions, and I have nowhere in the limestone region found any good indications of Jurassic fossils. Cretaceous forms, on the other hand, are very abundant, and just in the mountains of Tehuacan do they appear in great numbers. Furthermore, the fossils of Tehuacan, from the region of the large quarries of Mexican onyx, are almost precisely identical with those (*Hippurites*, *Radiolites*, etc.) which I have seen in the limestones of Coatepec (Jalapa), of Atoyac, the Cerro de Escamela, near the town of Orizaba, of Apasco, Yautepec, Coalcoman (in Michoacan), etc., showing the broad extent of an identical formation. Nyst and Galeotti in the memoir above cited describe twelve species of fossils—*Trigonia plicato-costata*, *Ostrea acuticosta*, *O. similis*, *Cerithium suturosum*, *C. Bustamentii*, *C. cingulatum*, *Terebra minuta*, *Ammonites Rioii*, *A. reconditus*, *Cidarites propinquus*, *C. pustulosus*, and *C. glandiferus*—and it is upon the supposed relationships of these that the reference to the Jurassic formation is made. *Cidarites propinquus* (Münster) and *C. glandiferus* (Goldfuss) are considered to be well-known species from the Jurassic deposits of Germany. The figures illustrating the above are apparently faithfully drawn, but I fail to find anything in them which would indicate that they deal with Jurassic, rather than with Cretaceous, fossils. *Trigonia plicato-costata*, which appears to be one of the most abundant of the fossils occurring in the region under consideration, represents a well-recognized Upper Cretaceous type of *Trigonia*, that of *T. alæformis* and *T. scabricola*, and is far removed from the distinctive Jurassic forms. Indeed, Nyst and Galeotti themselves recognize the relationship with the first-named, from which they distinguish it by the character of the costal ornamentation. While I am not certain that the Mexican species is really distinct, yet, in the absence of specimens for direct comparison, it may be well to consider it so. But I believe there can be no doubt as to the horizon which it represents. D'Orbigny, in his

Prodrome de Paléontologie,[1] has already corrected the error of Nyst and Galeotti, and transferred the species to the Upper Cretaceous horizon (his Senonien), where likewise it is placed by Lycett in his "Monograph of the British Fossil Trigoniæ."[2]

As regards *Ammonites Rioii*, which Nyst and Galeotti compare with *A. subradiatus* (Sowerby) and *A. complanatus* (Mantell)—the former a Jurassic species, and the latter first described from the Cretaceous marls of Sussex—there can be no question that the relationship is most intimate with the last named. *Ammonites subradiatus* is a distinctly carinated species, whereas the Mexican form has an evenly rounded dorsum. Again, *Ammonites reconditus* manifestly represents the type of *A. Duvalianus*, D'Orbigny, from the Cretaceous deposits of France,[3] and is in no wise a Jurassic form. D'Orbigny has correctly interpreted the aspect of the Mexican Ammonites by referring them to his Senonian horizon.[4]

I can speak with less certainty regarding the two species of sea-urchin which Nyst and Galeotti identify with *Cidarites propinquus* of Münster, and *C. glandiferus* of Goldfuss, since the drawings of the species are not sufficiently precise to permit of absolute determinations being made from them. But the form which, from the shape of its spines, is referred to *C. glandiferus*, appears to be at least as nearly related to the well-known Cretaceous *C. clavigera* of König, whose multiform spines are so largely scattered through the deposits of the Chalk. *Cidarites pustulosus* is probably a *Pseudodiadema*.[5]

The data that have here been given will probably be considered

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[1] Vol. II, p. 240. No. 605.

[2] Palæontographical Society Reports (Fossil Trigoniæ), 1872–79, pp. 131 and 229.

[3] D'Orbigny, Paléontologie Francaise, Terrains Crétacés, Atlas, I, pl. 50, figs. 4, 5.

[4] Prodr. de Paléont., II, p. 214.

[5] Since the above was written I have received folios 16–20 of vol. XVIII (3rd series) of the Bulletin de la Soc. Géol. de France (1890), containing Cotteau's article: "Notes sur quelques Echinides du terrain Crétacé du Mexique." The author reviews the species described by Nyst and Galeotti, and finds their determinations erroneous. The form referred to *Cidarites propinquus* of Münster, is an altogether different species; the so-called *Cidarites glandiferus* is a *Pseudocidaris*, related to *P. clunifera* and *P. mammosa;* and *Cidarites pustulosus* is either *Pseudocidaris or Diplopodia* (related to *D.* [*Pseudodiadema*] *Malbosi*). Cotteau concludes, from the facies of the echinoid fauna, that the formation which it represents is Cretaceous, and not Jurassic (p. 293).

amply sufficient for relegating the mountain deposits of the region under consideration to the Cretaceous formation; and Gabb implies as much in a prefatory remark contained in his report on a collection of fossils from near Arivechi, State of Sonora.[1] In this report the author clearly establishes the existence of Cretaceous deposits in the northern part of the Republic, and draws attention to the close connection existing between the contained fossils and those from the Cretaceous of Texas. Much more marked, on the other hand, is the variation from the Californian fossils of approximately the same horizon.[2]

Mr. Gabb records the following fossils from the deposits of Arivechi:

Ammonites Pedernalis, Von Buch.—Species also occurring in the Cretaceous of Texas.

Fusus Mexicanus, Gabb.
Lunatia Pedernalis, Roemer.—Also found in Texas.
Euspira tabulata, Gabb.
Chemnitzia zebra, Gabb.
C. Texana, Roemer.—Cretaceous of Texas.
Tylostoma mutabilis, Gabb.
Anchura monilifera, Gabb.
Cerithium Mexicanum, Gabb.
Turritella seriatim-granulata, Roemer.—Texas.
Angaria (Delphinula) cingulata, Gabb.
Cinulia rectilabrum, Gabb.
Pholadomya Sonoriensis, Gabb.
Tapes Hilgardi, Shumard.—Cretaceous of Texas.
Cardium (Granocardium) subulosum, Gabb.
C. (Protocardium) granuliferum, Gabb.
Cardita? alticosta, Gabb.
Pinna sp. indet.

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[1] Geological Survey of California, Palæontology, II, p. 258.

[2] A preliminary notice of the Sonoran fossils was published in vol. III of the Proceedings of the California Academy of Sciences, 1864, p. 153 The fossiliferous rock, as described by M. Rémond, lies about a league and a half east of Arivechi in the Sahuaripa Valley, and consists of clay-slates, 400–500 ft. in thickness, resting upon barren sandstones, and underlying thick strata of compact bluish limestone. "The strata dip to the south-east with an inclination of from thirty to fifty degrees, and form the first range of foot-hills of the Sierra Madre."

Trigonia Mooreana, Gabb.—Cretaceous of Texas.
(*Trigonia crenulata*, Roemer).
Remondia furcata, Gabb.
Gryphea mucronata, Gabb.
Exogyra plicata, Lam.—Cretaceous of Texas.
Ostrea sp. indet.
Pyrina Parryi, Hall.—Cretaceous of Texas.
Cyphosoma Texanum, Roemer.—Cretaceous of Texas.
Turbinolia ? Texana, Conrad.—Cretaceous of Texas.

There can be no question, it appears to me, that these fossils represent, as Gabb also supposed, a part of the Upper Cretaceous formation, synchronous with at least some of the deposits described by Roemer from Texas (Senonian or Turonian). Most of the species are beautifully, or, perhaps more properly, artistically, figured in Gabb's report, but in many cases the artistic effort renders determination from them all but impossible. Having had the type-series under my eye among the collections of the Academy of Natural Sciences I venture to subjoin the following notes on species, in anticipation of a more extended report which it is my intention to prepare at a future day.

Ammonites Pedernalis, Von Buch.

I am not sure that the form here described is really Von Buch's species. Gabb calls attention to the flattened dorsum in distinction to the sharp back of the typical *A. Pedernalis*, but remarks that he has observed variation in this respect. But whether the form or not, it certainly represents the group which Von Buch has designated "Cretaceous Ceratitic Ammonites."[1] In Gabb's figure (Pl. 35, fig. 1, 1a) the folds on the surface are much too numerous and regular; not more than one-half the number appear in the single type-specimen, and they are more in the nature of "swellings" than true plications. A portion of the inner whorl that is exposed is entirely destitute of these folds, and shows the ceratitic markings very clearly.

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[1] Ueber Ceratiten—Von Buch's Gesammelte Schriften, II, p. 871, Berlin, 1885. The species is referred by Neumayr and Uhlig to the group *Engonoceras* (Ueber Ammonitiden aus den Hilsbildungen Norddeutschlands, Palæontographica, 1881, p. 138), while by Douvillé, who more accurately represents the sutural configuration, it is placed in *Sphenodiscus* (Classification des Cératites de la Craie, Bull. Soc. Géol. de France, 1890, pp. 288-89.)

Gryphæa mucronata.

I see no reason to separate this species from *Gryphæa navia* Conrad (*G. Pitcheri ?* Morton), despite the points of difference indicated by Gabb. Dr. White, in his review of the "Fossil Ostreidæ of North America," has correctly referred it to that species.[1]

Cardita alticosta.

This species is unrecognizably figured. The radiating ribs are in nearly all cases prominently echinated—instead of being smooth—and they are placed much closer to one another than appears in the drawing. As the specific name *alticosta* is preoccupied by a well-known fossil from the Tertiary deposits of the United States (*Cardita alticosta* Conrad + *C. Blandingi*), I would propose for the Mexican species the name *Cardita Arivechensis.*

Trigonia Mooreana.

Gabb is right in separating Roemer's *Trigonia crenulata* of Texas from the true *Trigonia crenulata* of Europe. The closely placed ribs of the latter, and its deep lunular groove, serve readily to distinguish it from *Trigonia Mooreana.*

Remondia furcata.

This peculiar trigonioid species, for which Gabb created the new genus *Remondia*, is seemingly closely related to *Astarte Bronnii*, of Krauss, from the Cretaceous deposits of South Africa.[2] I know of

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[1] 4th Annual Report Director U. S. Geol. Survey, 1884, p. 302. As regards the species or varieties of grypheate oysters occurring in the Cretaceous deposits of the southern United States, and known as *Gryphea Pitcheri*, *G. dilatata*, *G. navia*, *G. Tucumcarrii* and *G. Washitaensis*, I believe they are all referable to a single, or at most, two species—*Gryphea Pitcheri* (Morton) and *G. navia* (Conrad). Whether or not these two should be considered distinct, will depend upon the view of species which each paleontologist holds. They are certainly very closely inter-related, and I believe that Dr. White is right in recognizing only *G. Pitcheri* and *G. Pitcheri* var. *navia* (*Loc. cit.* pp. 302–3. *Gryphea Pitcheri* was first described from the Cretaceous deposits of Arkansas, and not from New Jersey, as is sometimes assumed). Roemer's figures (Plate IX, figs. 1a, b, c—Kreidebildungen von Texas, 1852) represent the variety *navia*, as do likewise figs. 5 and 6 of Marcou's Plate IV (Geology of North America, 1858). *Gryphea Washitaensis* of Hill (Annotated Check List Cretac. Invert. Fossils Texas, Bulletin 4, Geol. Survey of Texas, p. 4, 1889), specimens of which Professor Hill has kindly sent to me, is true *G. Pitcheri*, corresponding almost absolutely with the type specimen of that species (Morton's) which is contained in the collections of the Academy of Natural Sciences.

[2] Nova Acta Acad. Cæsar. Leop. Carol., XXII, p. 449, pl. 48, figs. 1, a, b c, d, e.

no other form that approaches it. Zittel refers both species to the genus *Remondia*.[1]

Chemnitzia zebra.

This species is poorly drawn. The spire broadens out considerably more than is represented in the figure (pl. 35, fig. 5), and the whorls are almost flat-sided.

Anchura monilifera.

The figure-measure (pl. 35, fig. 7) is considerably larger than the specimen actually figured, and it exceeds by about one-sixth the largest specimen in the collection.

Euspira tabulata.

Gabb states that this species "looks much more like a Jurassic than like a Cretaceous species" (p. 260). I cannot concur in this opinion. The Academy collections contain specimens of *Natica subbulbiformis* D'Orb., from the Cretaceous deposits (Turonian) of Uchaux, France, which are barely distinguishable from the Mexican form.

Natica Pedernalis, as it is represented on Plate 35, fig. 3, does not exist. The figure is compounded from two fossils, which have little in common with one another, and seemingly represent two distinct genera. The specimen which gives the outline to the drawing is very imperfect and shows no trace of an umbilicus. I doubt much if it is even a member of the *Naticidæ*. The second form is a true *Natica*, which may or may not be Roemer's *N. Pedernalis*, the type cast of which does not permit of the identification of the species. The Mexican specimen, although somewhat distorted, is perfectly preserved, and I cannot understand how Gabb could have confounded it with the form which he erroneously describes and figures as *Natica Pedernalis*.

Neither the material published by Gabb, nor the somewhat more extended note on the formation which is furnished by Rémond,[2] is sufficient to allow us to state positively whether the deposits in question are absolutely synchronous with those of Jalapa and Tehuacan or not. Probably they represent a somewhat lower stage of the Cretaceous and are the quivalent of a portion of the Cenomanian. By Dr. White the beds are correlated with the Comanche

[1] Handbuch der Palæontologie, II, p. 58.

[2] Notice of Geological Explorations in Northern Mexico—Proc. California Acad. Nat. Sci. III, pp. 5 and 11, 1866.

or lower series of the Texan Cretaceous,[1] but the position of these beds in the true geological scale is not stated. Roemer referred all the Cretaceous deposits of the State of Texas to the Turonian and Senonian of D'Orbigny, but Prof. Hill, as the result of more recent surveys, places the Comanche series in the Lower Cretaceous formation.[2] This determination is, it appears to me, erroneous, and is not borne out by the lists of fossils which are given by Prof. Hill. The deposits may strictly be the Lower Cretaceous of America, but they are not the correspondents of what is recognized as the Lower Cretaceous of geologists generally, inasmuch as they represent a horizon at least as high up in the series as the Cenomanian (not Neocomian, as stated by Hill). It is only necessary to name a few of the species indicated by Prof. Hill as occurring in the formation to be convinced of the true (comparatively high) position of the horizon: *Exogyra Matheroniana*, *Ostrea carinata*, *Pecten æquicostatus*, *Pecten quadricostatus* (?), *Protocardia Hillanum*, etc., all well-known European forms, and mostly distinctive of the Cenomanian horizon. In addition to these forms *Janira Fleuriausiana*, of D'Orbigny, also a Cenomanian form, is enumerated in one of the lists.[3] Prof. Hill refers to a species of *Crioceras* (*Ancyloceras*) as indicating the Neocomian horizon, but the form in question has been identified by Prof. Hyatt with *Lituites Bickmoreanus*, from the Niagara (Silurian) limestone of Indiana;[4] nor is the generalization correct that the presence of Rudistes, Nerinæas, Pleurotomarias, and Globiconchas "while not decisive, is corroborative of the low position of the Comanche series."[5] If the word "high" were substituted for "low" the generalization would have been more nearly correct. It is stated that "it was chiefly upon the evidence of the *Exogyra Texana* and the *Ostrea carinata* that Roemer made this Comanche series belong to the Upper Chalk of Europe." This is hardly the fact. Roemer rightly emphasizes the presence in the formation of *Cardium Hillanum* and *Pecten quadricostatus*—European Upper Cretaceous species—and of the following analogues of the Upper Cretaceous species: *Actæonella dolium* (representing *A. lævis*),

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[1] Proc. Acad. Nat. Sciences, Phila. 1887, p. 43.

[2] Check List Cret. Inv. Foss, Texas, 1889; Am. Journ. Science, 1887, pp. 303–307.

[3] Am. Journ. Science, 1887, part 2, p. 303.

[4] Hill, Check List, p. 21.

[5] Am. Journ. Science, 1887, part. 2, p. 307.

Arcopagia Texana (rep. *A. numismalis*), *Cardium Sancti Sabæ* (rep. *C. caudatum*), *Avicula convexo-plana* (rep. *A. anomala*), *Exogyra Texana* (rep. *E. Matheroniana*), and *Cyphosoma Texanum* (rep. *C. tiara*). *Toxaster Texanus* appeared to this observer to be the only fossil indicative of a low horizon.[1]

The cumulative evidence that we have, thus tends to prove that the Comanche beds of Texas occupy a horizon not lower than the Cenomanian; in other words, they are a part correspondent to what some geologists recognize as the Middle Cretaceous, and what others, who admit but two divisions in the formation, class as Upper Cretaceous. They are distinctly *not* Lower Cretaceous (or Neocomian) and this lower member of the series has still to be found in the United States east of the Rocky Mountains.[2] The opposing evidence of the single Echinoid, *Toxaster*, counts for little in this connection.[3]

M. Virlet d'Aoust in a paper "Coup d'œil sur la Topographie et la Géologie du Mexique et de l'Amérique Centrale," mentions the occurrence of a Hippuritic limestone, containing numerous Echinoids, near Tula, State of Hidalgo, about 40 miles north of the city of Mexico.[4] Without doubt this is a portion of the limestone, rich

[1] Kreidebildungen von Texas, p. 18.

[2] Prof. Hill appears to have been, to a certain extent, misled in his correlation of the Texas and Arkansas Cretaceous deposits through an unfortunate error which is contained in Prof Whitfield's Report on the "Brachiopoda and Lamellibranchiata of the Raritan Clays and Greensand Marls of New Jersey" (Monogr. U. S. Geol. Survey, 1885). It is there stated that *Exogyra costata* occurs only in the "Lower Marl Beds" of the State (pp. XVIII, 41), and this assertion is accepted by Hill (A. J. Science, 1889, part 2, p. 472—"Relations of the Uppermost

[3] Cotteau has recently described or recorded a number of Echinoids, from various parts of Mexico, which he considers to be indicative of the Lower Cretaceous horizon (Bulletin Soc. Géol. de France, 1890, pp. 292–99—Echinides Crétacés du Mexique). These are: *Pseudocidaris Saussurei*, from San-Juan Raya, in the State of Puebla; *Salenia prestensis*, from Guadalupe, Chihuahua; *Enallaster Mexicanus*, from Guadalupe (Chihuahua) and Colima (Colima); *Diplopodia* (*Pseudodiadema*) *Malbosi*, from Arivechi, Sonora and *Holectypus Castilloi*, from Jalpa, Jalisco. The last named species is considered to represent either the Lower or the Middle Cretaceous. *Pseudocidaris Saussurei* occurs also in the deposits of Tehuacan, and is the form which Nyst and Galeotti erroneously referred to *Cidaris glandiferus* of Goldfuss; the species is thus manifestly Upper Cretaceous. Again, the so-called *Diplopodia Malbosi*, which is identified from two imperfect specimens, both of which differ in certain characters from typical representatives of that species, is admitted to be "assurément voisine de *Diplopodia variolaris*" (Cotteau, *loc. cit.*, p. 294), which is also a distinctively Upper Cretaceous species.

[4] Bull. Soc. Géol. de France, 1866, p. 23.

in Hippuritic remains, which crops out at Apasco, and which has been referred to by Ramirez in his "Memoria para la Carta Geologica del Distrito de Zumpango."[1] I have seen the fossils from this region, and am satisfied that they are largely identical with those found in the Hippuritic limestones on the south side of the Mexican plateau, in the mountains of Tehuacan and of Yautepec. Virlet d'Aoust mentions the occurrence of broadly-distributed beds containing *Ananchytes sulcata*, but it has not been my good fortune to meet with this very characteristic fossil of the Chalk (Senonian), nor have I seen it in any of the collections of Mexican fossils.

Without doubt the limestone of Tula and Apasco is identical with that which Bárcena has recorded as occurring in Querétaro, and in the districts of Yolotepec, Zimapan and Jacala, in the State of Hidalgo, where the rock contains impressions of Hippurites, Radiolites and Nerinæas.[2] That this is a part of the true typical Upper Cretaceous formation, the character of the fossil remains, it appears to me, abundantly proves. Bárcena, while recognizing the Cretaceous age of the formation, mentions the occurrence in it of a supposed Jurassic fossil, *Nerinæa hieroglyphica*. The same fossil was also found by Bárcena, associated with *Hippurites*, *Radiolites* (referred to as *Crania*), etc., in the rock of the Cave of Cacahuamilpa, in the northern part of the State of Guerero, and the distinguished Mexican geologist was originally led to conclude from this occurrence that

Cretaceous Beds of the Eastern and Southern United States;" "The Neozoic Geology of Southwestern Arkansas," Report Geol. Surv. Arkansas, 1888, p, 106). The statement is, however, erroneous: *Exogyra costata* is an abundant fossil of the red sands which underlie or form the base of the Middle Marl Bed (as may be seen in the section at Mullica Hill), where it is associated with *Gryphea vesicularis*, *Belemnitella mucronata*, etc. Its position, in fact, is very near to the top of the Cretaceous series of the State.

It is much to be regretted that American geologists so persistently use the almost meaningless terms "upper" and "lower" as applied to formations occurring in special localities, without determining or stating the relations of such terms in a general geological classification. This indiscriminate use of broad subdivisions cannot but lead to confusion. How often we hear mention of Lower, Middle and Upper Cretaceous deposits of New Jersey, when in reality beds referable only to the Senonian and Danian (possibly also the Turonian)—consequently, equivalents only of the higher Cretaceous of the continent of Europe and of England—are intended; indeed, a Jurassic deposit has even cropped up in the same State,

[1] Anales del Ministerio de Fomento, Mexico.

[2] Anales del Ministerio de Fomento, Mexico, 1, 1877, p. 349.

the formation in question represented a transition bed between the Jurassic and Cretaceous systems.[1] I am not acquainted with the species to which the form figured[2] by Bárcena is referred, nor am I able to determine its special Jurassic features. On the other hand, I have identified the same species, associated with an abundance of Hippurites and with *Nerinæa Castilli* (Bárcena), in the limestone of the Cerro de Escamela, near the town of Orizaba, whose position in the Upper Cretaceous series (Senonian) is well established. The fragment from the same region which Bárcena doubtfully refers to *Nerinæa Goodhalli* (Jurassic) is much too imperfect for recognition.

Ramirez has identified, as he believes, the limestone of Apasco in the Sierra Mojada of Coahuila, which would carry the formation close on to the Texan frontier. The determination is based largely upon the recognition in both localities of an identical species of Hippurite, which the author figures.[3] The form certainly appears identical with a species which I have myself collected in the southern mountains, and which is also reported from Tancanhuitz, in the State of San Luis Potosí. It seems to me possible, however, that a portion of the Sierra Mojada limestone may represent a somewhat lower horizon, the Cenomanian (=the formation of Arivechi, in Sonora), but the data on this point are still obscure. Ramirez enumerates and

since a local bed, containing some fossil remains less Cretaceous in aspect than those found in the upper beds, has been found to underlie the so-called Lower Cretaceous. Dr. White, in his valuable paper on the "Lower Cretaceous of the Southwest" (Am. Journ. Science, 1889, 2nd part, p. 440), well recognizes that the Lower Cretaceous of that section of the United States is not the equivalent of the Lower Cretaceous of Europe, and it is therefore the more to be regretted that he makes use of a classification which cannot be of general application. The confusion arising from such loose classification is immediately shown in the conclusions that are deduced from it. Thus, being Lower Cretaceous (in the American sense), Dr. White seeks for the equivalents of the Comanche series in the Lower Cretaceous of Europe, and it is perhaps not surprising that "we cannot say with confidence that the Comanche series really represents any one of the divisions of the European Cretaceous from the Gault to the Lower Neocomian inclusive" (*loc. cit*, p. 442). Assuredly not, since the deposits in question lie above the European Lower Cretaceous, and are, as I have shown, not older than the Cenomanian.

[1] Viaje a la Caverna de Cacahuamilpa, p. 17, Mexico, 1874.

[2] Datos para el Estudio de las Rocas Mesozoicas de México, p. 12, 1875; Materiales para la Formacion de una Obra de Paleontologia Mexicana, Anales del Museo Nacional de México, 1877, p. 201.

[3] Exploracion en la Sierra Mojada—Anales del Ministerio de Fomento, 1880, pl. 1, fig. 1.

figures a number of fossils, some of which at least, seem to more nearly represent the Middle Cretaceous than the Upper Cretaceous system. Such is the Ammonite referred to *Ammonites inflatus*, which it really appears to be. The second form of Ammonite, which is identified with *Ammonites planicostatus*, is hardly that species, if the drawing is at all to be relied upon; the broad back and crowded costæ distinguish it from the well-known European species. It seems to be more nearly a member of the group of *A. Mantelli*, if indeed, it is not that species. The large gasteropod, which is identified with *Pterodonta inflata* (Cenomanian), is scarcely in a condition to be determined; it may, or may not, be that species, or it may be a true *Tylostoma*. Ramirez also figures (and comments upon its occurrence here) a *Posidonomya*, but the imperfect drawing does not permit the form to be recognized, or to be distinguished from a young Inoceramus.

I am not aware that the great limestone formation of South-Central Mexico has been identified in the northern part of the Republic east of the Sierra Mojada region, except along the immediate borders of the Rio Grande. It is more than likely that it outcrops in the State of Nuevo Leon, as Dr. White has evidence for believing,[1] but I know of no positive statement to that effect. The supposed Cretaceous which Wislizenus describes as being found near Mier, on the Alamo River, about four miles above its discharge into the Rio Grande[2] (State of Tamaulipas), is Tertiary, and with little doubt either Miocene or Oligocene. The large oyster occurring there is manifestly the species which is referred to by Penrose as occurring on the Rio Grande, near Roma, Texas, and is doubtfully identified with Conrad's *Ostrea Georgiana*.[3]

The oyster is, however, not *Ostrea Georgiana*, but a much more ponderous form, and one which is barely to be distinguished from *Ostrea Gingensis*, of Schlotheim, a giant species of the Miocene deposits of continental Europe; the specimen in my possession measures a foot in length and fully six inches in width. Dr. Penrose is, I believe, justified in (doubtfully) referring the beds in which it occurs to the base of the Grand Gulf Series; the horizon represented is surely above the Eocene.

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[1] Am. Journ. Science, 1889, part 2, p. 441.

[2] Memoir of a Tour to Northern Mexico, U. S. Senate Publications, 1848, p. 138.

[3] First Annual Report, Geol. Surv. Texas, 1889, pp. 46, 50, 56.

Dr. White mentions[1] the occurrence of heavy deposits of hard blue limestone of the Comanche series in the Sierra San Carlos, in the State of Chihuahua, 75 miles southeastward of Presidio del Norte; the beds are here said to have a thickness of not less than 4000 feet, and are thrown into a nearly vertical position, with the so-called "Upper" Cretaceous beds lying conformably on their eastern face. It is probably from the lower portion of this series that Wislizenus obtained (through presentation) the *Pecten quinque-costatus* (Cenomanian), which was reported to have come from a locality, near Corralitas, "about 250 miles northwest of Chihuahua."[2]

The numerous localities that have here been cited for the occurrence of Cretaceous fossils on and beyond the Mexican plateau indicate the broad range over which the deposits of the period were laid down; there can be little or no question that all the outcrops that have been observed are either now united continuously with one another, or had been so united during the time of their formation and uplift. The great volcanic outpourings which followed the catastrophic uplift have largely obscured the giant masses of the formations, whose full forms are still so beautifully displayed along the eastern and southern edges of the plateau, but we find the connections in the scattered islands or oases of rock which have from time to time been noted in the interior states.

The preceding references cover outcrops in the States of Sonora, Chihuahua, Coahuila, Nuevo Leon (?), San Luis Potosí, Hidalgo, Vera Cruz, Puebla, Mexico, Morelos and Guerero, but the formation has also been identified in Jalisco, Colima,[3] Zacatecas (at Noria de Angeles, Fresnillo, Veta Grande, etc., along the spurs or extensions of the Asientos Mountains of Aguascalientes), Aguascalientes (district of the Cerro de Temascal, the Asientos Mountains),[4] Querétaro (district of the "Doctor"), and Michoacan (district of Coalcoman).[5] Over all this area there is a remarkable similarity in the

[1] Am. Journ. Science, 1889, part 2, p. 444.

[2] Op. cit., p. 138.

[3] On the authority of Antonio del Castillo, as stated by Bárcena—Datos para el Estudio de las Rocas Mesozoicas de México, p. 34.

[4] Bárcena, Noticia Geologica del Estado de Aguascalientes, 1876, p. 2.

[5] Urquiza, Exploracion del Distrito de Coalcoman, Estado de Michoacan—Anales del Ministerio de Fomento, VII, 1882. The fossils found in this region have been referred by Urquiza to *Hippurites bioculata*, *H. calamitiformis*, *H. Mexicana*, *Radiolites turbinatus*, *R. foliaceus ? Astarte* sp. indet., *Pecten* sp. indet.,

general lithological features of the formation—which is largely composed of massive cream, gray and blue (partially bituminous) limestones and marbles—and in the fossils which they contain. The rocks over the greater part of their extent pitch at steep angles, but in some districts they dip regularly and evenly over long distances; in others they are badly folded and dislocated, and rapidly alternate in inversions and fractures. This condition is especially well marked on the eastern face of the plateau, and can be seen at many points along the line of the Mexican Railway between the Boca del Monte and Nogales. In the deep gorge of the Infierno, below Maltrata, the effects of crushing are exhibited on a wonderful scale. The predominant strike of the formation seems to be N. W.—S. E., with dips both to the eastward and to the westward, and it is carried along this line, or in a direction more nearly north-and-south, in the long declining ridges (as in the mountains of Tehuacan and Yautepec) which continue the formation of the plateau into the lowland beyond the southern scarp. In the first range of elevations facing the Gulf, as I observed in the Chiquihuite Mountains near Atoyac, the strike is directed N. E.—S. W. (with a steep dip to the southeast), the limestone ridge trending off in the direction of the foothills east of Jalapa; possibly the special forces which built up the giant trio of volcanoes situated on the eastern edge of the plateau—Orizaba, the Sierra Negra and the Cofre de Perote—were the determining factors in producing this change in position. In the Atoyac or Chiquihuite range the limestones are of a cream color, heavily bedded, and compact in texture, much resembling in places lithographic stone.

For a long time I searched in vain for fossil remains in these rocks, but eventually discovered, both above and below the town of Atoyac, a number of beds of limited extent which were densely charged with organic fragments. Their condition of preservation was in most cases too unsatisfactory to permit of either specific or generic identification, but I determined the outlines of several Hippuritidæ,

Gryphea sp. indet., *Nerinæa Castilli*, *N. hieroglyphica*, *Pterodonta* sp. indet., and among corals, *Trochoseris sinuosa* and *Thamnastræa pedunculata*. From personal knowledge I can say but little regarding these determinations. The identification of the *Hippuritidæ* and the *Nerinæas* is probably in the main correct. I have myself observed the former in the rock of Coalcoman, and Bárcena mentions *Radiolites Mendozæ* (=*R. foliaceus?*), in association with *Hippurites* and *Nerinæa Castilli*, as occuring in the State (Anales del Museo Nacional, 1877). The determinations of the species of coral are, with little doubt, erroneous.

as well as of their finely striated cortical surfaces. The latter in section much resemble some of the giant Foraminifera, while the cups, where they partially protrude from the rock, strikingly recall the rugose corals. I have little doubt that it is from these resemblances that some of the Mexican (Cretaceous) limestones have from time to time been referred to the Paleozoic period, and it was sometime before I could myself determine the precise nature of the fossils which it was my good fortune to discover. No mention of their occurrence in these rocks is, so far as I am aware, made by any earlier investigator. The discovery is particularly interesting since it helps to delimit the eastern boundary of the Cretaceous deposits at a point far removed from the actual crest of the plateau. To what extent these same rocks extend Gulf-ward beneath the capping of lava, boulders and volcanic sand which fills in the basal plain east of the first true range of mountains, I could not ascertain. But it is certain that the limestone is largely developed in these eastern lowlands, and it is more than probable that the outcrops which appear in and about the line of the Vera Cruz-Jalapa railroad, such as I had occasion to observe at Plan del Rio, at an elevation of about 1000 feet above the sea, are a continuation of the Atoyac rock, just as the fossiliferous rocks about Jalapa and Coatepec are a continuation of the rocks of Orizaba. I failed, however, to find any trace of fossils in the rock of Plan del Rio, nor could I obtain any positive information from the natives that any such fossils had been found; but the rock is lithologically very similar to that of Atoyac, which is also largely non-fossiliferous, and it lies directly in the line of strike of the Chiquihuite mountains—i. e. in a line parallel with the eastern crest of this portion of the plateau.

The Cordoba Mountains, which succeed the Chiquihuite range westward, are without doubt a part of the same system of elevations which begin with the latter as their lowest crest and culminate in the chain, rising to a total elevation of some 8500 feet, which passes southward from the plateau in the region of Esperanza. Being projections on the plateau itself, this chain presents the appearance of insignificant hills, but the crests can be followed fifty or more miles southward, along the declining valley of the Rio Salado, when the full height of the mountains appears in thousands of feet of elevation.

The typical fossiliferous strata of the Upper Cretaceous period are beautifully exhibited in the steep beds of the Cerro de Escamela, just outside of the town of Orizaba. Fossils are here very abundant, and they can be readily identified on the polished surfaces of the marbles which are worked in the village of Nogales. I determined here various forms of Hippuritidæ—*Hippurites*, *Radiolites*, *Ichthyosarcolithes*—*Nerinæa Castilli*, the species of *Nerinæa* referred to by Bárcena as *N. hieroglyphica* and *N. Goodhalli*, a species of *Murex*, a large *Actæonella* (?) or possibly *Tylostoma*, and the oyster which Bárcena has identified with *Ostrea virgula*. The Escamela Mountain, as determined by Guillermo G. y Puga, rises 1417 feet above the valley, or to absolute height of some 5800 feet. To the opposite side of the town of Orizaba the Borrego presents a steep face, some 800 feet in height, of heavily bedded blue limestones whose general dip is to the southwest. I found no fossils in this rock, and I suspect that it belongs to a somewhat different horizon from that of the gray marbles of the Cerro de Escamela, but I could not absolutely satisfy myself as to its true relations.

In the valleys leading out from Orizaba there are a vast series of river deposits, which appear here and there exposed in massive stratified beds of shingle, sand, and trap boulders. The section along the Metlac, whose one face is bounded by limestone, well exhibits this feature. But I could nowhere find any evidence of interbedding with the limestone such as Guillermo G. y Puga represents in his geological section along the line of the Mexican Railway from Orizaba to Vera Cruz.[1] These river deposits are all comparatively recent, and can be traced almost completely across the coast-land to the sea.

Between Orizaba and the eastern crest of the plateau the limestones, rising higher and higher, are exposed in almost continuous section. In the deep gorge of the Infierno, below Maltrata, the shattered and contorted beds form a wonderful exhibit, and bear witness to the tremendous strains that were impressed upon the rock-masses at the time of their uplifting. It seems to me probable that the mountains about here have suffered secondary dislocation, having been warped and twisted from a primal position through successive volcanic squeezes and discharges. Along the northern face of the gorge heavy beds of lava, representing probably an early discharge from the Sierra Negra, rest directly upon the limestone, which appears, however, to have suffered but little alteration through contact with the igneous mass. Above Maltrata the rock-

[1] La Naturaleza, 1888, pp. 49–53. With little doubt the section was inadvertently drawn in its present form to represent interbedding.

fractures and dislocations follow rapidly on one another, and in short intervals the beds assume all positions and reversions. No more magnificent display of mountain architecture can be conceived than that which is presented in the steep upper face of the plateau scarp. In some places, as at Alta Luz, the strata become "flaggy," and appear in thin shales verging on to slates. Possibly it is some of this rock, having a clearly ancient look, which geologists have from time to time considered as being Palæozoic. Dollfuss[1] mentions the occurrence of Palæozoic strata near the Boca del Monte, but I failed to find any such outcrop; and I am certain that the series of Palæozoic strata, from the Carboniferous to the Silurian, which Packard mentions[2] as outcropping between the eastern crest of the great central plateau and the basal plain does not exist.

For some distance after the summit of the plateau is reached, up to and beyond the town of San Andres, the limestone appears in low ridges trending southward, which ridges are but the backbones of the main chain rising through the flat surface of the plateau. We traced these seemingly low ridges southward to Tehuacan and beyond, following in the line of the rapidly declining valley of the Salado. With our descent from the plateau the hills, becoming more and more exposed to their bases, rose majestically above us, and were seen to constitute a true axial system of mountains, the inner folds, manifestly, of the system which builds up the eastern face of the plateau. Black cinder cones appear at intervals planted on the white limestone. In the region immediately about Tehuacan, the height of the ridges locally known as the Sierra de San Antonio Tlascala and Sierra San Felipe Maderas cannot be less in places than 8000–9000 feet (absolute elevation). The dominant dip of the beds, which outcrop in sharp lines on the eastern faces of the hillsides, is westward, with varying angles.

In the trough of the long sloping valley which leads southward from the plateau vast deposits of detrital material have accumulated; masses of shingle and boulders, representing largely the debris from the table-land, are exposed in all the stream-cuts, and build up river-terraces of broad extent and distribution. Secondary lime deposits, known as *tepetate*, have resulted from the re-deposition of

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[1] Observations Géologiques, Arch. Comm. Scientifique du Mexique; Felix und Lenk, Beiträge zur Geologie und Paläontologie der Republik Mexico, p. 11, 1890.

[2] American Naturalist, XX, p. 122.

of the higher volcanic ash-sands, or through simple precipitation from waters highly charged with lime-carbonate. Much of this deposit is strikingly firm and compact, and in parts so completely interwoven with the basal limestone of the region as to be only with difficulty distinguished from it. Bones of one or more forms of extinct elephant are found imbedded in the tepetate.

From any of the eminences about Tehuacan the valley can be traced southeastward very nearly to the limits of vision, with the bounding ridges following in the same direction into the State of Oaxaca (where they are met by a more or less transverse system of elevations). The fact that these ridges pass for such long distances beyond the true edge of the plateau, and retain throughout a general parallelism of structure, is to me sufficient evidence that the plateau is not the result of uplift along an east-and-west line of faulting, such as has been assumed by Felix and Lenk, and which is made by these authors to conform with the (assumed) east-and-west fissure upon which the principal volcanic vents—Orizaba, Popocatepetl, Nevado de Toluca, Jorullo—are supposed to stand. The plateau, in this part at least, represents compressional uplift, in which an east-and-west thrust has produced a series of folds running in a direction more or less at right-angles to this line. The inequalities or saddles of folding have been largely filled in through volcanic and fissure discharges, which have thus mainly been instrumental in shaping the existing physiognomy of the plateau. Parallel chains of hills or mountains, similar to those of the region about Tehuacan, also pass southward from the plateau in the State of Morelos, near Cuautla and Yautepec, and between Yautepec and Cuernavaca, but these will be considered later on.

About ten miles to the southward of Tehuacan, following in the direction of San Antonio and Zapotitlan, are the hills upon which are situated many of the quarries of the famous Mexican onyx ("Esperanza marble"). They lie at an elevation of between 6000 and 7000 feet, where the chain is deflected slightly to the northwest, with a dip of the strata varying from west to southwest. This so-called onyx occurs in light and heavy beds, sometimes several feet in thickness, and is manifestly an infiltration product of a stalagmitic nature. It is, in fact, a floor or crust stalagmite, interbedded with the distinctive Cretaceous limestones. I found numerous fossils of the Hippuritic period in beds both underlying and overlying the onyx, so that there can be no question as to the position of that rock; but when it was formed—how soon or how long after the close of the Cretaceous epoch—there seems to be no data for determining. And for aught we know to the contrary, the onyx may be forming to-day.[1]

Westward of the region that has just been described the limestone ridges are continued through much of the State of Puebla, both on and off the plateau; while many of the more characteristic fossils that occur elsewhere have not yet been recognized in these deposits, their position and association leave no doubt that they are a belonging, in part at least, of the same general Cretaceous formation which occupies so much of the Republic.[2] Some of the most extensive deposits of Mexican onyx, here known as "Puebla" marble, are worked in the region about (southwest of) Tecali, a few leagues to the south of the city of Puebla.[3]

In the State of Morelos, most marked in the region of Cuautla and Yautepec, limestone ranges similar to those of Tehuacan trend southward from the plateau scarp; more properly, perhaps, they might be described as abutting against the southeastern face of the plateau, whose giant volcanic masses are reared up in imposing grandeur in bastion-like towers and mural serrations, thousands of feet in elevation. The emergence of the limestone from the abrupt wall of the plateau is here clearly marked. Between Cuautla and Yautepec the parallel ridges of limestone are but feebly devel-

[1] Many workers of the onyx believe the rock to be a united breccia, or a compound of large angular fragments which cross one another in all directions. This misconception arises from the peculiar interblending of the laminal lines in geodic sections, appearing as though distinct blocks of rock had been brought in opposition. The broken appearance is in reality only the result of involution, by which different sections of the same series of laminæ are brought into a variety of antagonistic positions.

[2] Bárcena describes *Ammonites James–Danae* from Acaxochitlan, Ferreria de la Trinidad, and Abra de Huilacapixtla (Anales del Museo Nacional, I, p. 286 1877). The author justly calls attention, as had already been done by Mr. Meek, to the Jurassic aspect of this Ammonite (*Arietes ?*), which much recalls the type of *A. Bucklandi*. Whether the presence of this form alone can be considered sufficient evidence for recognizing in the region of its occurrence a Jurassic formation I am not prepared to say. It may be a Jurassic type which has lingered well on into the Cretaceous period; or, the discovery of additional fossils may clearly establish the existence of true Jurassic deposits. There is nothing in the stratigraphy of the rocks of the region which, as far as I can see, is opposed to the pos-

[3] Bárcena—Las Rocas de Tecali —La Naturaleza, III, 1876, pp. 7–9; Proc. Acad. Nat. Sci. Phila., 1876, p. 166.

oped, rising from 150 to 200 or 300 feet above the general level of the country; yet, if their elevation above the level of the sea is considered, they are mountains of noble proportions, rising to nearly 5,000 feet West of Yautepec, however, they gradually increase in height, and in what is locally known as the Sierra Blanca—the long divide which separates the region of Yautepec from that of Cuernavaca—they attain an absolute elevation of probably not less than 6,500 or 7,000 feet, thus reaching to within a short distance of the actual level of the plateau. Mr. Baker and I traversed the eastern slope of the divide to an elevation a little exceeding 6,000 feet. The general features of the region, both in their geological and botanical aspects, are very similar to those of the mountains of Tehuacan and Zapotitlan. Heavy beds of white or gray limestone crop out on the hillsides and give to them that distinctive light color which so eminently serves to distinguish the sedimentary deposits from the dark, in some places almost black, volcanic masses ("Sierra Negra") with which they are associated. We found the dip of the beds to be uniformly east or southeast, with a declination ranging to nearly 40 degrees. A short distance to the westward of Yautepec, a volcanic cone, whose lava-stream reaches the town, rises through the limestone ridge, but I could not detect that the dip of the beds was materially affected by its presence; both east and west of it the beds dipped eastward, and at almost identical angles. A slight

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sibility or probability of Jurassic masses being here and there protruded through the Cretaceous limestones, and indeed, such protrusions and intercalations may be much more numerous than the general similarity of the rock-masses would lead one to suppose. Nikitin has also quite recently described (Einiges über den Jura in Mexico und Centralasien—Neues Jahrbuch für Mineralogie, 1890, p. 273) what are assumed to be Jurassic fossils (*Aucella*, closely related to *A. Pallasi*, etc.) from the region about San Luis Potosí, and he identifies the formation containing the fossils as the equivalent of the Russian "Aucella beds." It is, however, not at all unlikely that a number of Jurassic forms have actually survived in the Mexican region into the Cretaceous period, and possibly the *Aucella* (which in Europe survives into the Tithonian étage=passage beds between the Jurassic and the Cretaceous and into the Lower Cretaceous itself) is one of these. Bárcena assumed that the *Nerinæa* which he referred to *N. hieroglyphica* was a Jurassic form, and he also cites the occurrence of *Ostrea* (*Gryphea*) *virgula* in the limestone of Apasco (Datos pare el Estudio de las Rocas Mesozoicas, p. 18); but this limestone, as has already been seen, is a part of the true Hippuritic series, and a member, consequently, of the Cretaceous system. I have also found the same species of oyster, whether true *Ostrea virgula* or not, in the Escamela rock of Orizaba, where it is very clearly associated with the large *Nerinæa*, *N. Castilli*, and with various *Hippuritidæ*; its position there is thus firmly fixed.

variation in the direction was possibly due to intrusion-warping. For some distance around the volcano, however, the limestone beds were shattered into cubical blocks; how far this condition may have been induced through volcanic pressure, I cannot say, but it seems probable that the breakage is not a simple form of jointing. Some of the loose blocks of limestone show distinct traces of scorching and semi-fusion, and are manifestly products of eruption; they are in part crystalline, breaking along well-defined cleavage planes.

We found numerous fossils both in the ejected boulders and, *in situ*, in the stratified layers; unfortunately, their condition of preservation was such as not to permit of specific recognition in most cases, but there was no difficulty in determining the outlines of various Hippuritidæ, and of seemingly the same forms which we had already observed in the limestones and marbles of Orizaba. The same fossiliferous limestone outcrops at various places in the town of Yautepec and forms the Cerro de Calvaria just outside (east) of it. Beautiful exposures are seen along the small stream which, in the center of the town, forms the parting between the limestones and the lava stream which enters from the west; a strong easterly dip is here well shown. There is no doubt in my mind that the limestones of this region, with a pronounced easterly dip, are part of the same series which, further to the east, in the region about Tehuacan, dip in the opposite direction. They represent one section of a chain of folds which passes continuously from the eastern face of the plateau far into its interior, or even completely through it, likewise traversing it from north to south. How many inversions or compressions are involved in this gigantic mountain uplift, research has not yet made clear.

From the summit of the Calvaria hill the eye can readily trace the backbones of the various ridges as they trend southward, until they are lost from view. At their further end these ridges probably inosculate with the series of heights whose trend is directed more or less nearly at right angles to them, and whose age belongs to a much more ancient period of geological time.

Paleontology.

With few exceptions, all the fossils that have heretofore been described from the Cretaceous deposits of Mexico are enumerated in the preceding pages. I append herewith a list of a few of the species, with their recognized distribution, which will serve more clearly to indicate the identity of the formation which covers, or at one time covered, the greater part of the Republic:

Hippurites Mexicana.—States of Mexico, Querétaro, Hidalgo, San Luis Potosí, Coahuila, Vera Cruz, Puebla, Guerero, Morelos.

Hippurites calamitiformis.—Mexico, Querétaro, Vera Cruz, Puebla, Morelos, Michoacan.

Radiolites Mendozæ.—Querétaro, San Luis Potosí, Vera Cruz, Guerero, Michoacan.

Nerinæa Castilli.—Querétaro, Hidalgo, Vera Cruz, Morelos, Michoacan.

Nerinæa Barcenæ (N. hieroglyphica, of Bárcena).—Vera Cruz, Guerero, Michoacan.

Enallaster Mexicanus.—Chihuahua, Colima.

I have little doubt that some of the species above enumerated are found in States other than those mentioned, but the distribution as given sufficiently illustrates the broad range of the species.

Plates XII–XIV illustrate the forms which I myself found in the limestones and marbles of the Cerro de Escamela, near the town of Orizaba. Some of these are clearly identical with the species which Bárcena first described in his "Datos para el Estudio de las Rocas Mesozoicas," but I have thought well to figure them, together with the other unnamed and less recognizable forms, so that they might more readily serve the wants of the paleontological student.

Nerinæa Castilli. (Pl. XII, fig. 1).

The fragment of this species, as shown on a polished surface of marble, measures three and a half inches in length; what the total length of the shell may have been I am unable to say, but it doubtless considerably exceeded half a foot. The species, which Bárcena has minutely described, seems to be well defined from any of its European congeners.

Nerinæa Barcenæ. (Plate XIII, figs. 3 and 4).

This is the form which Bárcena doubtfully identifies with *N. hieroglyphica*, supposed to represent the European Jurassic formation. I have in vain searched for a recognized species of that name, nor have I been able to find a species, either Jurassic or Cretaceous, which agrees in its columellar features with the Mexican fossil. With the strong probability that the identification with a Jurassic form is erroneous, I have thought it best to rename the species, and in doing so take pleasure in recalling the name of the distinguished Mexican geologist, Mariano Bárcena.

Nerinæa sp.? (Pl. XIII, fig. 6).

The form here represented is likely to be a deeper section of the last-named, or it may be the form which Bárcena doubtfully identifies as *Nerinæa Goodhalli.* The absence of the columellar characteristics prevents positive determination.

Murex *sp. indet.* (Plate XIII, fig. 2).

The drawing is from a tracing made on a polished marble which shows the contour of the species perfectly, but unfortunately fails to furnish the specific characters. I obtained a perfect specimen of the same species in the Escamela quarry, but it was lost before I had an opportunity to fully examine it.

Tylostoma ? (Plate XIII, fig. 1.)

Two section-specimens of this large gasteropod were found in the rocks of the Escamela quarry, from one of which the figure was carefully traced. The unequal balancing of the whorls and the somewhat irregular flow of the columellar surface would seem to indicate that the specimen had undergone some little distortion. I am not sure of the generic position of the shell, but it appears to be nearest to Tylostoma or to Pterodonta, and it may not unlikely be the giant *Tylostoma* (*T. princeps*) which Dr. White has described from the mountains of Tehuacan (La Naturaleza, Mexico, 1883, p. 220). The casts (of *Pterodonta inflata ?*) figured by Ramirez in his geological report on the Sierra Mojada mountains (Anales del Ministerio de Fomento, III, 1880) not impossibly represent the same species.

Ostrea *sp. indet.* (Plate XIII, fig. 8).

This is, without doubt, the oyster which has been referred to by Bárcena as *Ostrea* (*Exogyra*) *virgula.* It is certainly of the type of that species, but yet it may equally represent one of the closely related Cretaceous forms, and is, perhaps, not far removed from Gabb's *Gryphea mucronata* (*G. Pitcheri.*)

Caprina ? (Plate XIII, fig. 7).

Ichthyosarcolithes ? (Plate XII, figs. 2, 3, 4, 5).

Hippurites *sp. indet.* (Plate XIV).

This is by far the largest Hippurite which I found in the Mexican rocks. I strongly suspect that it is the common European *H. cornu-vaccinum,* but the condition of preservation of the specimen does not permit its specific affinities to be positively determined. The drawing is traced from a polished marble.

The following annual reports were read and referred to the Publication Committee:—

REPORT OF RECORDING SECRETARY.

The average attendance at the meetings of the Academy during the year ending Nov. 30 has been thirty, a marked improvement on that of preceding years. The meeting of the Sections at stated intervals continues to be productive of good results, as specialists are in this way enabled to attend the meetings at which matters of interest will be presented for their consideration. Verbal communications have been made by Messrs. Leidy, Heilprin, Brinton, Houston, Horn, Meehan, Woolman, Rothrock, Pilsbry, Allen, Dall, Wilson, McCook, Koenig, Ryder, Meyer, Rand, English, Calvert, Sharp, Rex, Thomas, Wingate, Baker, Goldsmith, Morris, U. C. Smith, Willcox, Sudduth, Lyman, Schaeffer, Martindale, Skinner, Foote, Redfield and Bancroft.

Ninty-six pages of the Proceedings for 1889 and three hundred and thirty-six of the volume for 1890 have been issued, the former illustrated by two and the latter by seven plates. The distribution remains the same as last year. The publications of the Conchological and Entomological Sections noted in my last report have been issued regularly during the year.

Forty-two papers have been presented for publication as follows:—H. A. Pilsbry 6, F. C. Baker 4, Angelo Heilprin 4, A. E. Brown 2, J. E. Ives 2, J. B. Ellis and B. M. Everhart 2, Witmer Stone 2, V. Sterki 1, Harrison Allen 1, W. D. Hartman 1, D. S. Jordan 1, Louis Woolman 1, T. D. Rand 1, H. F. Osborn 1, Chas. R. Keyes 1, John Ford 1, Geo. A. Rex 1, Nathan Banks 1, T. Meehan 1, B. Sharp 1, Charles Morris 1, C. Wachsmuth and F. Springer 1, Jos. Leidy 1, John A. Ryder 1, Edw. Bancroft 1, H. C. Chapman and A. P. Brubaker 1. Forty of these have been accepted for publication in the Proceedings, one for the Journal and one has been recommended for publication in a medical journal to be selected by the author.

Twenty-eight members and eight correspondents have been elected. The deaths of fifteen members and two correspondents were announced and resignations of membership by Dr. Edw. Jackson and Emily G. Hunt were accepted.

Mr. Isaac C. Martindale was elected Treasurer September 23rd to supply the vacancy caused by the death of Mr. Wm. C. Henszey which occurred September 7th. Mr. Chas. P. Perot was elected September 30th to fill the vacancy in the Finance Committee caused by the election of Mr. Martindale to the Treasurership.

The first award of the Hayden Memorial Medal was made, on the recommendation of the Committee appointed to report on the subject, to Prof. James Hall as a well merited recognition of the value of his geological work.

A second invitation having been received from the University of Pennsylvania to remove to a position on the University grounds in West Philadelphia, the subject was maturely considered by the Council of the Academy and on its recommendation again declined by the society at a meeting held March 11th.

Apart from the purely scientific operations of the society, the most important event of the year was the beginning of work on the proposed new building. For the details and dates of the work of construction as far as it has advanced reference is made to the report of the Curators.

All of which is respectfully submitted.

EDW. J. NOLAN,

Recording Secretary.

REPORT OF CORRESPONDING SECRETARY.

While the correspondence of the past year has been of the usual routine character it continues to show the steady progress of the Academy in its exchange relations with the scientific societies of the world. Each year adds many exchanges, rendering the library more useful to those who consult it with the view of obtaining a knowledge of what is being published abroad. The study of the natural sciences seems to be increasing, so that in nearly every town, of any size, in the civilized world, societies are established and soon thereafter a publication of their work in serial form begins.

During the year sixty-eight circular letters and sixty-five cards of acknowledgements of the reception of our publications have been received from societies and other bodies. The nearly equal numbers of the two methods of acknowledgement is doubtless due to the fact that the larger portion of our exchange is sent by mail and is promptly acknowledged by card.

Letters accompanying publications number thirty-one and indicate in great part the number received through the International Exchange.

The demand for missing parts of our publications has been less during the past year than formerly, indicating the greater degree of safety in mail transmission. These deficiencies we have in every instance endeavored to supply.

During the year eight correspondents have been elected and notifications sent. Acceptances have been received from nearly all.

Formal notifications of the death of four correspondents have been received.

With this, my fourteenth annual report, my official connection with the Academy in this position ceases. In conclusion I desire to return my thanks for the compliment paid me in the repeated elections, which have made my service so long.

Respectfully submitted,

GEORGE H. HORN, M. D.,

Corresponding Secretary.

REPORT OF THE LIBRARIAN.

The Librarian respectfully reports that the number of additions to the library of the Academy during the twelve months ending Nov. 30, 1890 amounts to 4179; composed of 424 volumes, 3651 pamphlets and parts of periodicals and 104 maps, engravings, photographs, etc.

They were received from the following sources:—

Societies,	1663
I. V. Williamson Fund,	392
Editors,	845
Authors,	171
Special Appropriation,	114
Roberts Le Boutillier,	79
Wilson Fund,	42
Geological Survey of Sweden,	38
Thomas Meehan,	36
Chas. P. Perot,	25
Stephen Parrish,	23
U. S. Department of Agriculture,	23
U. S. Department of the Interior,	23
Geological Survey of Russia,	17
Geological Survey of Canada,	3
Indian Museum,	3
Geological Survey of Minnesota,	3
Geological Survey of Pennsylvania,	3
U. S. War Department.	3
Geological Survey of New Jersey,	3
Geological Survey of Kentucky,	2
H. B. M. Government,	2
Wm. W. Jefferis,	2
Australian Museum,	2
Geological Survey of Brazil,	2
Isaac Norris,	2
U. S. Fish Commission,	1
Geological Survey of Roumania,	1

U. S. Department of State,	16	Department of Mines N. S. W.,	1
Reuben Haines,	15	W. G. Thompson,	1
Kew Gardens,	13	Niagara Commission,	1
Geological Survey of India,	12	E. Indian Government,	1
J. H. Redfield,	11	Department of Mines, Nova Scotia,	1
James N. Stone,	10	Capt. L. de Saldanha de Gama,	1
British Museum,	9	Dr. Jos. Leidy,	1
U. S. Treasury Deparment,	7	Geological Survey of Missouri,	1
Geological Survey of New South Wales,	6	Geological Survey of Texas,	1
		California State Mining Bureau,	1
Prof. Angelo Heilprin,	6	Norwegian Government,	1
H. A. Pilsbry,	6	Jas. M. McDonald,	1
Geological Survey of Finland,	5	Minister of Agriculture, Toronto,	1
Ministry of Public Works in France,	5	Dr. Henry Skinner,	1
		Government of Victoria,	1
Engineer Department U. S. A.,	5	Trustees of East Indian Museum,	1
Chas. E. Smith,	4	Hon. G. E. Foster,	1
C. M. Betts,	4	Rev. G. A. Latimer,	1
Geological Survey of Portugal,	3	J. M. Hartman,	1

They are classified as follows :—

Journals,	3272	Ichthyology,	15
Geology,	282	Herpetology,	14
Botany,	134	Anthropology,	10
General Natural History,	100	Physical Science,	10
Entomology,	61	Helminthology,	8
Conchology,	47	Mammalogy,	7
Ornithology,	40	Chemistry,	3
Anatomy and Physiology,	36	Geography,	3
Mineralogy,	26	Agriculture,	2
Encyclopedias,	24	Medicine,	1
Bibliography,	20	Languages,	1
Voyages and Travels,	17	Miscellaneous,	46

The most important additions as heretofore have been obtained from corresponding societies and by means of the I. V. Williamson Library Fund.

The subject catalogues of the departments of the library in most general use, have been completed and the cards arranged alphabetically in the drawers provided for them. The books and pamphlets on Physical Science, Chemistry, Geography, Agriculture and Medicine only remain to be catalogued and the entire work, it is hoped, will be finished early in the spring.

Two hundred and two volumes have been bound since last report.

For the satisfactory progress on the subject catalogue which I am able to report, I am indebted to the efficient assistance of Mr. E. Fronani while to Mr. Wm. J. Fox acknowledgment is due for satisfactory aid in the current work of the year.

The Academy is indebted to Mr. S. Raymond Roberts for a fine crayon portrait, properly framed, of the late Geo. W. Tryon, Jr. whose long continued services to the society richly merit such a memorial.

Respectfully submitted,

EDW. J. NOLAN,

Librarian.

REPORT OF THE CURATORS.

The Curators present the following statement of the Curator-in-Charge as their report for the year 1890:—

The Curator-in-Charge respectfully reports that the collections of the Academy, in so far as their state of preservation is concerned, are in a satisfactory condition, probably more so than at any previous time in the past decade. But if satisfactory in this important respect, they suffer largely and increasingly through lack of room for their proper display. The additions to the Museum, since the occupancy by the Academy of its present building, have been so numerous and so varied that they have far outstripped the possibilities of location, and to-day it is no longer permitted to carry out that system of orderly classification and arrangement which is a necessity with every large museum of natural history. The steady growth of the collections is an encouraging sign of the increased attention that is given to the study of the natural sciences, and it cannot but be a satisfaction to all friends of the Academy, and a matter of just pride to the citizens of Philadelphia, that the institution which was the first one founded in this country for the exclusive purpose of furthering a knowledge of nature, has been able, after an existence of three-quarters of a century, to still claim the first place in the appreciation of students. That it will continue to hold its own, is amply indicated by the numerous benefits which its patrons and friends generously bestow upon it; but whether the Academy will be able to adequately respond to these benefits, will depend largely upon the helping hand which, it is hoped, an appreciative public will extend to it.

The Academy is to-day laboring to increase the capacity of its domicile. The grant of $50,000 made by the Legislature of the State during the session of 1889, has permitted it to definitely realize a scheme of enlargement, which, when fully carried into execution, will supply that need from which the institution at present most suffers. The contemplated new building (of which perspective view, ground-plan and section are appended to this report), will, when completed, cover a surface area of approximately 23,000 square feet. The main structure will be of rectangular form, with a frontage on Nineteenth Street of 150 feet, and on Cherry Street of 130 feet. Four tiers of galleries, each 32 feet in width, will surround an open central hall, to which unbroken illumination will be afforded by an arched glass roof, springing at a height of 80 feet above the floor. A two-story building, measuring 57 by 49 feet, and containing a lecture amphitheatre designed to accommodate 600 persons, will connect the new structure with the edifice now occupied by the Academy. Active work on this "connecting museum" is now in progress, and it is expected that the structure will be ready for occupancy in the beginning of spring. With the prospect of early carrying to completion the main building it has been deemed advisable, even in the absence of the funds needed to fully erect the structure, to begin work on it at once, and the foundation course has now been laid.

The plans, in accordance with which the new Academy building is to be constructed, were reported from the Board of Trustees of the Building Fund and the special Committee on Plans (appointed November 5th) at a meeting of the Academy held on November 26th, 1889, and were definitely approved by the Academy at the following meeting, December 3d. They are drawn by Mr. John H. Windrim, architect, and contemplate an expenditure in construction of $239,000. The needs of the Academy make it highly important that this amount be secured, and it is sincerely hoped that the desired funds may be provided at as early a day as possible. Delay in the completion of the building must prove seriously hurtful to the institution and to the interests to which it ministers.

The new edifice will constitute one of the architectural features of Philadelphia; and it is not too much to say that it will surpass any other museum building in the country. In evidence of this, attention is called to the engraving (elevation on Nineteenth Street), in which the comparative dimensions of the present and proposed structures are clearly shown.

The routine work in the museum during the past year has been much as in previous years. As heretofore, the Academy has profited largely through the work of volunteer specialists, and is thus placed under special obligation to those who have generously contributed their time and assistance. To Mr. John H. Redfield, the Conservator of the Herbarium, and to Mr. Thomas Meehan, the Academy is indebted for the greater part of the systematic work that is being done toward the expansion and proper distribution of the botanical collections; similarly, to the officers of the Entomological Section and the American Entomological Society, it is placed under obligation for work done in connection with the department of Entomology.

In the early part of the year the Curator-in-Charge was designated as the head of a scientific expedition to Yucatan and Mexico, having for its special purpose the exploration—geological, zoölogical, and botanical—of much of the still unexplored sections of the Mexican Republic. The party as organized consisted of, besides the Curator-in-Charge, Messrs. J. E. Ives, Witmer Stone, Roberts Le Boutillier, and Frank C. Baker. The greater part of four months was passed in exploration, and a rich harvest of facts and material was secured for the Academy. A special report covering the general results of the expedition is herewith appended. Attention has already been called in previous reports to the value of this form of scientific research, and too much emphasis cannot be laid upon the advisability of endowing a moderate zoögeographical research fund, the interest from which should be annually applied to exploration of the numerous regions which still await investigation. In no better way, it is believed, could the good of science be subserved, and the general interests of the Academy promoted.

As in previous years, the entire collection of alcoholics has been carefully examined and overhauled, and it is a satisfaction to be able to state that but few removals were found to be necessary. The same satisfactory condition characterizes the collection of birds, which has received much attention from Mr. Witmer Stone, Jessup Fund beneficiary. The Conchological department continues to receive the energetic services of Mr. H. A. Pilsbry, its Conservator, and it is encouraging to know that, despite the comparatively small expenditure of money which its maintenance involves, it still retains its position as the first collection of the kind in the world. The number of trays of mounted specimens in this department is now upwards of 61,000. Through the hearty cooperation of the American Conchologists' Association, and the special endeavors of the President of that Association, Mr. John H. Campbell, much new material, intended to illustrate the complete malacological fauna, fossil as well as recent, of the United States, has been received, and the hope is held out that before very long this important series may be fully established.

The department of the Academy which is to-day perhaps most deficient is that of Mammalogy. This department has been in a practically stationary condition for a number of years past; but latterly the generosity of the Zoological Society of Philadelphia, acting under the authority of its able Director, Mr. Arthur Erwin Brown, has permitted a number of important lacunæ to be filled by the contribution of much important material that could be furnished only by an institution of its kind. Through its assistance the Academy has added very largely to the collections of osteology and comparative anatomy, which are now in a fair way to become leading features of the museum.

Among the donations which it has been the pleasure of the Academy to receive during the past year, is the highly valuable collection of fresh-water sponges made by one of its members, Mr. Edward Potts—without doubt the most comprehensive collection of the kind in the world. It comprises specimens of all the species that have heretofore been discovered or described, and is doubly valuable as being presented by the principal expounder in this field of zoölogical inquiry.

The type microscopic slides (several hundred in number), prepared by Mr. Potts in the course of his investigations, are a part of this donation.

In departments of the Academy not previously specified, the work done has been mainly of a general character. It is a pleasure, in this connection, for the Curator-in-Charge to express his obligations to his able assistant, Mr. J. E. Ives, who continues to render valuable service in the general care and management of the museum.

Specimens for study have been loaned during the year to Prof. W. B. Scott, of Princeton; to Dr. G. Baur, of the Clark University, Worcester, and to Mr. Daniel Giraud Elliot, of New York.

With the view of bringing the Academy into closer contact with its friends and patrons, and to more freely illustrate the nature of its work, it has been thought desirable by many to inaugurate a series of evening gatherings or receptions, at which the representatives of different professions and walks of life might meet in social converse. Two such receptions, under the direction of a specially-appointed Reception Committee, were held in the early part of the year, and one in December, and their success fully testifies to the wisdom of the course suggested, and justifies the continuance of the same in the coming year. No expense is entailed upon the Academy as a body, the subscriptions to the Reception Fund being borne individually by such members of the institution as wish to participate in the meetings.

Respectfully submitted,

JOSEPH LEIDY, *Ch'n Curators.* ANGELO HEILPRIN, *Curator-in-Charge.*

REPORT ON THE OPERATIONS OF THE EXPEDITION TO YUCATAN AND MEXICO.

The Chief of the expedition, organized under the auspices of the Academy, for the exploration of Yucatan and Mexico, presents the following brief *résumé* of the operations which were conducted under his charge. The expedition, consisting of the undersigned, and of Messrs. J. E. Ives, Roberts Le Boutillier, Witmer Stone and Frank C. Baker, sailed from New York on February 15th, arriving at Progreso, Yucatan, on the 22d of the same month. A full month was spent in the exploration of the northern portion of the peninsula, the operations of the party extending to Calcehtok, on the southwest, to Labna, on the south, to Tunkas, on the east, and to the Port of Silam, on the north. The wonderful caves (Calcehtok, Loltun) and ruins (Uxmal, Labna) of the first range of mountains were incidentally visited, and collections of various kinds made at almost all points touched by the expedition; some little dredging was also done off the coast at Progreso. Headquarters were established for ten days in the railroad camp of Col. John W. Glenn, constructing engineer of the railroad connecting Tekantó with Izamal, where the most liberal hospitality was extended to the members of the party, and facilities furnished for the prosecution of their work. To the generosity and courtesy of Colonel and Mrs. Glenn the expedition is largely indebted for the success of its Yucatan explorations.

On the 23rd of March the expedition sailed from Progreso to Vera Cruz, the remainder of the explorations, extending into June, being conducted in major Mexico.

The route of travel embraced the principal sites of (recent) volcanic activity in the Republic, and thus permitted of a close examination of the physiographical and biological features of some of the most gigantic volcanic summits on the surface of the earth. The four highest mountains of the Republic were ascended by two or more members of the party within the limited period of three weeks, and thus a good opportunity was afforded for testing relative (altitude) values by means of the barometer. The order of the ascents was as follows: The peak of Orizaba, 6th and 7th of April; Popocatepetl, 16th and 17th of the same month; Nevado de Toluca, on the 21st, and Ixtaccihuatl, on the 26th and 27th. The determinations of altitude have been recorded in a paper published in the October issue of the Proceedings of the Academy.

Some little exploration was made of the lake and valley region of the capital city; but the most important work was accomplished along the eastern and southern face of the central plateau, or in the great contour comprised between Jalapa and the volcano of Jorullo, on the Pacific slope. The edge of the plateau was crossed and recrossed at several points, and it was thus possible to fix definitely the structural relations of one of the most remarkable orographic features on the American continent. The quarries of the famous Mexican onyx, lying in the mountain fastnesses southwest of Tehuacan, were visited, and the geological relations of the peculiar marble ascertained. The ten days immediately preceding the departure from Mexico were devoted to a zoölogical reconnoissance of the ocean-front about Vera Cruz, and to the exploration of the outlying coral reefs.

It is not yet possible to recite fully the scientific results of the Academy's expedition, inasmuch as a considerable part of the material and data obtained by it still awaits study and examination. But it is certain that they have fully met the expectations of the principal promoters of the enterprise, even if it cannot be said that the success was equal in all the special departments which the expedition attempted to cover. Among the more important results obtained may now be mentioned:

1. The determination of the geological features of Yucatan.

2. The discovery (at least to science) of the existence of extensive coral reefs in the western waters of the Gulf of Mexico.

3. The determination of the culminating point of the Mexican Republic, which is also the culminating point of the North American Continent.

4. The determination of the principal geological features of the Republic.

Much of the zoölogical and botanical material obtained by the expedition is new either to science or to the Academy's collection, and thus makes most valuable additions to the museum. The elaboration of this material has been confided to special investigators, whose reports (some of them already either printed or in preparation) will appear in the Proceedings of the Academy, and in a final publication dealing with the explorations generally.

The following papers have already been issued by the Academy:

"Birds collected in Yucatan and Southern Mexico." By Witmer Stone.

"Barometric Observations among the High Volcanoes of Mexico, with a Consideration of the Culminating Point of the North American Continent." By Angelo Heilprin.

"The Corals and Coral Reefs of the Western Waters of the Gulf of Mexico." By Angelo Heilprin.

"Echinoderms from the Northern Coast of Yucatan and the Harbor of Vera Cruz." By J. E. Ives.

"The Geology and Paleontology of the Cretaceous Deposits of Mexico." By Angelo Heilprin.

"Notes on a Collection of Shells from Southern Mexico." By Frank C. Baker.

Other papers now in course of preparation will appear during the early part of the year.

Respectfully submitted,

ANGELO HEILPRIN.

REPORT OF THE BIOLOGICAL AND MICROSCOPICAL SECTION.

During the year 1890 this Section has held fifteen meetings.

Dr. Samuel G. Dixon has been elected a member.

Several papers of interest have been read at the joint sessions with the Academy, and interesting verbal communications have been made by Messrs. Sharp, Ryder, Rex, Wingate, Sudduth and others.

The officers elected to serve for the ensuing year are as follows:—

Director, ...	Dr. Benjamin Sharp.
Vice-Director, ...	John C. Wilson.
Recorder, ...	Harold Wingate.

Treasurer, ... Charles P. Perot.
Conservator, ... Dr. George A. Rex.
Corresponding Secretary, ... Dr. Charles Schäffer.

Very respectfully submitted,

HAROLD WINGATE,
Recorder.

REPORT OF THE CONCHOLOGICAL SECTION.

Since the last annual meeting of the Section specimens have been received from forty-three sources, to the number of 1698 trays, a detailed list of which will be found in the record of additions to the museum.

The most important collection received is that made by the expedition from the Academy to Yucatan and Mexico, under the charge ot Professor Angelo Heilprin. Marine shells were collected at Progreso, Silam, Campeche, and Vera Cruz—some 325 trays in all. Land shells were collected in Yucatan and Mexico at many localities, to the number of 406 trays, including many species not before in the collection, and a few probably new. A catalogue of the marine forms has been prepared by Mr. Frank C. Baker, my former assistant, for publication in the Proceedings of the Academy. It will be found of great value to students of the West Indian fauna, as many species are for the first time recorded from the mainland. The condition of many of the specimens is not very good, but this does not materially lessen their value to the zoögeographer. The land and fresh-water forms are being studied by the Conservator of the Section, and a catalogue of them will be offered for publication later.

A collection of 203 trays of land and fresh-water shells from California, Idaho and Washington, purchased by the Conchological Section from Henry Hemphill, increases our suites of western species, and adds to the museum many new species and varieties, a part of which have been described by the writer and others.

A collection of shells, including many alcoholic specimens made by Dr. Benjamin Sharp in the Caribbean Islands, adds 94 trays to our suites of West Indian marine shells, and 25 trays of land species. Dr. Sharp has also presented 30 bottles of excellently hardened and preserved alcoholic material collected by him at Naples and Villa Franca.

The Section has acquired by purchase a fine collection of the remarkable fresh-water shells of the African Lake Tanganika. Eighteen species, belonging to thirteen genera, are represented, the number of specimens being over 100.

The Conservator has also obtained, in exchange from Mr. Robert Jelschin, of Patschkan, Silesia, 100 species of rare land and fresh-water shells, nearly all the species being new to the museum.

Our extensive suites of American shells have been added to by the donations of Messrs. F. A. Sampson, O. A. Crandall, John Ford, J. A. Singley, G. H. Ragsdale, E. W. Roper, W. S. Strode, the Conservator, and many others as set forth in the list of accessions appended.

A special collection of the shells of the United States has been commenced under the auspices of the American Association of Conchologists. It is the intention of the officers, with the coöperation of the large membership of the association, to make this collection a complete exposition of the molluscan life of America. None but the finest specimens of each species or variety are accepted. John H. Campbell, Esq., of Philadelphia, the President of the Association, and the originator of the enterprise, has already received a large number of specimens, 153 trays of which have been placed in the cases, and form an excellent beginning of what promises to be a most valuable addition to the museum. These specimens are presented with no conditions save that they shall form a United States collection separate from the general collection and that they be received from members of the American Association of Conchologists only. The plan is heartily approved by the Curator-in-Charge of the Academy, as a step toward the formation of special collections illustrating characteristic faunæ of the globe.

The museum work has progressed rapidly, and is now as close to the literary part of the work as it can be kept. During the year the entire collection of Helices has been rearranged in harmony with the Manual of Conchology, up to the end of the last completed volume, filling five double table cases and sixty-two drawers, representing the groups of Helicoid shells included in volumes III, IV and V of the Manual. This work has been rendered possible by the addition to our space of two double table cases containing sixteen drawers.

In the current volumes of the Manual of Conchology, the Conservator has monographed the families *Stomatellidæ*, *Scissurellidæ*, *Scutellinidæ*, *Haliotidæ* and *Fissurellidæ*, and the Helices of Madagascar, Japan and Australia. He has identified and relabeled the specimens of each group in the collection as they were studied. The first series of the Manual now approaches an end; the true Limpets and the Chitons only remaining unfinished. The second series has progressed as far as the completion of the true Helices. The Philippine Island group *Cochlostyla* will be considered in the volume for 1891, the illustrations for which are already well advanced. The Conservator has been assisted during a number of months of the year by Mr. F. C. Baker, a gentleman whose willingness and efficiency deserve high commendation.

At the annual meeting, held December 4th, the following officers were elected to serve during the ensuing year:—

Director, ...	W. S. W. Ruschenberger.
Vice-Director, ...	John Ford.
Recorder, ...	Edward J. Nolan.
Secretary, ...	J. H. Redfield.
Treasurer, ...	S. R. Roberts.
Librarian, ...	Edw. J. Nolan.
Conservator, ...	Henry A. Pilsbry.

H. A. Pilsbry,
Conservator.

REPORT OF THE ENTOMOLOGICAL SECTION.

Since the last report the Section has prospered in many ways. There has been an increase in the interest taken in entomology by its members, and the meetings have been well attended. A number of interesting verbal communications on entomology have been made at the several meetings, and several valuable papers have been published by the Society and Section. Two members and two associates have been elected during the year. The various collections are in fairly good order. The arrangement of the exotic lepidoptera has been completed; it was made up of the collections of the American Entomological Society, the Academy, and that given by the heirs of Mr. T. R. Peale. Over one thousand specimens have been added to the North American collection, a very small proportion of these having been purchased.

There have been over seven hundred additions to the library. The journal entitled "Entomological News," which is published by the Section, with the financial aid of the American Entomological Society, has been successful beyond our expectations. The first volume, now completed, consists of one hundred and sixty-eight pages of interesting matter contributed by many of the leading Entomologists of the country. It will be continued and increased to twenty or more pages per number, and be illustrated whenever possible. The proceedings of the Section for each month have been published in the "News."

At the public receptions given by the Academy, the Section has made displays of insects which have elicited favorable comment, and will no doubt help to popularize this branch of natural history. As the "Entomological News" identifies insects for subscribers, it becomes necessary to have the collections in good condition and species well represented, so that this may be properly done. All insects received for determination through the committee having charge of the publication of the "Entomological News" become the property of the Society. At the last meeting of the year the following officers were elected:—

Director, ...	George H. Horn, M.D.
Vice-Director, ...	Rev. H. C. McCook, D.D.
Treasurer, ...	E. T. Cresson.
Recorder, ...	Henry Skinner, M.D.
Publication Committee, ...	Philip Laurent, Henry Skinner, M.D.
Corresponding Secretary, . . .	Angelo Heilprin.
Conservator, ...	Henry Skinner, M.D.

HENRY SKINNER,
Recorder.

REPORT OF THE BOTANICAL SECTION.

The Vice-Director of the Botanical Section has the honor to report the continued prosperity of the Section. It has no debts, and has a balance in its treasury. The stated meetings have been held regularly, and communications of interest to botanists received at each meeting, some of which have subsequently appeared in the Proceedings of the Academy.

The officers elected for the coming year are as follows:—

Director, ...	W. S. W. Ruschenberger, M.D.
Vice-Director, ...	Thomas Meehan.
Treas. and Corres'g Sec'y, .	Isaac C. Martindale.

Recorder, ... Charles Schäffer, M.D.
Conservator, . . . John H. Redfield.

The report of the Conservator, which is submitted as part of this report, shows a gratifying increase in the Herbarium—the number of determined species of flowering plants and ferns now exceeding 30,000.

THOMAS MEEHAN,
Vice-Director.

Conservator's Report for 1890.—The Conservator respectfully submits the following Annual Report upon the condition and progress of the Academy's Herbarium:—

During the past year large and valuable additions have been made to our collections, reminding us that the time has already arrived when we need larger apartments to provide suitable space for such accessions. The chief contributions have been of plants of the tropical regions of America, of which we are now enabled to display a creditable representation, constituting a nucleus for such future accretions as will in time render our Herbarium indispensable to the student of the floras of Mexico and South America.

Prof. Rovirosa has continued his researches in the rich flora of the province of Tabasco, and has added three hundred species to his former gifts, a large number of them of great interest, and till now unrepresented in the collection. Mr. C. G. Pringle, noted for his long experience in collecting, and for the judgment and care manifested in the selection and preparation of his specimens, spent the season of 1889 in the Mexican Province of Jalisco, and we have the result in a series of 335 species, a large proportion of which are new to us. Mr. T. S. Brandegee, of the California Academy of Natural Sciences, has sent us a collection made by him in 1889, in the peninsula of Lower California, a region hitherto so little known that more than half the species were new to us. The scientific expedition sent out by the Academy in the early part of the year, under the guidance of Prof. Heilprin, though mainly devoted to other branches, did not neglect the flora of the regions which it traversed; and by the aid of Messrs. Stone and Baker, it has contributed 325 species, mostly from Yucatan, and from the region about Orizaba and Mexico, a fair proportion of which are novelties. From South America we have received a collection made in Bolivia by Miguel Bang, admirably supplementing those previously made by Dr. H. H. Rusby, in the same region.

Besides these American plants, we may specify a valuable collection of 700 species recently made by Prof. J. Bornmüller, in the province of Amasia, in the northern portion of Asia Minor. For this contribution, of which more than half the species are new to our shelves, we are indebted to the kindness of Mr. W. G. Warden, of Germantown.

Other lesser contributions will appear in the usual detailed list of plants recorded in the additions to the museum.

The total number of species received during the year has been 3,289, of which 2,811 were Phanerogams and vascular Cryptogams. Of these latter 1,161 are believed to be new to our collection, and among them are representatives of 49 new genera; 241 are from our own territory; 1,759 are from tropical America; 777 are from the northern portions of the eastern hemisphere, and 34 are from its more southern portions. The remaining 478 species received are of the lower Cryptogams, and include some valuable collections of mosses. The additions of the past year raise the estimated number of species of Phanerogams and vascular Cryptogams in the Academy's Herbarium to 30,053.

The Vice-Director of the Section has contributed a large share of his valuable time to the study and determination of the plants received from Prof. Rovirosa, and from the Heilprin expedition. In this work he has been aided to some extent by Mr. Burk and by the Conservator, who have therefore not been able to accomplish as much as heretofore in the work of mounting the collection, yet all the North American accessions have received this attention, and all others have been placed in covers and carefully distributed.

JOHN H. REDFIELD,
Conservator.

REPORT OF THE MINERALOGICAL AND GEOLOGICAL SECTION.

Fewer meetings than usual have been held this year, most of them under the new arrangement with the meetings of the Academy, on the first Tuesday of each alternate month. Long-continued absence of the more active members, has also operated this year, as it did last, to the detriment of the meetings, but they have not been without interest.

A number of specimens have been purchased by the Section, and added to the collection of the Academy.

Respectfully submitted,

THEO. D. RAND,

Director.

REPORT OF THE PROFESSOR OF INVERTEBRATE PALEONTOLOGY.

The Professor of Invertebrate Paleontology respectfully reports that owing to protracted absence in Mexico and Yucatan, acting as director of the scientific expedition organized under the auspices of the Academy, he was unable to participate in the regular spring course of instruction. He hopes, however, to make good the deficiency by extending the course of lectures contemplated for the coming season.

The collections of the Academy in the department of Paleontology continue to receive steady accessions of material, so that it is able to maintain itself as one of the leading departments of the institution. Among the more important accessions of the year is a large collection of Eocene fossils from the State of Texas, kindly presented by the State Geologist, Mr. E. T. Dumble. The collections obtained in Mexico and Yucatan by the Academy's expedition, which still largely await critical examination, are a contribution alike new to science and to the Academy's museum.

Respectfully submitted,

ANGELO HEILPRIN.

REPORT OF THE PROFESSOR OF ETHNOLOGY AND ARCHÆOLOGY.

In the early months of 1890 I delivered a series of ten lectures on the "General Science of Ethnography," including its main principles and their application to the study of man throughout the world.

These lectures were well attended, from 150 to 175 being the average number of persons present. They appeared to excite an interest in the subject, and at the request of several of the auditors the lectures have since been written out and published under the title, "Races and Peoples; Lectures on the Science of Ethnography." It is believed that the attention thus directed to this important science will have good results both generally and for this institution. A similar series, limiting the field to modern Europe, is in preparation for the present winter.

The collections in the departments of Archæology and Ethnology are substantially in the same condition as at the date of my last annual report. Want of exhibition space has prevented any material increase in the number of specimens, and even the present collections are barely accessible to students. The construction of a new building for the use of the Academy gives hope that before long a more satisfactory display of these collections will be possible.

Respectfully submitted,

D. G. Brinton.

REPORT OF THE PROFESSOR OF INVERTEBRATE ZOOLOGY.

The Professor of Invertebrate Zoology respectfully reports that ninety trays of marine, fresh-water and land shells, collected by him during the winter of 1888–89, on the Caribbean Islands, have been presented.

During the past year he delivered seven lectures on the "Caribbean Islands," five of which were illustrated with lantern slides.

It is proposed to give a course of lectures on the "Principles of Zoological Philosophy" during the spring of the coming year.

The additions to the museum have been important. A small part of the collection made by the expedition of the Academy of Natural Sciences, under the charge of Professor Angelo Heilprin, including Echinodermata and corals, have been presented. The bulk of the collection is now being worked up, and will be formally presented in the coming year.

A collection of Echinoidea, Asteroidea, Ophiuroidea, Holothuroidea, Crinoidea, Anthozoa, Hydroidea, Crustacea and Annelida, principally from the dredgings of the U. S. Fish Commission steamers, have been presented by the Smithsonian Institution.

Respectfully submitted,

Benjamin Sharp,

Prof. of Invert. Zool.

REPORT OF THE CURATOR OF THE WILLIAM S. VAUX COLLECTIONS.

The Curator of the W. S. Vaux collections submits his report for the years 1889 and 1890.

The collections are in good condition. One hundred and forty specimens were added during the two years embraced by the report, at a cost of $379.28. Sixteen upright cases have been prepared at an outlay of $523.22, and placed above the horizontal cases for the proper systematic arrangement of the additions.

The additions now reported increase the number of specimens in the Mineralogical collection to 7,028. No additions have been made to the Archeological collection, and the specimens at present number 2,940, the same as reported in 1888.

Respectfully submitted,

JACOB BINDER,

Curator.

The election of Officers, Councillors and Members of the Finance Committee, to serve during the year 1891, was held with the following result:—

President, ...	Joseph Leidy, 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, ...	Isaac C. Martindale.
Librarian, ...	Edward J. Nolan, M.D.
Curators, ...	Joseph Leidy, M.D., Jacob Binder, W. S. W. Ruschenberger, M.D., Angelo Heilprin.
Councillor to serve for an unexpired term, . . .	Gavin W. Hart.
Councillors to serve three years, ...	Charles P. Perot, J. H. Redfield, Charles Morris, Harold Wingate.
Finance Committee, . .	Charles P. Perot, Charles Morris, Charles E. Smith, Gavin W. Hart, Uselma C. Smith.

ELECTIONS DURING 1890.

MEMBERS.

January 28.—Carl Edelheim.

February 25.—William H. Bricker, M.D., Samuel G. Dixon, M.D., David J. Bullock, Stephen Farrelly, Baird Halberstadt, Mahlon Walker, M.D.

March 25.—Thomas H. Dudley.

April 29.—William K. Shryock, Abraham Barker, Walter Conrad.

May 27.—Caleb J. Milne, David Milne, John C. Garland, Annesley R. Govett, Alfred G. Baker, Charles Platt, John Cadwalader, Clement A. Griscom, Charles P. Hayes, James MacAllister, Thomas Miles.

June 24.—J. Dundas Lippincott.

October 28.—Charles S. Welles, Thomas B. Harned, Ida A. Keller, Ph.D.

November 25.—Albert P. Brubaker, M.D., Virginia Maitland.

CORRESPONDENTS.

January 28.—Henry M. Stanley.

July 29.—George Frederick Kunz, of New York.

October 28.—Ernst Haeckel, of Jena; Edw. L. Greene, of Berkeley, Cal.

November 25.—Alfred Giard, of Paris; C. Hart Merriam, M.D., of Washington; R. W. Shufeldt, M.D., of Washington; Florentino Ameghino, of Buenos Ayres.

ADDITIONS TO THE MUSEUM.

1890.

Mammalia.

Zoological Society of Philadelphia. Mounted specimens of *Synotheres prehensilis* and *Crossarchus obscurus;* prepared skeletons of *Auchenia guanaco*, *Oreas canna*, *Cervus Canadensis*, *Equus zebra*, *Macacus arctoides* and *Cervus Sika;* skin of *Macacus arctoides*.

Birds.

F. C. Baker. A collection of sixty-nine birds from Rhode Island and Florida.

E. Fronani. *Chrysotis ochrocephala* and *Icterus icterus*.

Chas. Liebeck. Nest and eggs of chewink (*Pipilo erythrophthalmus*), from Willow Grove, Pa.

Zoological Society of Philadelphia. Skin of *Aramus giganteus*.

Academy Expedition to Mexico (1890.) Two hundred and thirty-three specimens (108 species, about one-fifth new to the Academy's collection) of birds from Yucatan and Mexico.

Reptiles and Amphibians.

Mrs. J. B. Ellis. Snake-skin from Sierra Leone, Africa.

F. M. Beamer. Two skins (slough) of *Eutænia sirtalis*.

John Ford. *Ophibolus doliatus*, var. *triangulus*, from Belmont, Philadelphia.

Louis Vossion. Skin of the Cobra di Capello, from Madras.

Chas. Liebeck. *Salamandra fasciatus*, from Hammonton, N. J.; *Sceloporus undulatus*, from Atlantic City, N. J.; *Bufo Americanus*, *Spelerpes ruber*, and *Sceloporus undulatus*, from Camden, N. J.

Wm. J. Fox. *Amblystoma opacum*, from Atlantic City, N. J.

Arthur Erwin Brown. *Stilosoma extenuata*, from Lake Kerr, Florida (type); *Eutænia nigrolateris*, from Tucson, Arizona (type.)

F. C. Baker. *Cyclophis æstivus*, *Elaps fulvius*, *Tropidonotus*, *sp?* from Oak Lodge, Fla.; *Eutænia sirtalis*, from Philadelphia.

F. W. Walmsley. *Heterodon simus*, from Bridgeton, N. J.; *Eutænia sirtalis*.

Fishes.

Benjamin Sharp. Collection of fishes from the Caribbees; *Cyclopterus lumpus;* *Gobiesox*, *sp?* from Villafranca.

P. Laurent. *Lutjanus Stearnsii*, from Anglesea, N. J.

Recent Invertebrata (excluding Mollusca and Insecta.)

Miss L. Kromer. A collection of Bryozoa, and *Lepidonotus squamatus*, from Nantucket, Mass.

Angelo Heilprin. Two trays of *Suberites compacta*, *Balanus*, *sp?* sponges, and worms from Nantucket, Mass.

Wesley P. Wright. Four trays of mounted specimens of *Aglaophenia struthionides*, from the Californian coast.

Eugene M. Aaron. *Julus sp ?*, from a bunch of bananas.

Witmer Stone. Parasitic worms from the intestine of Cooper's Hawk.

S. G. Dixon. Boring of Carpenter Ant in cherry-wood.

Benjamin Sharp Collection of Invertebrates from the Caribbees; *Arenicola ecaudata* and *Spirographis Spallanzanii*, from Villafranca, near Nice; *Ascidia intestinalis*, *Hermione sp ?*, *Thysanozoon Brocchii*, from Naples; *Arenicola piscatorum*, *Psammolyce arenosa*, *Sternaspis sp ?*, *Phascolosoma*, *sp ?* and *Scorpio Europæus*, from Villafranca.

Collection of Invertebrates from the Mediterranean.

Uselma C. Smith. *Arenicola cristata*, from Anglesea, N. J.

Smithsonian Institution. A collection of *Echinoidea*, *Asteroidea*, *Ophiuroidea*, *Holothuroidea*, *Crinoidea*, *Anthozoa*, *Hydroidea*, *Crustacea* and *Annelida*, principally from the dredgings of the U. S. Fish Commission.

Jas. T. B. Ives. *Flustra foliacea*, from Hartlepool, Eng.

Wm. J. Fox. Turret Spider (*Lycosa arenicola*) from Atlantic City, N. J.; nest of *Polistes pallipes*.

Miss Edith Ives. *Medusa* and *Ocypoda arenaria*, from Atlantic City, N. J. A collection of Invertebrates from Five Mile Beach, N. J.

John Ford. *Lepas fascicularis*, from Atlantic City, N. J.; Serpuloid tubes on *Natica duplicata*, from Anglesea, N. J.; *Echinoneus semilunaris*, from Cuba.

J. E. Ives. Nine species of Invertebrates from Holly Beach, N. J. A collection of Invertebrates from Five Mile Beach, N. J.

Academy of Natural Sciences Expedition to Mexico, 1890. Thirteen species of Echinoderms, and a collection of Corals and Bryozoans from the northern coast of Yucatan and the harbor of Vera Cruz.

F. C. Baker. Scorpions from Oak Lodge, Fla.

H. C. McCook. *Lumbricus terrestris*, from Hollidaysburg, Pa.

D. J. Bullock. *Cucumaria frondosa*, from Bar Harbor, Me.

Isaac Norris. *Strongylocentrotus Drobachiensis.*

W. S. W. Ruschenberger. *Pollicipes mitella*, from Cochin-China.

Joseph Leidy. *Velella mutica*, from Beach Haven, N. J.

MOLLUSCA (recent.)

Academy Expedition to Mexico (1890). Three hundred and twenty-five trays of marine shells from Yucatan and Mexico; 406 trays of land and fresh-water shells, collected by Prof. Heilprin and others; eight trays and bottles of mollusca, collected at Havana, Cuba.

Dr. Harrison Allen. *Helix hortensis L.*, Nantucket.

American Association of Conchologists (through Mr. Campbell, President), 153 trays of marine, land, and fresh-water shells of the United States and Alaska (detailed list of which will be found in *The Nautilus* for November and December, 1890.

F. C. Baker. *Murex haustellum* var. *longicauda* Baker; *Lyogyrus Brownii* Cpr. R. I., *Planaxis lineatus* Bahamas; *Ricinula Pilsbryana* Baker (type), Ceylon.

Strophia lineata Mayn.; *Peristernia nassulata* Lam.; ten species of Polynesian marine shells.

John Brazier. Five species of Australian mollusks in alcohol.

John H. Campbell. *Helix trizonaloides* A. D. Brown, type. *Ricinula iodostoma* Ducl. N Zealand.

Dr. H. Chapman. *Neptunea decemcostata*, *Terebratulina septentrionalis*, etc., from Mt. Desert, Maine, contained in ten trays and bottles.

Conchological Section (obtained by purchase.) Twenty-five trays of Philippine Island land shells; *Helix Gaberti* from New Ireland; 18 species of Lake Tanganyika shells; 54 trays of marine shells, new to the museum; 203 trays of land and fresh-water shells from the western U. S., and (by exchange) 100 species of Palæarctic land and fresh-water shells, from Robert Jetschin.

O. A. Crandall. Twelve species of fresh-water shells from Missouri and Arkansas, including types of *Goniobasis Crandalli* Pilsbry.

W. H. Dall. *Halistylus columna* Dall.

Geo W. Dean. *Helix Tiesenhauseni* Gredl. Tyrol.

F. J. Ford. Five species of land shells from Kansas.

John Ford. Types of *Helicina Dentoni* Pilsbry, and *Helix Deaniana* Ford, from New Guinea; *Gibbula obliquata*, *Helix candidissima* large var., *H. tigri* var. *dicallistodon* Bgt., *Helix tigri* Gervais, *Solen*, from N. J.; *Astralium*, *Monodonta* (4 spp.) and *Trochus*: *Haliotis gigantea* Chemn. and four species of New Jersey shells.

Wm. J. Fox. Twenty-eight species of New Jersey land and fresh-water shells. *Peristernia Wagneri* Anton. One species of *Cerithium*; *Helix introferens* Bld. from Atco, N. J.; *Bulimus* sp.; *Turbinella muricatum* var.; 4 species of marine shells.

I. Greegor. *Triton femorale*, L., Bahamas.

Dr. W. H. Hartman. Two species of *Strephobasis*; eight species of *Helicina*.

Prof. F. L. Harvey. Four species of Pacific Ocean shells (new to collection), type of *Engina Harveyana*, Baker.

J. E. Ives. *Nassa obsoleta*, and eight other mollusks, Sea Isle City. N. J.

C. W. Johnson. *Neritina Virginea*, L., Fla.; *Cerithium atratum*, Marco, Fla.; six species of *Monodonta* and *Euchelus*.

G. W. Lichtenthaler. *Ostræa edulis* var. *Adriatica*, *Dosinia lupinus*, from Venice; *Anodonta cygnæa* var., England.

G. D. Lind. Three species of fresh-water shells from St. Louis, Mo.

Geo. T. Marston. *Bythinella obtusa* Lea, Green Bay, Wis.

Wm. J. McGinty. *Astyris lunata* Say, Atlantic City, N. J.

D. R. Pilsbry. *Vivipara* sp., Orange Co., Fla.

H. A. Pilsbry. *Venus merceneria* var. *antiqua*, Nantucket; *Limax agrestis*; *Helix Ræmeri*; 4 sp. *Zonites* and 4 sp. *Helix*, Natural Bridge, Va.; *Helix Hyeli* Mitt., Balearic Is; *Bythinella latheineri*, Italy; *Holospira Elizabethæ*, section and abnormal shell with double aperture.—*Helicina occulta* Say, Natural Bridge, Va. *Goniobasis Ozarkensis* Call, Mo.; *G. nigrina* Lea, Oregon. Sixteen species fresh-water shells from New Orleans; *Limnæa bulimoides* Lea, Dakota; *Gundlachia Meekiana*, Rock Island, Ill.; *Succinea Salleana*, New Orleans, La. (alcoholic); *Limax campestris*, New Orleans, La.; *Helix hæmas-*

toma var. *concolor*, type of var., Ceylon; *Limnæa bulimoides* Lea, *Ogalalla*, Neb.

Henry Prime. Forty species of Haytian mollusks, preserved in glycerine.

G. H. Ragsdale. *Bulimulus Ragsdalei*, from Texas (types of sp.) *Helicina orbiculata*, Texas. *Unio tuberculatus*, Texas. *Helix thyroides* var., Texas.

S. R. Roberts. Three species of *Unio*, from Florida.

E. W. Roper. Ten species of land and fresh-water mollusks.

F. A. Sampson. Six species of *Strepomatidæ*; *Helix Kiowaensis* var. *Arkansænsis* Pils., types of var., 4 sp. land shells, Sedalia, Mo.

J. Shallcross. *Voluta Férussaci* Don., Patagonia.

Dr. Benjamin Sharp. Ninety-four trays of Caribbæan shells, and thirty bottles of alcoholic specimens, from Naples and Villafranca.

J. A. Singley. Twenty species of fresh-water and land shells from Texas.

U. C. Smith. Three species of marine shells, Anglesea and Atlantic City, N. J. *Littorina irrorata*, Atlantic City, N. J.; *Scalaria turricula* Sowb., Anglesea, N. J.

Frederick Stearns. *Helix*, six species, Japan and China.

R. E. C. Stearns. Four species of *Bulimus*, Buenos Ayres.

W. S. Strode. Suite of twelve *Anodonta suborbiculata*; *A. grandis*, from Illinois.

M. B. Taylor. Collection of seventy-five trays of East Indian shells, collected by the late Marmaduke Burrows.

A. W. Vogdes. *Dentalium* sp., Florida.

Jos. Willcox. Six species of mollusks from Florida.

B. H. Wright. *Bulimulus* from Florida. *Goniobasis Etawahensis* Lea, Florida.

S. Hart Wright. *Planorbis scalaris* Jay, in alcohol.

Fossil Vertebrata.

Joseph Willcox. Hyposternal bone of *Emys*, from the Pliocene of Florida.

Joseph Leidy (in exchange.) *Emys Wyomingensis*, from the Bridger Eocene of Wyoming.

A. E. Foote. Fragment of molar of elephant, from Jalisco, Mexico.

J. K. Corson. Vertebræ of Saurian, from the Ft. Bridger Eocene.

Joseph Jeanes. A collection of mammalian remains from the Oligocene and Miocene deposits of France.

Fossil Invertebrata.

R. T. Hill. A collection of fossils (and rocks) from the Cretaceous of Texas and Arkansas.

George Dare. Eleven trays of fossils from New Jersey.

L. Woolman. Ten trays of Post-Pliocene fossils from New Jersey.

John H. Campbell. Two species of Post-Pliocene fossils from California.

J. K. Corson. A collection of Cretaceous fossils from Wyoming.

Morris B. Miller. *Inoceramus Cripsii* (?) from near Fort Wingate, New Mexico

Joseph Willcox. *Balanus*, sp? from the Caloosahatchie deposits, Florida (Pliocene,) and six species of Mollusca.

J. E. Ives. *Lituites sp?* from Henderson's Station, Pa.; a collection of Cretaceous fossils from the region of Mullica Hill, N. J.

Joseph Leidy, *Scolithus linearis*, from the grounds of the University, Philadelphia.

H. A. Pilsbry. *Dreissena sp?* from the Congeria beds of the Caspian basin.

T. D. Rand. Coralliferous pebble (Lower Silurian?), from Southern New Jersey.

State Geological Survey of Texas. A collection of Eocene fossils (comprising the greater number of the known species) from the Gulf border of the State.

Minerals, Rocks, etc.

Miss Frances Lea. Phlogopite, St. Lawrence Co., N. Y., from the collection of the late Dr. Isaac Lea.

W. W. Jefferis. Leelite, Leni, Delaware Co., Pa.; Capillary Pyrite and Sphalerite, from Mineral Point, Wis.; Orthoclase, from Johnson's Quarry, Delaware Co., Pa.; Chondrodite, from Putnam Co., N. Y.; Apophyllite and Calcite, from French Creek Mines, Pa.; Amethyst from Oglethorpe Co., Georgia; Asbestus from Pelham, Mass.; Serpentine from Texas, Lancaster Co., Pa.; Menaccanite from Dublin, Harford Co., Md.; Phlogopite and Serpentine, Edwards, St Lawrence Co., N. Y.; Phlogopite from Muscalonge Lake, St. Lawrence Co., N. Y.; Trap rock from West Chester, Pa.

Angelo Heilprin. Clays from Martha's Vineyard, Mass.

Benjamin Sharp. Nine trays of minerals from Antigua.

Mrs C. J. Bloomfield Moore. Agate chimney filled with crystallized quartz, from 35 m. northwest of Green River Station, on the Union Pacific Railroad.

W. H. Witte. Siderite and Jasper from Ivy's Mine, Northampton Co., Pa.

M. Hartman. Five specimens of iron-ore, from Texada Island, British Columbia.

A. W. Moore. Specimens of Guano from Navassa, West Indies.

E. Fronani. Nodular Quartz, from Philadelphia.

Joseph Leidy. A collection of rocks from Kennebunkport, Me.; decomposed granite, from the grounds of the University, West Philadelphia.

J. E. Ives. Limestone containing a vein of quartz from Henderson's Station, Pa.

Mrs. W. P. Saunders. Quartz crystals, from Crystal Hill, near Delaware Water Gap, Pa.

Plants.

Prof. José N. Rovirosa. Three hundred species of plants from the State of Tabasco, Mexico.

Thomas Meehan. Sixty-one species of plants from various regions, mostly cultivated.

Prof. J. C. Arthur. Specimens of *Tilletia fœtens* B. and C. (stinking smut or bunt), from fields of Fultz wheat, Haw Patch, Ind.

Townsend S. Brandegee. One hundred and twenty-one species of plants collected by him in the peninsula of Lower California, Mexico, January, May, 1889.

John Archagouni. Tubers of *Arum orientale* L., from Constantinople.

Dr. Edward J. Dirickson (through Mr. H. N. Potts.) *Phoradendron flavescens* Nutt. (American mistletoe) in fruit.

John H. Redfield. Six hundred and seventy-nine species of plants collected by Miguel Bang in Bolivia, S. A., in 1889; 127 species of mosses from Ceylon, collected and named by Thwaites; 13 species of mosses from Sandwich Islands; 335 species of plants collected by C. G. Pringle, mostly in the Republic of Mexico, in 1889; Underwood and Cook's N. American Hepaticæ, Decades V–VIII; 40 species.

Wm. M. Canby. *Aquilegia Jonesii* Parry, collected by F. Tweedy, in Montana; 59 species of European plants, mostly collected in Spain, by E. Reverchon, in 1889.

Ellis and Everhart. Centuries 24 and 25 of North American Fungi, received in exchange for duplicate Centuries heretofore received from estate of Dr. George A. Martin.

Dr. J. H. Sandberg, Minneapolis, Minn. Four species of plants from Idaho.

Agricultural Department, Washington, D. C. Forty-four species of mosses, collected in California by H. N. Bolander, and determined by Mrs. E. G. Britton.

Isaac Burk. Five species of tropical American plants, cultivated at Horticultural Hall, Phila.; 14 species of plants, mostly from ballast grounds.

Prof. F. L. Scribner. Fifteen species of plants from Roane Mt., N. C.

Dr. J. Bernard Brinton. Thirteen species of plants, mostly from Tennessee.

Academy Expedition to Mexico, 1890. Three hundred and twenty-five species of plants collected in Yucatan, in the vicinity of Orizaba and Mexico, and on the Pacific slope, by Stone, Baker and Heilprin, February–May, 1890.

Mrs. E. G. Britton and Dr. J. B. Leiberg. Thirty-nine species of mosses, collected by Dr. Leiberg, in Idaho.

W. G. Warden, through Thomas Meehan. Seven hundred species collected by J. Bornmüller in the province of Amasia, Asia Minor.

Miss Mary A. Schively. Specimens of *Hormactis Quoyii*, a marine alga, mounted and in spirits.

Lewis Woolman. Section of red cedar (*Juniperus Virginiana* L.) from Long Beach, near Barnegat, N. J., prostrated by the blizzard of March 11th, 1888.

Eugene A. Rau, Bethlehem, Pa. *Tribulus terrestris* L. and *Centaurea solstitialis* L., natives of southern Europe, growing upon iron ore heaps at Bethlehem, Pa.

Dr. Samuel Lewis. Peloric form of *Digitalis purpurea* L.

John K. Small, Lancaster, Pa. Specimens of *Asplenium pinnatifidum* Nutt. from various localities in Lancaster Co., Pa.

Prof. Thos. C. Porter. Twenty-three species of plants from Pennsylvania and New Jersey.

Edward L. Rand and John H. Redfield. One hundred and sixty species of plants from Mt. Desert I., Me., being portion of a series intended as vouchers for a proposed Catalogue of the Flora of that island.

Mrs. Flora E. Haines, Bangor, Me. *Aspidium Filix-mas* from Cape Breton.

Additions to Library.

In consequence of the amount of scientific matter included in the Proceedings for 1890, the list of Additions to the Library has been omitted. The receipt of exchanges and donations will be acknowledged by mail.

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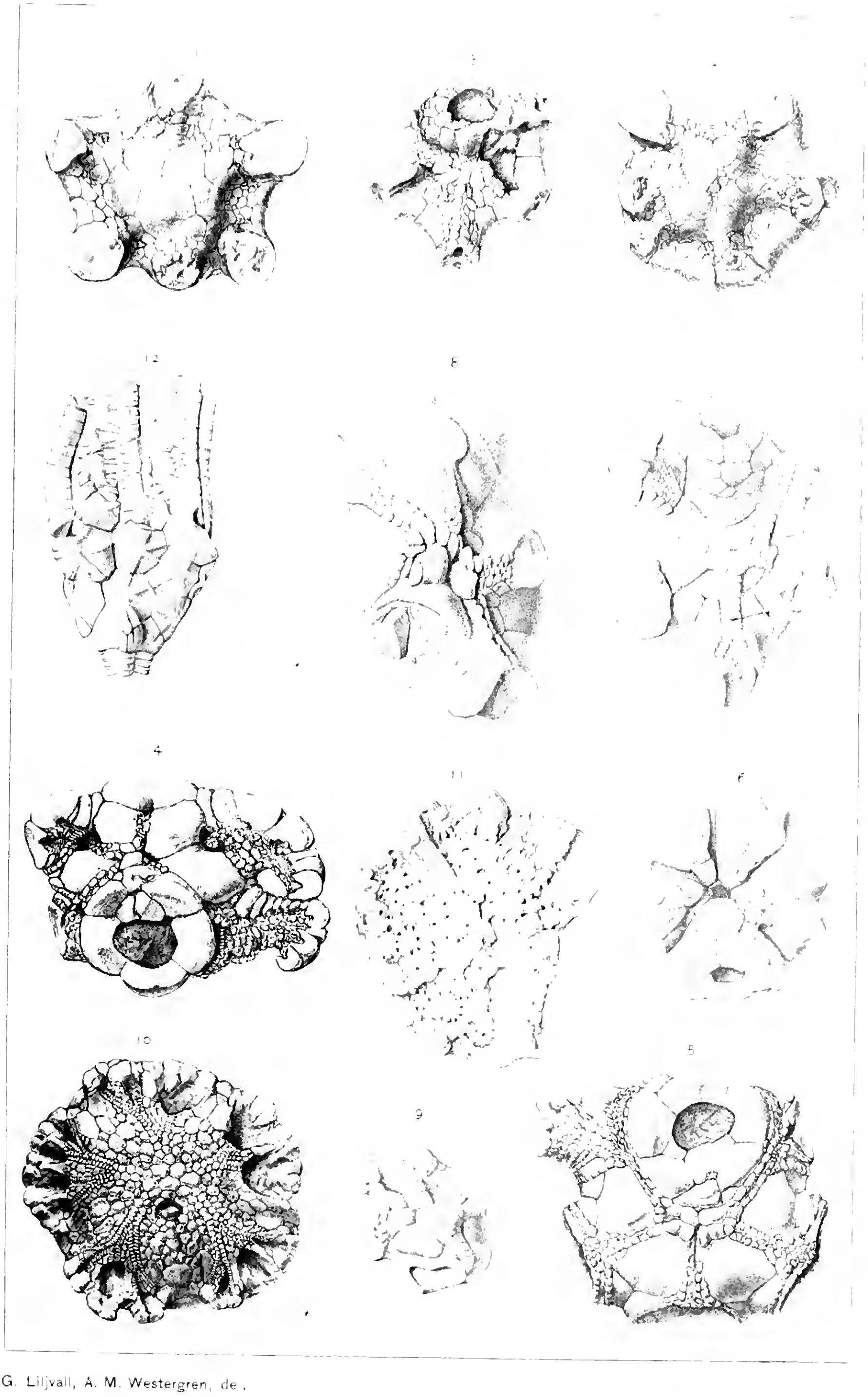

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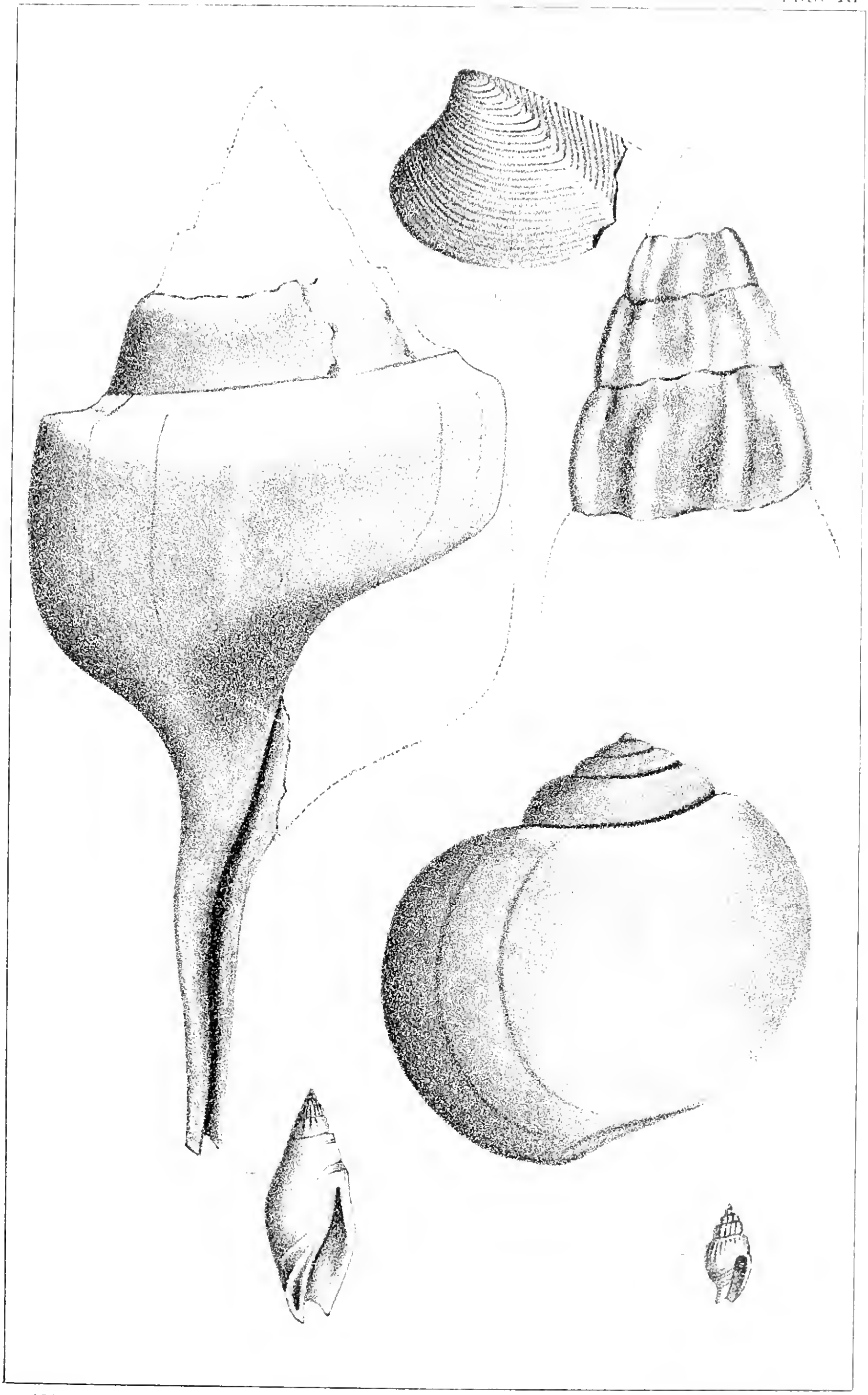

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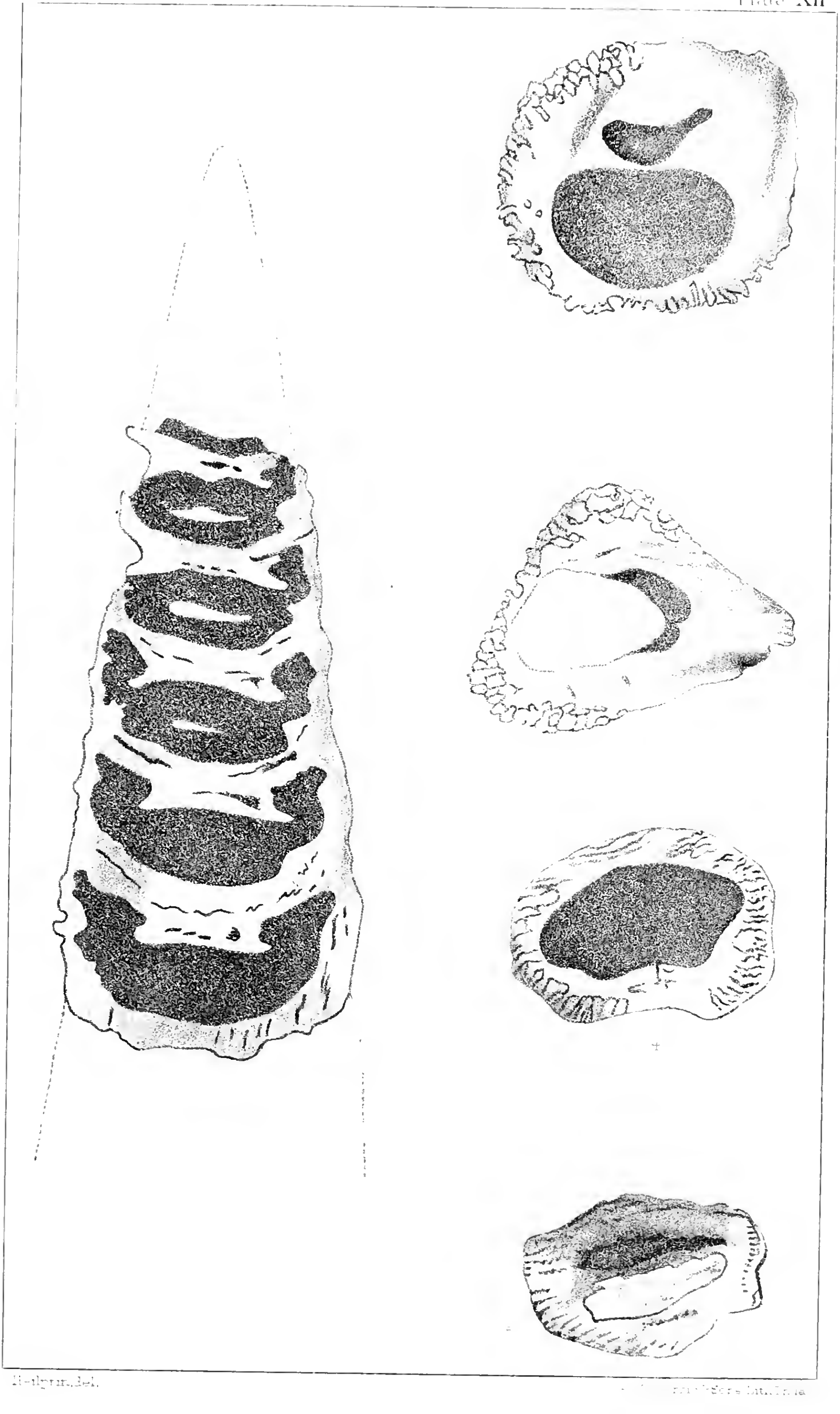

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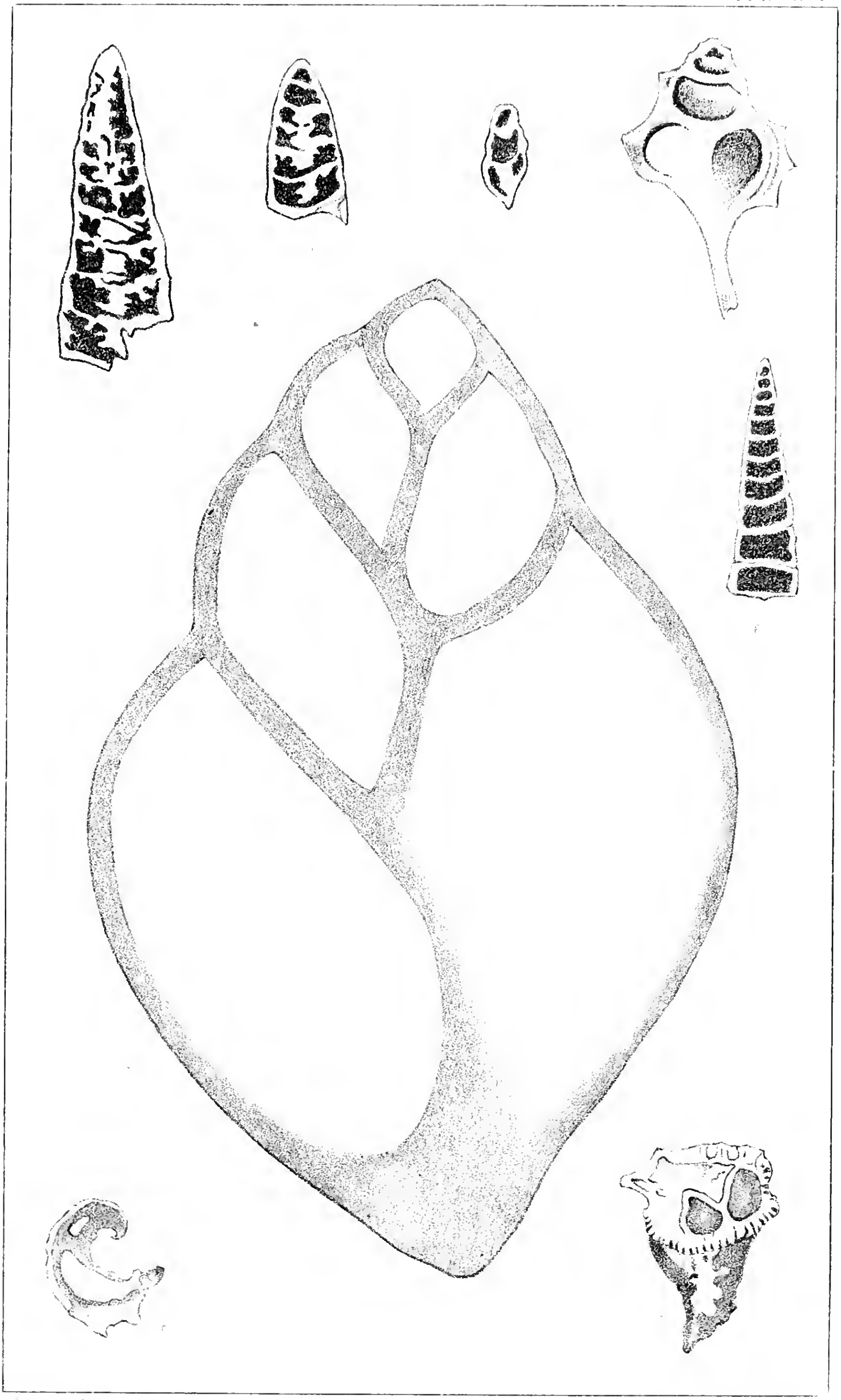

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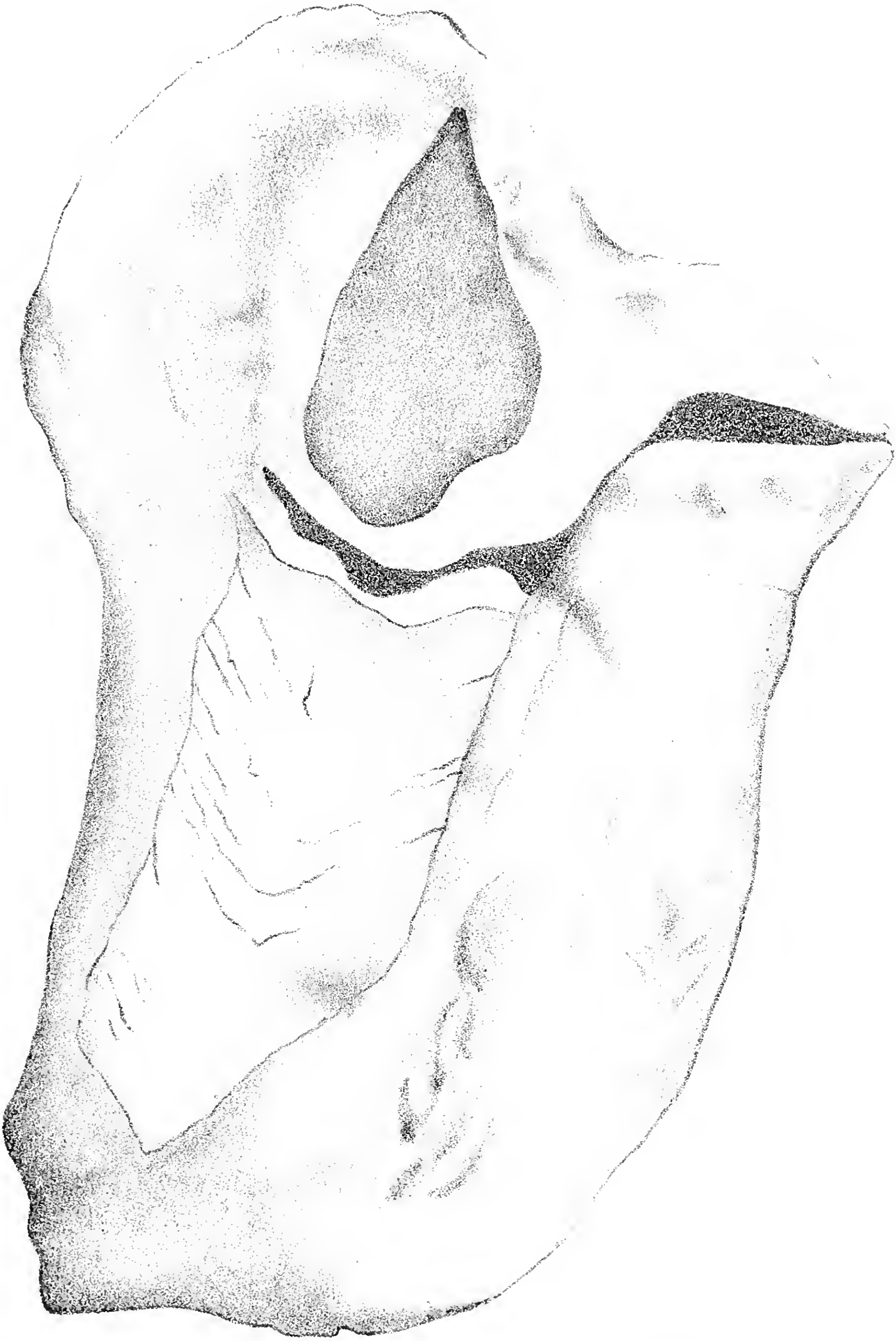

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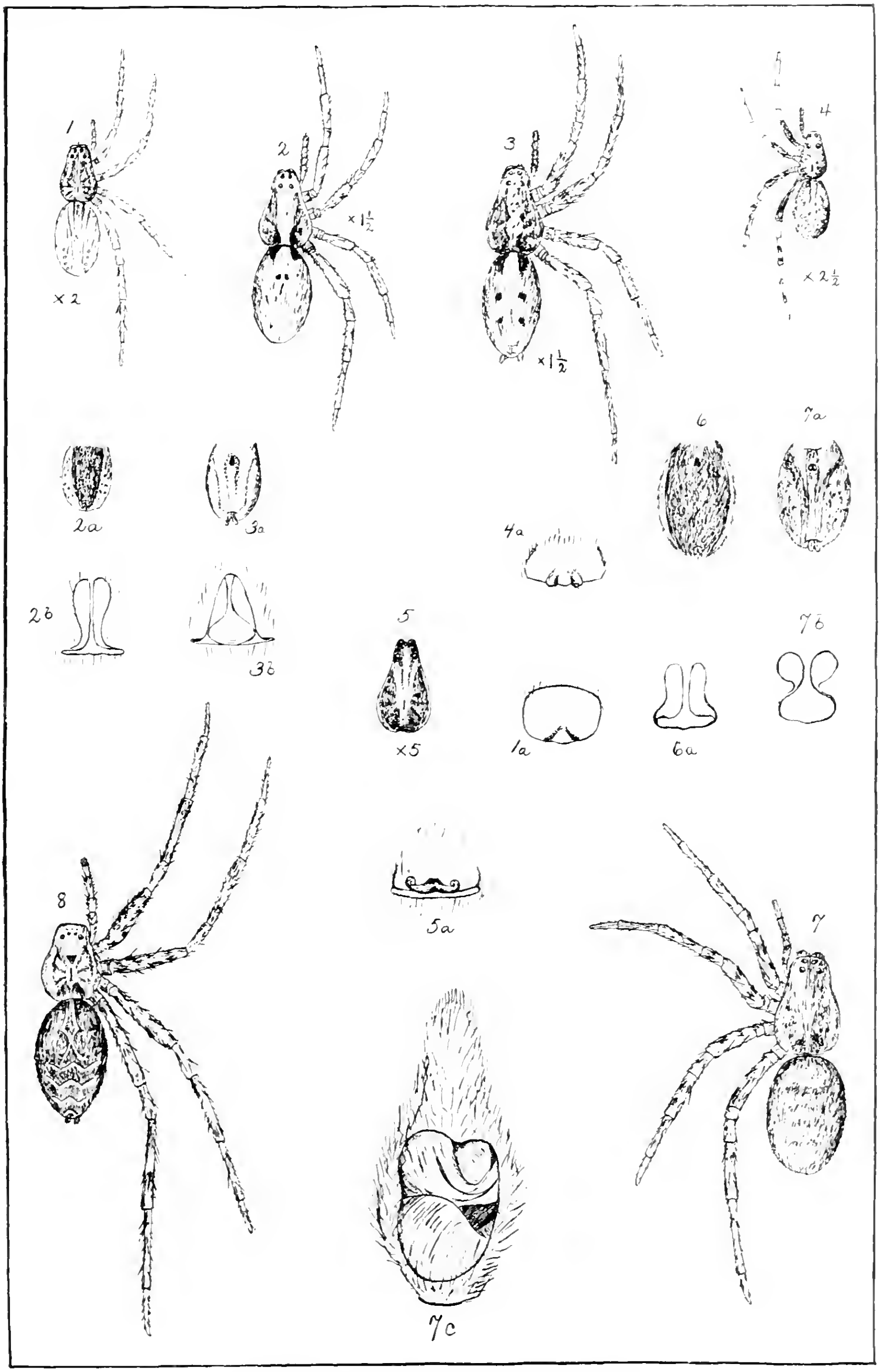

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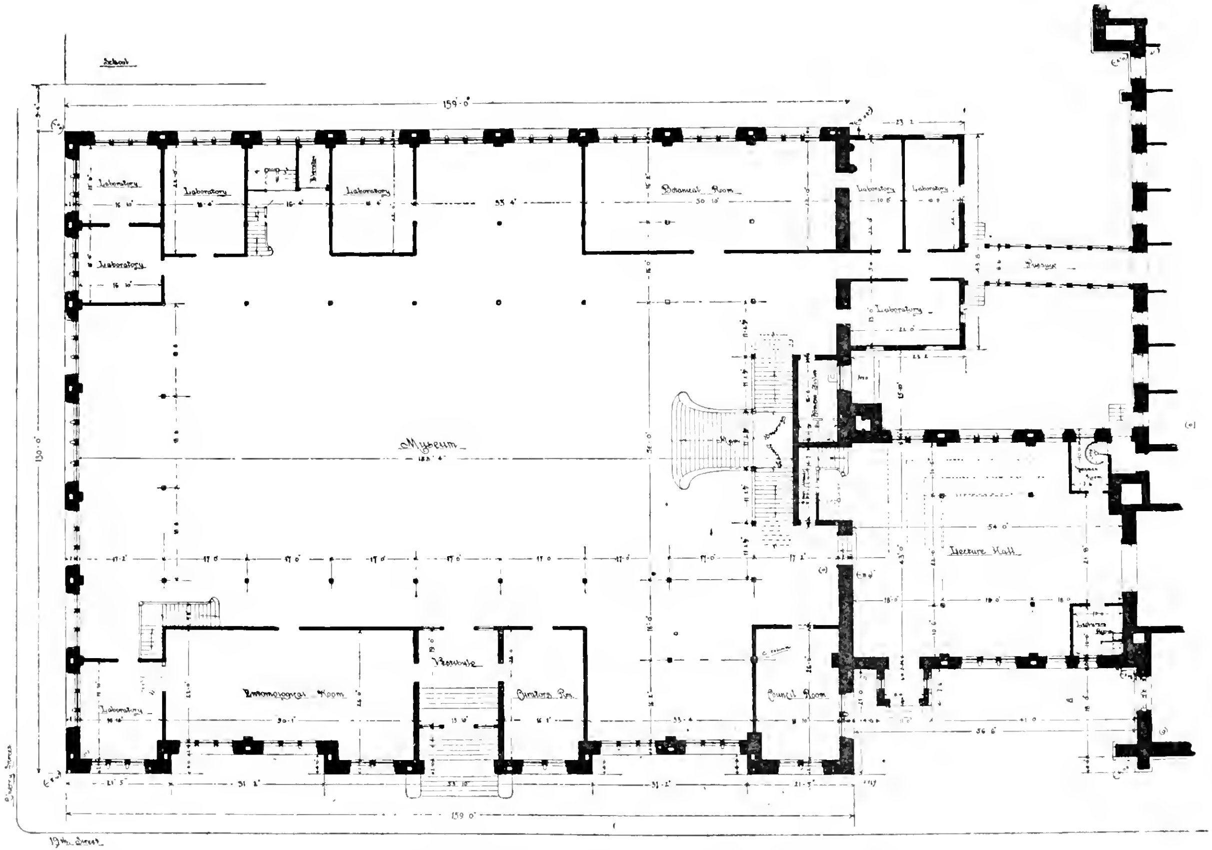

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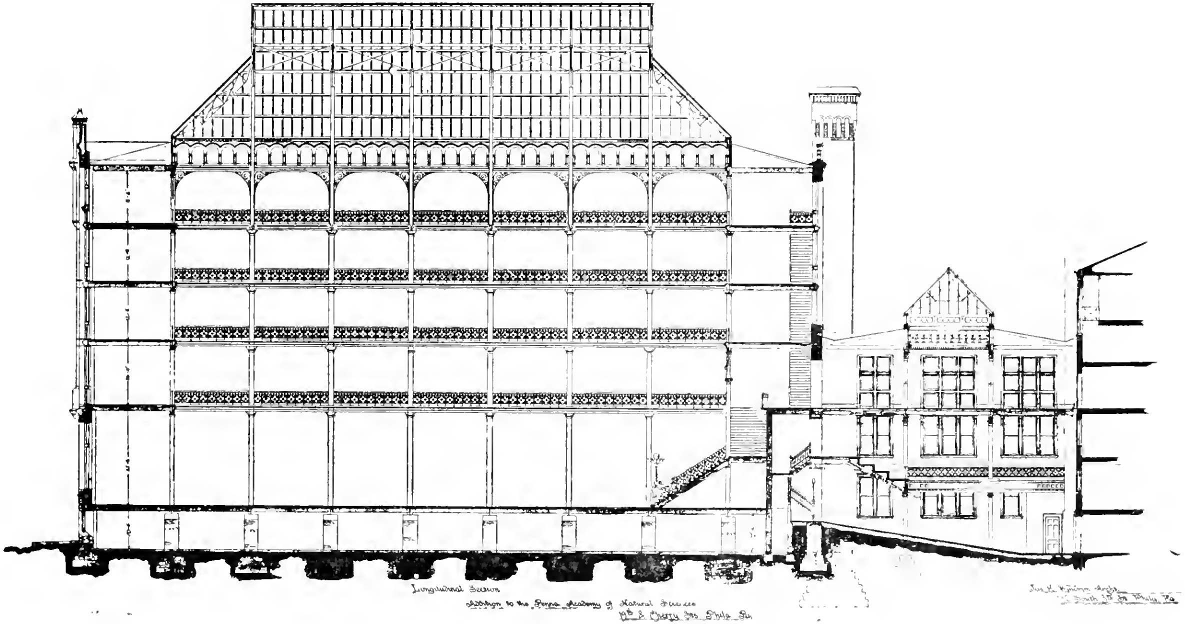
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PART II. APRIL—SEPTEMBER, 1890.

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