

SCIENTIFIC RESULTS OF EXPLORATIONS BY THE U. S.  
FISH COMMISSION STEAMER ALBATROSS.

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No. XXXIV.—REPORT ON MOLLUSCA AND BRACHIOPODA DREDGED IN  
DEEP WATER, CHIEFLY NEAR THE HAWAIIAN ISLANDS, WITH ILLUS-  
TRATIONS OF HITHERTO UNFIGURED SPECIES FROM NORTHWEST  
AMERICA.

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IN THE latter part of 1891 the *Albatross* was engaged in making soundings between the coast of California and the Hawaiian Islands, with the intention of obtaining a profile of the sea bottom for use in connection with plans for laying a submarine telegraph cable. This work was performed as rapidly as possible, and no delays made for dredging or other work not strictly germane to the purpose of the voyage until on approaching Honolulu the archibenthal plateau about the islands was reached, and here, in between 300 and 400 fathoms, eight hauls of the dredge were made, of which a table follows. Half a dozen small bottles, containing mollusks and brachiopods, were received in 1892, and the following account of their contents leads us to regret that more time could not have been devoted to dredging.

The material obtained is not only very interesting, zoologically, but wholly new, not a single species heretofore described, either from the deep sea or from the Hawaiian Archipelago, being found among the dredgings. A new subgenus of Pleurotomidæ, the hitherto unknown and very interesting soft parts of a species of *Euciroa*, regarded as belonging to the Verticordiidæ, but now necessarily raised to family rank, several new Brachiopods, etc., are among the material secured, and described in the following pages. To these are added a few new species from the northwest American coast, and a number of species described briefly without figures in 1891 are now suitably illustrated.

*Table of stations of U. S. Str. Albatross, near the Hawaiian Islands, December 3 to 6, 1891.*

Station.	Latitude N.	Longi- tude W.	Fathoms.	Bottom tempera- ture.	Character of bottom.
3467	21 13	157 43½	310	.....	Sand.
3470	21 08½	157 43½	343	43.3°	Do.
3471	21 10½	157 48½	337	.....	Do.
3472	21 12	157 49	295	.....	Do.
3473	21 15	157 30	313	43.8°	Do.
3474	21 12	157 38½	375	.....	Do.
3475	21 08	157 43	351	.....	Do.
3476	21 09	157 53	298	.....	Do.

The "sand" revealed by so much of the bottom as adhered to several of the specimens is wholly composed of organic debris, minute fragments of echinoderms, shells, corals, foraminifera, etc., in which small particles of pearly shell counterfeit the appearance of mica. No mineral matter of a purely inorganic character was detected.

Mollusks were received from all the stations except 3467 and 3470. Station 3476 afforded eight species; station 3475, seven species; station 3472, four species; and the others two species each.

The *Euciroa* was obtained at five stations, one of the Pleurotomidae at three stations, and the two species of *Dentalium* both occurred at stations 3475 and 3476.

As it seemed desirable to keep together the scanty data belonging to the Brachiopoda, rather than to scatter them through several papers, the species obtained by the *Albatross* at several stations along the eastern border of the Pacific, have been included with the others in treating of that group.

## Class GASTROPODA.

### Genus SCAPHANDER Montfort.

#### Section BUCCONIA, Dall.

#### SCAPHANDER ALATUS, new species.

#### Plate XXVII, fig. 2.

Shell pure white, with a pale straw-colored epidermis, polished, punctate, with a pervious axis; sculpture of faint lines of growth crossed by numerous fine rows of punctures, with wider, pretty regular, interspaces; behind the pillar-lip a few of these rows are so impressed as to form grooves; form of the shell ovate, attenuated in the posterior third; aperture as long as the shell, narrow behind, rounded in front; outer lip sharp, produced behind the immersed spire in an alate manner; body with a thin wash of smooth pure white callus; pillar lip twisted about a pervious axis, stout, thick, with a narrow groove behind its anterior part, but no umbilical chink. Extreme length of shell 35, maximum diameter 20 mm.

Station 3476, in 298 fathoms. No. 107161, U.S.N.M.

This species belongs to the section *Bucconia*, Dall. It is nearest allied to the type of that section, *S. nobilis*, Verrill, from which it may be at once discriminated by its more attenuated posterior third and generally thicker shell and less inflated form, and by its alate outer lip. The gizzard plates are somewhat less distinctly quadrate than in *S. nobilis*. The *Challenger* obtained west of Papua a species of this group, *S. mundus*, Watson,\* which is very like *S. nobilis*, but can not be confounded with the present species.

\* Challenger Gastr., pl. XLVIII, fig. 2.

Subgenus SABATIA, Bellardi.

SABATIA PUSTULOSA, new species.

Plate XXVI, fig. 10.

Shell solid, large, subpyriform, with wholly immersed spire and granular callous body lip; surface polished, sculptured by deep, rather wide, channeled grooves; punctate, but with the punctures overlapping one another so that the line presents an annulate aspect. There are a few intercalary, fine impunctate lines also. The form of the shell is rather rounded, smaller posteriorly, with an obscure constriction about the middle of the shell; apex dimpled, but imperforate; aperture narrow behind, wide and rounded in front; outer lip thin, raised above the apex, but hardly alate; inner lip thick, callous, with numerous pustules, the axis barely pervious; pillar thick, pustular, its outer edge high, with a groove behind it, but no umbilical chink. Extreme length of shell, 33; maximum diameter, 20 mm.

Station 3472, in 295 fathoms, one dead and discolored specimen. No. 107012, U.S.N.M.

This species recalls the more inflated *Scaphander niveus*, Watson, from near the Philippines, but is readily distinguished by its more attenuated *Bulla*-like form. It may, when older, exhibit a more prominent body callus than is shown by our specimen, the granulation of the pillar being much like that of adolescent specimens of *Sabatia bathymophila*, Dall, from the deeper waters of the Antilles.

Genus PLEUROTOMA, Lamarck.

PLEUROTOMA (DRILLIA) MICROSCELIDA, new species.

Shell with six or more whorls (all the specimens decollate), solid, white, with an ashy pale-brown epidermis; aperture less than half the length of the shell; suture distinct, not channeled; anal notch rather anterior, about as deep as wide, separated from the suture behind by a somewhat excavated area; spiral sculpture of, in front of the suture, a plain, strong thread, in front of that three or four anteriorly diminishing threads; the anal fasciole, contrary to the ordinary rule, projects, showing two small distinct adjacent threads, which overrun and somewhat nodulate numerous short abrupt peripheral wavelets; in front of the fasciole three strong alternate with three feeble revolving threads, and still in front of these six or eight small threads occupy the base: the siphonal part is decorticated. The transverse sculpture is composed of the peripheral wavelets before alluded to, which are rather close set and about 21 in number, on the penultimate whorl; there is no other transverse sculpture except lines of growth, which are not very prominent; aperture narrow, with a relatively wide canal; pillar solid, slender, and somewhat twisted; body not callous, and with no subsutural callosity; interior of aperture not lirate; length of five (decollate) whorls,

22; diameter of shell at posterior end of aperture, 8.5; length of aperture, 9 mm.

Station 3475, in 351 fathoms. No. 127122, U.S.N.M.

This species has somewhat such a sculpture as the Antillean *P. periscelida*, Dall, which is a much larger shell, and not a *Drillia*. The most closely allied form I have seen is one dredged in 50 fathoms in the harbor of Unalaska by the *Albatross*, but the latter is a shorter and stouter and probably a smaller shell when adult. The specimens of *P. microscelida*, though alive when collected, were much eroded, so that the description has been made up from the patches of uninjured surface. By an accident to the jar the alcohol had evaporated, and only the shell remained when received, so that nothing can be said as to the soft parts. It is probable, however, that the species should be referred to the genus *Drillia*.

Genus MANGILIA, RISSO.

Subgenus PLEUROTOMELLA, VERRILL.

PLEUROTOMELLA GYPSINA, new species.

Plate xxx, fig. 10.

Shell small, subfusiform, moderately thick, white, covered with a well-marked, unpolished brown epidermis; whorls six beside the (decollate) nucleus, rapidly increasing; aperture slightly exceeding half the total length; suture distinct, but not channeled or marked by any elevated thread; upper portion of the whorl, directly in front of the suture, somewhat excavated, forming a wide anal fasciole; spiral sculpture of, near the suture, fine, low, flattish, close-set threads, which, beyond the fasciole, are gradually more and more distant until, near the canal, the interspaces are thrice as wide as the threads; the sculpture, as usual, is stronger on the upper whorls; transverse sculpture of fine, even lines of growth, and (on the last whorl about 26) small, distinct, even, very oblique ribs, with slightly wider interspaces, beginning strong, but hardly nodular at the anterior edge of the fasciole, and becoming obsolete on the base; on the upper whorls they reach the suture; the last whorl is much the largest, the aperture and canal rather wide, the anal notch arched and shallow, the outer lip projecting below it; pillar lip but slightly callous, interior of the aperture smooth; pillar straight, attenuated in front, the canal obliquely cut off in front. Length of the shell, 23; width at the posterior angle of the aperture, 8.5 mm.

Station 3475, in 351 fathoms. No. 107015, U.S.N.M.

The single specimen is a good deal eroded and has lost its nucleus. The species is not unlike *P. gypsata*, Watson, from 700 fathoms near New Zealand, but that species has only fifteen ribs, which do not reach the suture on the earlier whorls. There are no remains of the soft parts, but the shell looks like a small *Pleurotomella*.



## PLEUROTOMELLA HAWAIIANA, new species.

Shell small, subfusiform, solid, polished, grayish white, with five or more whorls; suture distinct, the whorl in front of it somewhat excavated and appressed; spiral sculpture present only on the base, where it is faint, and on the pillar, where it is coarser, and composed of obscure close-set spiral threads; transverse sculpture near the apex of a few wrinkles, which are visible on the upper part of the anal fasciole, beginning at the suture, but these do not persist; the lines of growth are not generally perceptible without a glass; on the shoulder of the whorl are (on the last whorl about 17) numerous short oblique riblets with equal or wider interspaces, little raised, almost like nodules on the last whorl, but near the apex of the spire they are straighter, and extend from the anterior border of the fasciole to the suture, gradually becoming feebler as the shell grows; aperture rather narrow, the anal notch quite deep, reaching the suture above, while the lip below is produced forward; the pillar is stout and strong, the canal straight and rather shallow; length of (decollate) shell, 13; diameter of the last whorl at the posterior angle of the aperture, 5; length of last whorl, 10 mm.

Station 3475, in 351 fathoms. No. 107020, U.S.N.M.

This shell recalls *P. chariessa*, Watson, but is much smaller and relatively much more solid; the wrinkled subsutural band is absent and the shell is smoother. *P. chariessa* is an Atlantic species, as far as yet known. The single specimen obtained is somewhat broken; the form of the outer lip is described above from the lines of growth. The nucleus and probably a whorl or two more have been lost from the tip of the spire.

## ? PLEUROTOMELLA CLIMACELLA, new species.

Plate XXXI, fig. 14.

Shell slender, small, of five or more (decollate) whorls, covered with a pale straw-colored epidermis, underneath which the shell is porcellanous or chalky white; form elongated, slightly constricted in front of the suture, which, especially in the earlier whorls, is bordered by a somewhat irregular nodulous elevated thread; spiral sculpture of subequal flattened threads, with wider, irregular interspaces; these threads are coarser and more distant near the canal, and absent on the anal fasciole; transverse sculpture of irregular, often prominent, lines of growth, and thin, sharp, low, narrow, irregular riblets, with much wider interspaces, more prevalent on the earlier whorls and more or less obsolete on the last; these ribs tend to nodulate the shoulder and sutural thread when present; aperture less than half the length of the shell, rather narrow, with a wide, short canal, which is not, or but slightly, recurved; pillar lip not callous, pillar obliquely truncate in front, rather stout above; outer lip thin, not reflected, the anal notch almost obso-

lete. Length of the shell (decollate), 18.5; diameter at the posterior angle of the aperture, 6; length of the aperture, 8.5 mm.

Station 3475, in 351 fathoms. No. 127123, U.S.N.M.

Two somewhat eroded specimens were obtained, one of which contained the dried remains of the animal, which could not be extracted. There was no trace of any operculum, and the species can not therefore be referred to *Bela*, while it lacks the deep sutural sinus of *Daphnella*. Its resemblance to certain Atlantic species of *Pleurotomella* is sufficient to indicate the systematic place it should probably occupy.

The species is near *Bela climakis*, Watson, but has a proportionally longer aperture and larger last whorl. It is quite likely that Watson's species should be referred to the same group. *Clionella quadruplex*, Watson, is nearly allied by the shell characters.

SPERGO, new subgenus.

Shell large, thin, nearly destitute of sculpture, with an unrecurved pillar, a short, wide, straight canal, a wide shallow emargination representing the anal notch, and generally feeble anal fasciole, except in the very young; a sharp outer lip, unarmed aperture, and *Sinusigera* nucleus.

Animal with the muzzle formed by a stout squarely truncated rostrum opening into a capacious pharynx, provided internally with a degenerate proboscis not capable of extrusion beyond the oral orifice, with a poison gland and a degenerate radula. Eyes present and functional; tentacles low-seated, stout, and clavate; operculum absent; dentition resembling that of *Bela*.

This form resembles *Pleurotomella*, Verrill, from which it differs in the character of the rostrum and pharynx, in the possession of eyes, in its straight wide canal, and in having a feebler type of verge, anal notch and fasciole.

SPERGO GLANDINIFORMIS, new species.

Plate xxiv, figs. 1, 2.

Shell large, slender, glandiniform, with a typical brown *Sinusigera* nucleus of three and a half whorls, followed by eight normal whorls; color pale madder brown, more or less zoned in harmony with lines of growth, and with a peripheral and basal spiral paler band feebly indicated; the pillar in the young stained with a darker brown, or pinkish white in the full-grown shell; spire rather pointed, the apical whorls sculptured with incised spiral grooves below the shoulder and with numerous small oblique riblets over which the grooves run; the space between the shoulder and the suture behind it slightly impressed, smooth, or crossed by distant low sharp wrinkles, very narrow and not corresponding to the ribs. All this sculpture becomes rapidly obsolete, and on the greater part of the shell the sculpture is confined to silky

lines of growth, faint traces of obscure spiral lines, and a few feeble narrow threads on the base and canal under a pale thin epidermis. The last whorl is compressed at the periphery, as in *Glandina parallela*, giving the body whorl a subcylindric aspect; suture appressed; aperture long, rather narrow, internally smooth, and with very little callus on the pillar or body; outer lip sharp, emarginate before and behind and arched forward in the middle; pillar obscurely thickened behind, attenuated anteriorly, as long as the canal, straight, but slightly twisted; canal and anal emargination wide and shallow; length of an adult, 75; of the aperture, 45; width of the shell at the posterior angle of the aperture, 20 mm.; length of the figured specimen, 45 mm.

Stations 3471, in 337; 3474, in 375; and 3476, 298 fathoms, southeast of Honolulu. Nos. 107013, 107019, and 107160, U.S.N.M.

The animal is of a yellowish color, the columellar muscle attached very deeply within the shell. The foot is strong. In the alcoholic specimen it is transversely wrinkled below, wrinkled and more or less granose at the sides above, the posterior end obtusely pointed; anteriorly it is wider, with the lateral angles produced and the anterior margin double. The rostrum is quite peculiar, dilate, and squarely cut off at the end, which exhibits a flat, circular face concentrically wrinkled, with a very large rounded mouth, the edge of which is deeply radially wrinkled, giving it a papillose aspect externally. The horizontal line joining the bases of the tentacles will pass below the central axis of the rostrum, which is also distinctly constricted behind the tentacles. The surface of the rostrum is smooth, its dorsal line arched. The tentacles are short, stout, transversely wrinkled, and distinctly larger distally. There is a slight enlargement near their bases, where a small, black-pigmented eyespot is clearly visible on both. There is no trace of an operculum or opercular lobe, nor any epipodial processes. Raising the mantle, which has a slightly thickened, smooth edge, we find, rather far back, the verge, which consists of a rather stout, recurved basal portion, above which it is constricted, the remainder being more slender, subcylindrical, slightly enlarged distally, but beyond this tapering to a point. The organ is smaller in proportion to the size of the animal than in most Pleurotomidæ. Above, on the dome of the mantle, is attached the rectum, with an evenly tapered adherent termination and a longitudinally wrinkled subcylindrical lumen. To the left of this the muciparous gland and kidney cover a broad strip of the mantle. Farther to the left we find a ctenidium composed of a single series of leaflets of the ordinary type, succeeded on the left by a well-developed Sprengel's organ, as usual, of a dark-olive color. The siphon, which is closely adjacent, is of very substantial tissue, with an external tinge of olive brown. It presents nothing unusual.

Internally the anatomy offers several points of interest. Within the oral orifice is an immense "crop" or pharynx (22 mm. long in the specimen examined), which, from the deep longitudinal wrinkles of its sur-

face, is evidently capable of being greatly distended. It has a smooth, rather tough, lining without any horny appendages, and is lubricated by the discharge of several muciparous glands of rather small size. Its inner end is abrupt, and at the left of the middle line is the opening of the œsophagus, very much smaller than the pharynx in diameter. The proboscis proper is very short (in spirits), only about one-sixth as long as the pharynx, and therefore, unless capable of great extension in the living state, probably can not be extruded from the oral opening. The pharynx of the specimen examined was partly filled with a dark-greenish matter, apparently of a mucous character, which showed no traces of organization, leading to the supposition that the pharynx was adapted to the engorgement of large masses of protoplasmic matter rather than the pursuit of living animals of a higher order, as in most *Toxoglossa*. The modification is analogous to that by which *Turricula*, a derivative from a phytophagous stock, has become adapted to gorging itself with large quantities of foraminifera, algæ being absent from its habitat. The tooth sac opens near the end of the proboscis, but being filled with coagulated mucus, and extremely reduced in size by degeneration, could not be discovered until the mass was boiled in caustic potash in the hope of finding some traces of teeth.

The teeth are set regularly in a single row on each side of an epithelial strip of rather horny (not chitinous) consistency, the points of the teeth inclined obliquely inward and overlapping a little. The width of the radula from base to base of the opposite teeth is  $\frac{1}{1\frac{1}{2}}$  of an inch. The length of the developed radula is about  $\frac{1}{2}$  of an inch. There are forty or more developed teeth in each row, besides ten or twelve undeveloped germs of teeth. The fully developed teeth are  $\frac{1}{20}$  of an inch in length and about one-fourth as wide as long. This, for a creature over 4 inches long when extended, seems very minute. The form of the teeth is much like that of *Bela*; they are sharply pointed, translucent, and composed of a plate like the die for a steel pen folded closely upon itself with a U-shaped section. The shaft is set in a chitinous yellow socket, which is extended on the back of the tooth so as to form a little hooked knob; opposite this many of the teeth show a small sharp basal denticle. The anterior arm of the U is shorter than the other and obliquely trimmed off toward the apex of the fang. There is a well marked oval poison gland, about 2.5 mm. long, with a slender duct folded twice upon itself, very tortuous, and about 15 mm. long. Behind the proboscis the alimentary canal continues of moderate size for nearly a whorl, when there is an inconspicuous enlargement corresponding to a stomach, with its inner walls longitudinally wrinkled and no marked pyloric curve. It contained merely mucus, and resembled a slight enlargement of the esophagus rather than a well differentiated stomach.

The upper portion of the animal could not be extracted from the spire in spite of all efforts, and so great an advantage in this respect is



given by the deep insertion of the columellar muscle, I was unable to withdraw any part of the animal in good condition until after cutting into the penultimate whorl with a file and severing the muscle with a fine scalpel. This is a very interesting form, evidently related to some of Verrill's *Pleurotomellæ*, but differing in important respects as may be seen by the generic diagnosis. It should be remembered that Verrill's type is *P. packardi*, which differs considerably from most of the species afterwards referred to the group. An examination of specimens of *Pleurotomella agassizii*, Verrill, showed that the oral opening in that species did not markedly differ from other species of *Pleurotomidæ* and the tentacles were eyeless and cylindrical. The specimen being a female, the forms of the verge, which often offer good characters, could not be compared, but Verrill describes it in *P. packardi* as "very large and long, round, nearly cylindrical, except near the tip, where it tapers; in alcoholic specimens it is nearly as thick as the neck, from which it arises."\* It will be observed that this description does not accord closely with the characters in *Spergo*.

The shell figured is a young one with uneroded apex. It is less than half the size of the largest collected, but was chosen for figuring because it showed the characters more clearly.

SPERGO DAPHNELLOIDES, new species.

Plate XXXI, fig. 11.

Shell small, thin, polished, with a pointed *Sinusigera* nucleus of three and a half whorls and six subsequent whorls; nucleus bright yellow brown, often caducous, leaving the white internal callus to represent it, which being molded on the interior of the nuclear whorls, is polished and smooth, while the original nucleus has oblique reticular curved sculpture; sculpture much like that of *S. glandiniformis*, but having the whorls appressed at the suture lower on the antecedent whorl, the riblets more prominent, less oblique, and higher on the whorl, the fasciole more deeply impressed and its sculpture indicating a deeper sinus, and the fine spiral grooving continuous and uniform over the whole surface of the shell; whorls rounded, the last inflated with the outer lip greatly produced, as in *Daphnella*, and the sinus pronounced; pillar straight, brown tinted, canal shallow, narrow; outer lip thin, smooth and glassy within, sharp edged. Length of shell, 23; width at the periphery of the last whorl, 10; length of last whorl, 17.5 mm.

Station 3476, in 298 fathoms. No. 107015a, U.S.N.M.

Two specimens of this pretty little shell were obtained, which have so much the general color and surface of *S. glandiniformis*, that at first they were passed over as the young of that species. When both came to be studied carefully it was evident at once that they were distinct. The present species is more acute, more drawn out in coil, and more

\* Verrill, Trans. Conn. Acad., v, p. 454.



rounded than the young of the other, and has none of its cylindrical appearance.

The soft parts resembled those of *S. glandiniformis*, though the rostral disk was less conspicuous, but the eyes were very large and black, and the tentacles placed low on the side of the head, as in that species. The angles of the anterior edge of the foot were markedly produced.

It seems not unlikely that *Daphnella limacina*, Dall (*Pleurotoma* (*Defrancia*) *hormophora*, Watson), from the deep water of the North Atlantic, may be referable to the subgenus *Spergo*, as there is much similarity in many of the conchological characters, as well as the absence of an operculum and the presence of eyes.

Genus POLYNICES, Montfort.

Subgenus LUNATIA, Gray.

LUNATIA SANDWICHENSIS, new species.

Plate XXVI, fig. 8.

Shell small, thin, white, with a thin straw-colored epidermis and about five whorls; surface polished, with faint spiral markings and fine delicate lines of growth, which, between the shoulder of the whorl and the suture behind it, are irregularly elevated into fine, sharp, oblique wrinkles; suture appressed with a faint spiral impression in front of it; form recalling in miniature that of *Natica russa*, Gould, or *N. clausa*, Broderip; whorls well rounded, slightly flattened in front of the suture; aperture with a moderate callus on the body reaching, but not obscuring, a narrow deep umbilicus. Height of shell, 15.7; maximum diameter, 15 mm.

Station 3476, in 298 fathoms, one dead specimen. No. 107017, U.S.N.M.

Though this modest little species has no very marked characters, I have compared it with all our deep-water species described or imeditated, and find none with which it can be united. The wrinkles are an interesting feature, as they recall the grooves or wrinkles so frequently found on typical species of *Natica*; but the umbilical characters show that it must be referred to *Lunatia*, in the vicinity of *L. grönlandica*.

Genus MARGARITA, Leach.

Subgenus SOLARIELLA, A. Adams.

SOLARIELLA RETICULINA, new species.

Plate XXVI, fig. 9.

Shell thin, frosted-pearly white; depressed-conic, with a (lost) nucleus and five subsequent whorls; suture inconspicuous, appressed, undulated by the sculpture of the whorl upon which it is applied; sculpture of the spire very uniform, spiral sculpture of (on the upper whorls two or three and on the last whorl five) sharp, narrow, spiral ridges increasing

in strength peripherally, and with much wider interspaces; on the base are five more beside the umbilical carina. The peripheral ridge is the highest and the suture is applied against it, the interspace below the peripheral ridge is a little wider than the others; on the spire the transverse sculpture comprises numerous obliquely radiating short ridges which cross the spirals at regular intervals and extend more than half way across the adjacent interspaces; these radii are not continuous over any two spirals but alternate on the successive single spiral ridges, rising to a sharp point where they cross, the upper series beginning close to the suture; on the base the umbilical carina is marked by a strap-like flat rib across which lie close-set rectangular knobs from which radii extend continuously or nearly so to the outer basal spiral, with an intercalary set of radii appearing somewhat irregularly as the interspaces widen toward the periphery; inside the wide scalar umbilicus the radii are continued as vertical, close set liræ, only interrupted by an obscure spiral ridge just below the internal sutural line; aperture oblique, subquadrate, crenulated by the sculpture, the margins sharp and thin, the body with a thin wash of callus, the throat pearly and smooth where not angulated by the sculpture; the pillar lip not differentiated; epidermis pale straw color, extremely thin with a slightly silky luster; height of shell, 7; maximum diameter, 10; minor diameter, 8 mm.

Station 3475, in 351 fathoms; temperature 43° F. No. 127121, U. S. N. M.

The sculpture is something like that of *Trochus illotus*, Watson,\* but the form of the shell is different. It belongs to the group of *T. aglæis* Watson and *Solariella actinophora*, Dall.

Genus EMARGINULA, L a n a r c k.

EMARGINULA HAWAIIENSIS, new species.

Plate XXVI, fig. 7.

Shell large, thin, recurved conical, slightly wider behind than in front; of an ashy cream color, but probably white when fresh; nucleus lost; apex small, recurved, pointed, somewhat laterally compressed; anterior slope gently arched; posterior slope straight or possibly a little concave, shorter than the anterior; outline of the base evenly rounded; sinus narrow, one-fourth as long as the whole anterior slope, set in to the right of the middle line of the shell, its limbs tending to approach anteriorly; fasciole narrow, marked by close-set semicircular elevated ripples, concave forward; sculpture of close, even, regularly distributed, elevated threads, radiating from the apex with smaller intercalary threads toward the margin; these are crossed by even, regular, elevated concentric lamellæ, slightly nodulous at the intersections; at the margin of the shell the major radials are slightly more than a millimeter apart

\* Challenger Gastr., pl. XVII, fig. 3c.

from center to center; in the other direction there are about three concentric lamellæ to a millimeter; interior of the shell smooth; an obscure impressed rib marks the course of the fasciole; the margin is slightly radially grooved in harmony with the external radial sculpture. Length of the base, 23; width, 17; height of the shell, 11 mm.

Station 3473, in 313 fathoms. No. 107011, U.S.N.M.

This species has a good deal such sculpture as *Cranopsis asturiana*, Fischer, but the latter has the radii and concentric lines less elevated. On the plane of the base the apex is 17 mm. behind the anterior margin. Only one dead specimen was obtained.

## Class SCAPHOPODA.

Genus DENTALIUM, Linnæus.

DENTALIUM PHANEUM, new species.

Plate xxvi, fig. 1.

Shell rather thin, pale straw color, glistening, nearly straight, the curve chiefly in the earlier third; the shell originally is smooth or with few, feeble elevated lines, which in traversing the distance from the apex to the aperture revolve one-fourth of a turn to the right; surface marked by delicate annular lines of growth and longitudinally by about twenty-five very fine, sharp, little-elevated threads, which are strongest about the middle of the shell and more or less obsolete in front and behind; between these are faint obscure longitudinal striæ; both orifices of the shell are simply circular, the anterior sharp-edged and a little oblique. Length of the shell, 35; anterior diameter, 2.2; apical diameter, 0.5; maximum deviation of the curve from a chord drawn between the ends, 3.2 mm.

Stations 3475 and 3476, in 351 and 298 fathoms. Nos. 107025 and 107026, U.S.N.M.

This species is perhaps most nearly allied to *D. antillarum*, Orbigny, of the Antilles, a species which differs in its sharper and more numerous ribs, which become more prominent toward the apex instead of obsolete. Of Pacific species *D. numerosum*, Dall, a form which occurs in very deep water from the Galapagos to California abundantly, has the most general resemblance to the present species; but it grows to nearly twice the length, and when closely examined is seen to have a sharply pentagonal posterior section with a conspicuous ventral slit. *D. numerosum* is a somewhat straighter and longer shell than *D. phaneum*.

DENTALIUM COMPLEXUM, new species.

Plate xxvi, fig. 3.

Shell large, solid, thick, normally white (?), but discolored by sediments after death, so that the specimens received are a pale, rusty brown; surface glossy, sharply grooved, with wider flat interspaces, varying finer or coarser in different specimens; orifices circular, one

specimen showing indications of a wide, shallow ventral sinus at the apex; shell little curved, and the sculpture shows no rotary tendency. Length of shell, 78; diameter anteriorly, 8.5; posteriorly, 1.3; maximum divergence from a chord connecting the extremities, 8.5 mm.

Stations 3472 and 3476, in 295 and 298 fathoms. Nos. 107022 and 107023, U.S.N.M.

This shell differs from *D. candidum*, Jeffreys, by being more cylindrical and, so far as my present specimens go, without the long, slender ventral slit of that species. From *D. ceras*, Watson, as figured, it is distinguished by being straighter and less sharply sculptured, besides being much larger, but Watson's specimens were young. With a few specimens it is easy to separate species of *Dentalium*, but if one has numerous specimens from various kinds of bottom the difficulty increases greatly. *D. solidum*; Verrill; *D. ceras*, Watson, and *D. candidum*, Jeffreys, appear to merge into one another, yet individual specimens appear very distinct when one has not a connecting series. The present species, by its somewhat more cylindrical form, seems sufficiently distinct to be named, but, with that exception, is very closely related to the group of forms above enumerated.

All the specimens were dead, discolored, and occupied by annelid tenants.

## Class PELECYPODA.

### Family EUCIROIDÆ.

#### Genus EUCIROA, Dall.

When first proposed,\* this group was supposed to be sufficiently distinct from *Verticordia* as defined in the text-books, but later† a careful study of numerous species of *Verticordia*, including the type species of that genus, led to the belief that it could at most form a section of the older group, and as such it was included in my final report.‡ It was only known from separated valves of the type species *V. (E.) elegantissima*, Dall, dredged in 300–750 fathoms in the Antilles. Since then a related and very elegant species has been dredged in the Indian Ocean by the *Investigator*, and has been described§ by Wood-Mason and Allcock under the name of *Verticordia (Euciroa) eburnea*.||

I have now the pleasure of adding a third and very beautiful species from the Pacific, which, being taken with the soft parts intact, enables me to complete my description of the group and establish it as even more than generically separate from the typical *Verticordia*.

\* Bull. Mus. Comp. Zool., v, pp. 61, 62, 1878.

† *Op. cit.*, ix, p. 106, 1881.

‡ *Op. cit.*, xii, pp. 196, 291, Sept., 1886.

§ Ann. Mag. N. H., Dec., 1891, p. 447, fig. 14.

|| Sowerby, overlooking this description and figure, redescribed this species under the name of *V. optima* in Proc. Mal. Soc., Lond., i, p. 39, pl. v, fig. 3, Mar., 1894.



It may be well to recall here the essential characters of the anatomy of the *Verticordia acuticostata*, the type of that genus. It has two siphonal openings with their orifices fringed with several rows of papillæ; the anal siphon opens into a closed chamber, the floor of which is formed by a muscular fleshy septum imperforate except for the passage of a short, stout, stopper-like foot, around which the septum fits closely; the lower surface of this septum is devoid of any appendages; on each side of the foot lies, adnate upon its surface, a small elongate triangular gill resembling one of the oral palpi of ordinary pelecypods, but separated by some distance from the oral aperture. This gill is without doubt functional as a ctenidium, but may be homologous with the posterior palpus (a view suggested by the presence of palpi in *Euciroa*), a possibility which requires further investigation; at all events no other organ (unless it be the general surface of the septum and branchial chamber) is present for purposes of respiration. There are no palpi about the mouth. The edges of the mantle are separated only by a narrow opening sufficient to give passage to the foot. The septum was homologized by me with the siphonal septum of ordinary pelecypods, which was supposed to be extended forward to the visceral mass as it is in *Lophocardium*, though in the latter genus the usual functional gills are present.

In *Euciroa* the following differences may be noted: The opening between the lobes of the mantle is ample, the foot laterally compressed, though small, more nearly resembles the same organ in the average pelecypod; both pairs of labial palps are present and free; while a septum exists, the posterior part of which is obviously formed by an extension forward of the siphonal septum, yet a large part of it is formed by lamellar gills which extend backward from the visceral mass near the mouth enclosing the foot, and have their edges connected with each other on each side and with the tissue of the mantle laterally, so that, as in *Verticordia*, a complete separation between the anal and the branchial chamber is insured. These differences, which will be described in full detail under the species about to be named, are quite sufficient to justify the assignment of generic rank to the group separated by me under the name of *Euciroa*.

EUCIROA PACIFICA, new species.

Plate XXIII, figs. 2, 4; plate XXIV, figs. 4, 5, 7, 8.

Shell rounded, inflated, solid, brilliantly pearly within, of a frosty dull white externally, covered with a very thin pale brownish epidermis, under which the shell is everywhere minutely granular and sculptured with fine radiating lines of large, sometimes sharp-pointed and recurved, granules, the rows being very close set posteriorly but with wider interspaces toward the middle and anterior part of the valves; concentric sculpture only of feeble incremental lines, visible chiefly near the basal margin of the valves; beaks prominent, full, much incurved, anteriorly



twisted; in the young shell a prominent thread radiates from the beak, setting off a posterior area over which the granules do not have a distinct linear arrangement, but as the shell grows this thread becomes obsolete, though the difference in the distribution of the granules continues; internal surface of the valves polished, pearly, with obscure radiating and some vermicular impressions, the internal margin of the valves finely grooved radially; muscular impressions small, somewhat obscure, the posterior larger; external ligament thin, short, hardly functional; internal resilium short, strong, set obliquely under the dorsal margin and reenforced below by a calcareous lithodesma, thick, deltiform, rounded below with a short, pointed process on each side behind; there is a small, nearly smooth, deeply impressed lunule mostly attached to the right valve, the margin here projecting, while in the left valve a similar projection is so depressed as to pass for the most part below the projection of the right valve and perform the function of an anterior lateral tooth; the left valve behind the beak shows a long, almost linear, depression, which must be taken as the escutcheon, the most posterior part of which passes below the margin of the right valve, while on the edge of the latter, close to the resilium, is a small, little-elevated, narrow lateral tooth; in front of the resilium in the right valve is a large, stout, pointed, recurved cardinal tooth arising from the valve under the lunule and hooking into a funicular cavity below the beak of the left valve. Behind this in the left valve is a narrow little elevated cardinal, easily mistaken for a raised edge of the cartilage pit, and serving to defend the lithodesma from pressure by the right cardinal. Using  $e$  for the cartilage and  $l$  for the lateral teeth, the Steinmann formula for the hinge would be as follows:  $\frac{L}{R} \frac{l \ o \ e \ l \ o \ l}{\bar{o} \ l \ e \ o \ l \ o}$ ; though the laterals do not enter actual sockets in the opposite valve. Height of the shell, 25; length, 28; diameter, 21 mm. A dead valve reaches a length of 38 and a height of 35 mm.

Stations 3471, 3472, 3474, 3475, and 3476 in 295 to 375 fathoms: temperature between 43° and 44° F. Nos. 107008, 107027, 107028, 107029, 107030, and 107031, U.S.N.M.

This fine species differs from *E. eburnea* by its recurved, smaller, and more delicate and more numerous granules. It is more like *E. elegantissima*, from which it differs in the rounder form of the young shell and in the full grown by its thinner and anteriorly more produced valves. The minor details of the hinge, and the position of the pallial and muscular impressions on the valve also serve, when carefully compared, to discriminate the species.

The soft parts offer several points of interest already alluded to. The tissue, internal to the mantle and external to the viscera, especially on the ventral surface, is remarkably thick, almost jelly-like, and full of connective fibers. The margin of the mantle appears smooth and somewhat thickened by peripheral muscular fibers form-

ing a band; within the margin is a little elevated reduplication of the inner layer, the edge of which appeared to be minutely papillose, and which in life can probably be extended to several times its length as preserved in spirit. In front the lobes are separated in front of the anterior adductor and continue distinct three-fourths of the way to the incurrent siphon, when they are joined; around the oval area occupied by the papillæ about the siphonal orifices the border of the mantle, dividing again, forms a thickened frame which is united in front of the posterior adductor. The sides of the mantle in front of the incurrent siphon—below the middle line of the valves (drawn horizontally) and on each side of the pedal opening forward to the vertical of the anterior adductor—present rounded-triangular areas with their apices anterior, where the tissue of the mantle between the inner and outer laminae of each lobe is thickened by the presence of a quantity of columnar muscular tissue perpendicular to the surfaces of the laminae and very uniformly distributed. These areas are crossed by numerous branches (more or less bifurcated) given out by the pallial nerve, and the outer face of the area thus modified is attached to the valve, upon which it leaves somewhat vermicular surface markings.

Several longitudinal or radiating fibers or bands parallel to the surface of the mantle are also observable by transmitted light, the chief of which extend toward the base of the incurrent siphon or in the direction of the anterior adductor. These masses of muscle have no obvious function; they occupy the area of the radiating retractors of the siphons in ordinary *sinupalliata*, but they are not connected with the siphonal septum or the sphincter of the incurrent siphon and, with few exceptions, the columnar fibers simply connect the inner and outer laminae of the lobe of the mantle in which they are respectively situated. Over the surface of the muscular mass near the median line behind the commissure of the mantle edge is distributed a quantity of glandular tissue which reaches up to and partly around the lower portion of the sphincter of the branchial siphon between the laminae of the mantle lobe. The aggregation of glandular cells is so arranged as to leave channels which lead toward the vicinity of the sphincter, where they probably open to the surface, though I was not able to detect the orifices. The internal face of the incurrent siphon is concentrically wrinkled by the contracted sphincter, which below seems to merge with the pallial marginal band and above is overshadowed by a broad, smooth siphonal septum. The orifice itself, as retracted, from an internal point of view, presented a vertical smooth-edged slit, of which the margin projected internally to a marked degree. Externally the perisiphonal area is papillose, the papillæ not seemingly arranged in regular ranks, but the outer ones larger and the size diminishing focally toward each orifice. One papilla, larger than any of the rest, is situated in the median line above the excurrent orifice, but there is no medial papilla ventrally. The excurrent siphon, as usual, is

smaller than the other, and its valve or orifice in the alcoholic specimen does not project internally; both are surrounded with about the same relative amount of papillæ, which seem to be of about the same series of sizes for each orifice. The intestinal canal passes over the posterior adductor and terminates near the excurrent siphon, internally, but has no projecting free portion.

The outer lamina of the mantle when removed from the shell shows a band of short fibers less than 2 mm. in length and diminishing downward; they extend anteriorly from the mantle margin, and are disposed over the space in front of the siphonal area from the adductor above downward as far as the area extends. These are, without doubt, the retractor muscles of the siphons, and correspond to the slight concave curve below the adductor scar, which may be traced in the pallial impression. The mantle is remarkable for its large blood sinuses, and the pericardium is unusually large, as well as the ventricle of the heart. The latter is a thin, semitranslucent pear-shaped sac, dorsal to the rectum and not pierced by it. It is slightly asymmetrical, lying a little more to the right on the median line. The auricles enter the base laterally, being set off by a marked constriction, and are muscular and of a darker color than the ventricle, apparently having a thin glandular coating. Laterally from each auricle a funicular muscular tube extends to a capacious sinus in the wall of the mantle. There is a single anterior aorta starting from the base of the ventricle. The pericardium and its contents lie behind the cardinal teeth and beaks. The visceral mass below the latter seems but moderately supplied with hepatic lobules, and, superficially, exhibits the ramifications of the ovary. The male glands are lower down and of a pale color. The foot resembles that of *Verticordia* in being somewhat constricted above, but is much more like that of the average pelecypod. It is pointed and produced moderately in front, compressed, the lower part somewhat keeled, the posterior more swollen, with a slight "heel," and no trace of a byssal groove or gland. The retractor muscles of the foot form a slender, solid cord below, which ascends and bifurcates behind the middle of the shell and is attached on each side above the main body of the adductor, but forms an almost indistinguishable part of the same impression on the shell. The protractors, however, make separate scars a little behind and above the anterior adductor scar.

Reversing the animal and separating the lobes of the mantle, we find the foot closely embraced above by the ctenidia, which extend forward and are attached firmly to the mantle at their outer edges, and anteriorly reach to a point close to and just outside of the ventral pair of palpi. In looking down upon the reversed animal the most anterior part of the ctenidia is concealed by the foot and palpi. Leaving a fuller description of the gill until later, attention may be directed to the parts about the mouth. Just behind the anterior adductor are perceptible two or more pouch-like sacs on each side in front of the

dorsal palpus, which is more or less attached to this blister-like body. On cutting the tissues so as to expose the parts it is seen that the sacs form part of the dorsal palpi which are largely adnate upon the posterior faces of the sacs, with the free extremity recurved and coiled as in the figure.\* The sacs when opened appear empty and thin walled, resembling blood sinuses. The palpi are not distinctly cross striated, but are more or less folded, like a book, upon themselves. The ventral palpi are long, slender, and nearly smooth. Between the bases of these projects a sort of lappet of cuticular tissue, broad, flattish, bifurcate behind and lying against, but not attached to, the anterior edge of the upper part of the foot. Above it the mouth is visible as a narrow slightly arcuate slit. I have not observed before anything exactly corresponding to this lappet in any pelecypod I have examined or found mentioned in the literature. What the office of the sacs in connection with the palpi may be I can not imagine, unless, when filled with fluid, their contraction may erect the tissue of the palps.

The most interesting part of this investigation relates to the ctenidia. These resemble in construction the archaic gills of *Yoldia*, *Solemya*, etc., with interesting differences. Behind they are firmly attached to and continuous with the broad siphonal septum; on each side and in front their outer edges are firmly soldered to the mantle. The inner edges on each side of the foot are confluent near the base of insertion and bordered by a smooth band of connective tissue which is closely appressed to, but not organically connected with the foot, which passes between them. These edges behind the foot, however, are united to each other by delicate yet firm tissue not easily ruptured. Looking down upon this surface, beside the median line of junction it is seen to be marked by two impressed grooves on each side between which, obliquely waved, extend the edges of closely appressed plate-like lamellæ. On cutting the gills transversely it is found that these plates present much the appearance of the same organs in *Yoldia limatula* as figured by Mitsukuri,† but with important differences. The fibrous suspensory tissue, by which the ctenidia are connected with the mantle, forms a narrow band extending obliquely at an angle of 35° to 45° from the vertical plane of the body, when it is perforated by a large vessel running longitudinally. Morphologically below this, but actually obliquely outward, is a band of smooth tissue separating two sets of lamellæ. These lamellæ are not equal and symmetrical as in *Nucula*, nor are they set at right angles to the stem of the gill, but trend obliquely backward on each side like the vanes of a feather. The outer set of lamellæ are wider from side to side and shorter vertically than the inner set. The latter are separated by a narrow membranous band from a third set, forming an ascending or reflected lamina, for which I was unable to detect any main blood vessel comparable to that of the main stem of the gill. The upper surface of

\* Compare pl. XXIV, fig. 5, p.

† Studies from Biol. Lab., Johns Hopkins Univ., II, pl. XIX, fig. 11, 1882.



the gill is furnished with numerous longitudinal muscular fibers, at about equal distances apart, which firmly connect the upper edges of the lamella. The border of the inner lamina where it lies against the foot is defended, as above stated, by a thin band of smooth tissue, and where the plates join this band their edges are confluent. The same is true of the edges of the outer set where they impinge upon the mantle. The connection is very brief and just at the appressed edge of the gill. Each plate appears to form a single blood sinus or sac, as in *Nucula*, with numerous radiating muscular fibers, as figured by Mitsukur in *Yoldia* (Tab. cit., fig. 11). The main surface is composed of conspicuously cellular epithelium, as in *Nucula*; the edges are abundantly ciliated. The plates

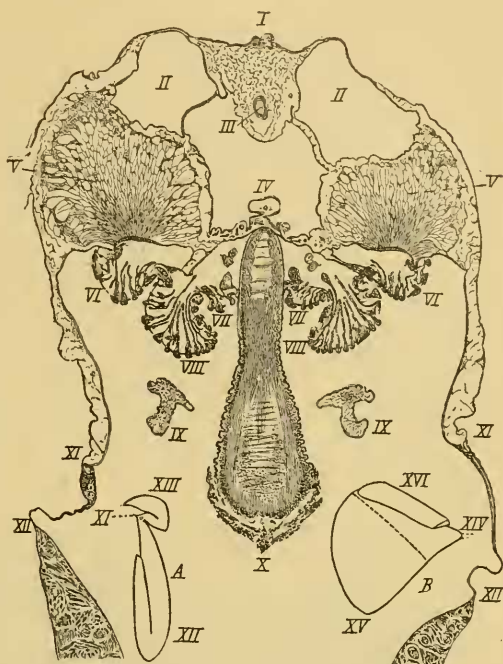


Fig. 1.

MICROTOMIC SECTIONS OF *EUCIROA PACIFICA* AND  
*Callocardia STEARNSII* \*

\* Figure 1. Microtomic section of *Euciroa pacifica*, Dall, taken through the middle of the foot, the lower part of the mantle lobes being omitted. From camera lucida drawing from the original by J. C. McConnell, †.

I, Dorsal commissure of the mantle; II, II, blood sinuses connected with the auricles of the heart; III, the rectum; IV, cavity of the nephridia; V, V, reticulated connective tissue; VI, VI, direct outer limbs of the ctenidia; VII, VII, inner reflected laminae, and VIII, VIII, inner direct laminae of the inner limb cut in a slightly oblique section across the single plates; IX, IX, the palpi; X, the foot, more or less surrounded by loose epithelial matter; XI, XI, lobes of the mantle; XII, XII, beginning of the muscular region of the mantle lobes; incomplete below.

Figure 1, A. Section of left ctenidium of *Callocardia stearnsii*, Dall, †.

A. XI, *Callocardia*, stem of the gill with blood vessel; XII, inner direct and reflected limb; XIII, outer direct and reflected limb in section.

Figure 1, B. Side view of left ctenidium of *Callocardia stearnsii*, showing outline of the inner and outer limbs; the dotted line showing the limit to which the inner reflected lamina of the inner limb rises on the side opposite that of the observer.

B. XIV, point where the ctenidium is attached to the siphonal septum; XV, ventral extreme of the inner direct limb; XVI, outline of the outer direct and reflected limb; the inner reflected laminae on the side next to the body rises to the height indicated by the dotted line. The single plates of which the gill-mass is composed are not indicated.



are distinctly margined, as in *Nucula*, but are connected together by small patches of what appeared to be fibrous tissue, which proves to be interlocked giant cilia (see fig. 2, VI). Owing to the oblique manner in which the plates are set on the stem, and the manner in which they are tied together, it is difficult to get a section which will show the whole face of any single lamella and determine exactly how many ciliary bridges exist to each plate, but the distal margins of the plates were free from each other for some little distance inward. The outer edges of the lamellæ appeared to be furnished with a small circular band of muscular fibers by which the periphery might be contracted, but no rigid chitinous framework could be detected. Along the channels between the series of plates were accumulations of dark-colored organic granules, indicating that the ctenidia perform the function of collecting food material.

After using a low-power lens in dissecting in the ordinary way, serial sections with the microtome, after hardening and staining, were

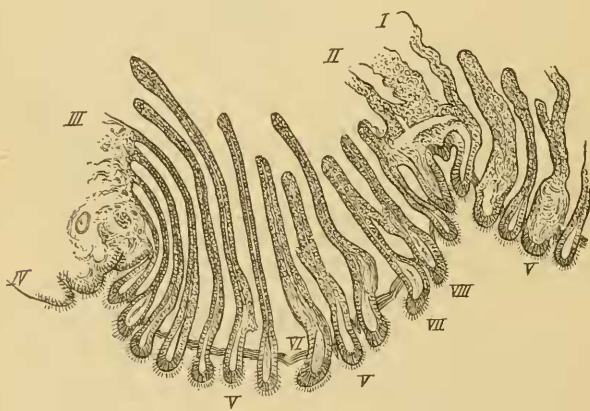


Fig. 2.

MICROTOMIC SECTION OF PORTIONS OF THE GILL OF *EUCIROA PACIFICA*.\*

resorted to, in order to get at the structure of these and other organs. Dr. Gray, microscopist of the Army Medical Museum, kindly undertook the manipulation and mounting. It was found that the processes required, as preliminary to sectionizing, were destructive of many delicate features which with the dissecting microscope are easily observed in fresh material. On the other hand, the sections (shriveled and distorted as they are, compared with fresh specimens) exhibited a number of

\* Figure 2; section of the plates of the inner reflected lamina of the gill of *Euciroa pacifica*, greatly enlarged, from microtomic section at a tangent to the anterior surface of the posterior adductor, camera lucida drawing by J. C. McConnell.

I, II, combined plates at the point of reflection, defective above; III, IV, mass of connective tissue, etc., forming the junction of the right and left ctenidia behind the foot; V, V, V, plates which have been torn by the knife in cutting, simulating vascular connections; VI, giant cilia connecting the plates distally; VII, VIII, plates connected by a true vascular junction.

For a proper conception of the real relation of the parts before shriveled by the staining process, the reader should refer to pl. XXIII, fig. 2.

points of structure which were not observable otherwise. It is evident that both methods are required for complete results. In the present instance, in examining the gills in water with low powers, it was observed that the close-set oblique plates, or lamellæ, are connected at their dorsal edges by a delicate series of connective fibers running in an antero-posterior direction and recalling the threads which connect the dorsal edges of the laminae in *Poromya*, but more numerous, and laterally, near the attachment to the mantle, forming a sort of *fascia*, or layer of fibres. Beside this, the dorsal portion of the plates near the arterial stem of the gill show a few reticulations carrying blood vessels, and a good many which appeared purely fibrous. The vascular connectives, except close to the stem as above mentioned, were not observed, though here and there a fibrous link united the faces of two plates near their dorsal margins, but without any regularity of situation or succession. The arterial stem, which anteriorly has a roughly triangular section, near the posterior ends of the gills is produced vertically, so that the short laterally extended plates of this part of the gill, instead of hanging below the stem, are projected from its opposite sides, and are not all of the same vertical width. This appeared very clearly in the microtomic sections, in which, however, no trace of the longitudinal dorsal fibers could be recognized, the latter having been apparently destroyed by the contraction induced by chemical treatment used in staining, with many other more delicate features. The sections therefore show the lamellæ as more isolated than they are in reality, except near their ventral edges, where they are bordered by a narrow band of giant cilia, which interlock between the plates, thus holding the ventral margins quite firmly together. These junctions were well shown in the sections, and also, though less clearly, the distal margins of the plates showed patches of smaller cilia, not continuous with the band above, but projecting into the peripodal cavity, and doubtless serving, as in other pelecypods, the purpose of collecting and propelling grains of edible matter toward the mouth.

The nephridia lie below the pericardium and are distinctly limited by the connective tissue made up of a radial network of fibers which constitutes the lamina to which the outer edges of the gills are attached. The nephridia have a common cavity (fig. 1, iv) more or less occupied by thin folds of very delicate tissue of a more or less glandular nature, upon and around which are clustered large numbers of spherical nucleated or concentric concretions similar to those already described in *Lyonsiella* and other Anatinacea. These concretions stain deeply and are very varied in size, the largest exceeding any of those noticed in *Halicardia*. The nephridia do not extend laterally into the lobes of the mantle as they do in *Halicardia*.

The character of the gills above described is such that it seems not unreasonable to regard them as intermediate between the foliobranchiate gills of such a mollusk as *Solemya* and the plicated reticulate gills of a more modern type of bivalves, such as *Lyonsiella* or *Halicardia*. They

are neither typically foliobranchiate nor normally reticulate. Hitherto those who would separate the filibranchs ordinarily from the modern reticulate forms have been obliged to institute an intermediate order, "pseudo lamellibranchs," to receive those pelecypods with a "filibranchiate" organization which persist in developing reticulate gills. The evidence of the ancestry of the filibranchiate types afforded by paleontology is sufficiently weighty to show how artificial is any such arrangement, and how little in accord with the phylogeny of the forms concerned. But while the transition between the filibranchiate and reticulate gills has always been sufficiently obvious, there has been a very marked gap between the foliobranchs and any of the others. This the present type does something to bridge, or, at least, to indicate how it might be and probably was bridged in the past. It adds something also to the testimony for archaicism in the *Anomalodesmacea* which the present writer, in conformity with paleontological evidence, has pointed out.

After the above was written the writer was unexpectedly enabled to examine the gill in two species of *Callocardia*, dredged in the Pacific Ocean by the *Albatross* off the coast of Central America, in about 400 fathoms. Contrary to the known *Cardium*-like type of reticulate gill which characterizes the shallow water *Isocardia* (with which *Callocardia* has hitherto been associated as a subgenus), the ctenidium proves to be even nearer to the typical foliobranch gill (such as that of *Solemya*) than is the gill of *Euciroa*. The single ctenidium in *Callocardia stearnsii*, Dall, is composed of the central stem and two sets of ribbon-like lamellæ, which spring from either side. These lamellæ are thick and fleshy (relatively to their size), and are attached to each other at their proximal ends by the common adhesion to the stem, and at their distal ends by a narrow fibrous strip, which may possibly contain a vascular channel, but did not show any in the present condition of the specimens. There are indications of a lateral band of cilia; at all events, the edges of the lamellæ are distinctly marginate and yet not organically connected. The inner limb of the ctenidium is much the larger, rounded triangular in outline and with a bluntly rounded keel below, the distal portion of the mass of lamellæ being reflected and closely appressed to the direct limb, and reaching upward about two-thirds of the way from the point of reflection to the arterial stem. The outer limb is very much smaller than the inner one, but has the reflected part longer and larger than the direct, so that the dorsal edge of the reflected portion extends toward the middle line of the body over the stem, covering the dorsal edge of the direct part. (See figure 1, A, B.)

The shell of *Callocardia* closes so tightly that the preservative used had penetrated slowly and the specimens are not in a condition to use for sections. It can be positively stated, however, that there are neither fibrous nor vascular connectives between the lamellæ, except as above mentioned, and the chief difference between the ctenidium of *Callocardia* and that of *Solemya* is obviously that the lamellæ are united by

a narrow band distally and reflected in the former, while they are comparatively free and not reflected in the latter. It may be added that the entire ctenidium is solid and fleshy as in *Nucula*, and when lifted separates from the body in a single mass. The two ctenidia are united to the siphonal septum behind the foot, but not to each other, so there is no complete anal chamber. The palps in *Callocardia* are very small, the foot is flattened and solelike below anteriorly and rounded behind. The siphons are complete and papillose, longer than in *Isocardia*, but still short.

The discovery of this type may be said to practically complete the series uniting the foliobranch with the reticulate gill and give the quietus to the classification based solely on the divergencies of the ctenidia.

It can hardly be doubted that the gills of *Euciroa* are represented by the degenerate small gill of *Verticordia acuticostata*, as formerly described by me. It seems possible, as will appear under the next species, that the fleshy septum of the so-called Septibranchia may be partly a modification of such an inwardly-directed lamina of the mantle as in *Euciroa* lies below the visceral mass; and in *Halicardia* has free edges; which in *Euciroa* is merely connective, but in *Halicardia* contains an extension of the nephridia. What part in *Verticordia* the siphonal septum plays remains to be decided by further researches, but it also contributes more or less extensively to the total septum. Geologically the *Verticordiidae* are an ancient group, and the fossil *Pecchiolia* would seem to be very nearly related to *Euciroa*. At all events the latter, in its dorsal heart not pierced by the rectum, its single aorta, and archaic type of gills, adds a very interesting member to the small list of pelecypods of varying affinity, which retain in their organization indisputable traces of archaic origin.

In this connection I was led to examine the following species, also dredged by the *Albatross*, but on the northeastern coast of the United States, a specimen of which recently came into my possession. Owing to its large size the characters of this mollusk are very plain and unmistakable. Hoping to obtain some light on the vexed question of the origin of the fleshy septum of *Verticordia*, I examined it with a good deal of interest, and found, as will be seen, a type of septum which seems wholly distinct from either of those hitherto described. The species referred by its describer to *Mytilimeria* and by the writer to *Verticordia* s. s., must evidently form the type of a new genus.

#### Genus HALICARDIA, Dall.

##### HALICARDIA FLEXUOSA, Verrill and Smith.

Plate XXIII, figs. 1, 3, 5, 6; plate XXIV, fig. 3.

*Mytilimeria flexuosa*, VERRILL and SMITH, Trans. Conn. Acad., v., 567, pl. 58, fig. 38; Am. Journ. Sci., XXII, 1881, p. 302; Trans. Conn. Acad., VI, 1884, p. 258.

*Verticordia flexuosa*, DALL, Blake Pelecypoda, Bull. Mus. Comp. Zool., XII, p. 286, Sept., 1886.

The specimen was dredged east of Georges Bank, in the Gulf of Maine, in 677 fathoms, brown sand; bottom temperature, 39° F., by the



U. S. Fish Commission in 1885. The shell measured 45 mm. wide and high by 39 mm. long. No. 50785, U.S.N.M.

The shell is wide and angular, resembling a large *Hemicardium*, with a granular ashy-white or pale brown granulose surface, showing faint traces of radiating ridges. The hinge is obsolete, an obscure swelling represents the sublunular tooth in the right valve and a still feebler one in the left valve. In *Euciroa* the left portion of the lunule is the most prominent; in *Halicardia* the opposite is the case. The lithodesma is an asymmetrical slender, solid, shelly arch, with the right limb decidedly longer than the left one. The inner margin of the shell is smooth, the valves are a very trifle unequal and shut closely.

To facilitate comparison the characters of the soft parts are given in the same order as under *Euciroa*.

The mantle, in its thickness and consistency, resembles that of *Euciroa*. Its margin is thick and solid, and the inner ridge more distinctly papillose than in *Euciroa*, but not conspicuously so. The lobes of the mantle are first separated in front of the middle of the anterior adductor and continue so, backward, about halfway to the siphon, thus leaving a shorter pedal opening than in *Euciroa*. The thickened mantle-edge frames the perisiphonal area, and its two sides are united above and a little in front of the posterior adductor. In the lobes of the mantle behind the siphon there is nothing corresponding to the muscular areas of *Euciroa*. The siphons recall those of *Poromya*. The excurrent siphon is small, short, surrounded by insignificant granular papillae irregularly distributed sparsely over the perisiphonal surface; a single larger but still very small papilla is visible in the median line above the siphon, and distant half the diameter of the orifice. The edges of the siphon are thin and entire; between it and the incurrent siphon the surface of the perisiphonal area is finely granular and somewhat impressed. The branchial siphon is enormous, its longest diameter externally about one-sixth the total circumference of the mantle. It is surrounded by a single row of long, strong tentacular processes, flattened on their inner faces, rounded and inflated outwardly, and covered with a distinctly granular epithelium. There are fourteen on each side, and one in the median line above, not differing from the rest. Externally these tentacles (as contracted in alcohol) are as long as one-fifth the greatest diameter of the whole siphon, and are of nearly equal size and length. They are surrounded by a cingulum rising from the perisiphonal area elevated and constricted; from within, the wall of the siphon is seen to be formed by parallel cylindrical prominences which continue the tentacula forward to the base of the siphonal tube. The siphonal valve is circular, broad, and with a thin edge finely crenulated. The valve occupies the base of the siphon like a perforated diaphragm, and does not project inward. Above it the siphonal septum is narrow, smooth, and a little produced forward in the median line. There is no special set of muscular fibers inserted upon the valve



for the retraction of the siphons; this is doubtless performed by the contractility of the thick and wide muscular mantle edge. The mantle, owing to its thickness, affords abundant space for blood sinuses, but they are less marked than in *Euciroa*. The pericardium, proportionally, is much smaller than in *Euciroa*, and the ventricle of the heart is reduced to a small, rounded-triangular body, which is perforated by the rectum, gives off an anterior aorta and two unequal lateral auricles, either of which is as large or larger than the heart itself, and the right auricle distinctly larger than the other. The position of the pericardium with respect to the hinge is about the same in both genera. Below and around it, occupying a very large part of the upper portion of the visceral mass, is the ovary, easily discriminated from adjacent structures by its deep purple color. This is due, not to the ovary itself, apparently, but to the presence of the nephridium more or less closely interramified with it. A section of the latter just behind the pericardium shows that it occupies, not only nearly the whole space between the dome of the mantle and the roof of the anal chamber, but extends on each side downward, occupying the lateral walls as well as the roof, and is then produced inward from the mantle as a thick, longitudinally plicate, and variously recurved lamina, forming equally part of the floor of the anal chamber (into which its free edges project) and of the roof of the peri-pedal or branchial chamber. It thus contributes to form about half the septum between the two chambers, and, unless the fleshy septum of the typical *Verticordia* proves on reexamination to be of this character, we have here an example of an unexpected and wholly new element contributing to the building up of that part of the organization. Investigation shows that an analogous but less conspicuous instance may be found in some species of *Ijonsiella*.

Internally the nephridium is irregularly cavernous in its thicker parts, traversed by multitudinous columnar fibers covered with a glandular endothelium. Where the walls of the organ are close together as they are laterally, and in the recurved lamina, the fibers run almost directly from one wall to the other. In the thicker portion they pass radially in every direction. The substance of the ovarian gland is whitish, and from its surface project in various stages of protrusion and pedunculation the growing ova, which are externally smooth and opaque, but in the free ripe ova are covered with a thin, perfectly transparent layer. The nephridia, or organs of Bojanus, carpet much of the peripheral and part of the internal surface with a rich deep purple glandular tissue, giving rise to multitudes of circular, somewhat compressed, calcareous granules, which, by transmitted light, appear of a rich amber color with a strongly marked nucleus. The ova are discharged in large numbers into the anal chamber, where they lie immersed in a transparent glairy mucus, which does not seem to be affected by water. I was unable to find any eggs which showed signs of segmentation. The walls of the laminar portion of the nephridia are double, externally smooth,

and show the marbled whitish and purple coloration of the interior. The purple matter tinges fresh water of a yellowish amber color.

The anterior portion of the foot resembles that of *Euciroa*, and it shows a small byssal groove, from which an extremely slender byssal thread or two proceeds, and was observed by Verrill. But behind the byssal groove, on the median line of the visceral mass, is produced a thin, compressed, fin-like body, which I propose to name the opisthopodium, and which in life may be nearly flat vertically, but in alcohol is so contracted as to cockle the distal margin, giving the organ a peculiar aspect, entirely unlike that of any pelecypod foot I have ever examined, and strikingly like a fin. Something analogous was described by Owen in *Pholadomya*. The retractors of the foot are double on each side for more than half their length. The attachment is behind and somewhat separated from the anterior adductor in the case of the protractors, while the retractor scar touches the upper angle of the posterior adductor.

On separating the mantle lobes and examining the roof of the peripodal cavity we observe a large visceral cone of oblong section, at the anterior lower extremity of which is the functional foot, while behind the latter is the fin-like expansion I have already referred to. Closely embracing the base of the pedo-visceral cone, and extending forward to the mantle at the sides of the mouth, partly covered by the free edges of the palpi, and backward to the siphonal septum, are the ctenidia. These are the morphological equivalents of a single gill stem on each side, with lateral expansions; on the one hand closely appressed to the side of the foot, on the other to the lower face of the longitudinally plicate inwardly extended nephridial lamina. The stem containing the main venous trunk is not perceptible from below, except under magnification, when a parting between the surface crenulations of each lateral portion is visible, but very inconspicuous. The whole of the gill except the stem is of extreme thinness, like a canopy of lace, and the portions on each side of the stem are full and irregularly pendulous. There is no vertical gill lamina, but the canopy, between its attached edges, bulges downward in an irregular longitudinal prominence, as if not drawn sufficiently taut. By careful scrutiny on the prominence corresponding to the inner lamina a very slender longitudinal raphe may be detected, probably corresponding to the morphologically lower edge of the inner reflected lamina of the gill in normal ctenidia. On the outer prominence corresponding to the outer lamina there is no raphe. The lower or respiratory surface of the gill resembles in miniature that of the so called Turkish bath towel, the transverse lamellæ being disposed in rather regular zigzag, extremely minute, elevated bands, frequently interrupted, but often continuous across the whole lamina. The edge next the foot is defended by a narrow membranous margin, which is firmly attached to the median line of the foot behind, but only closely appressed elsewhere. The stem of each gill curves round behind the foot about midway of the ctenidial surface, and the two are joined in

the median line, recurving to the point of attachment to the foot, thus showing that the gill, if normal, would not be attached (as in so many cases it is) to the siphonal septum, but to the foot. The structure of the gill comprises large lateral branches, given out from the sides of the stem at intervals (which grow smaller posteriorly); below these are close-set smaller longitudinal tubes extending from one end to the other, below which again is a reticulate surface of cellular epithelium, from which are given out the very narrow, zigzag, transverse lamelle already referred to, hardly projecting from the epithelial carpet. The portions corresponding to the outer lamina of each gill are more bellied downward than the inner lamina, but both are otherwise alike in tenuity and structure, except for the presence of the raphe on the inner one.

The oral palpi are thin, muscular, and smooth, except for wrinkles radially directed toward the periphery from the mouth, but the surface is not regularly striated. The palps are continuous in the median line above and below and adnate to the surface of the mantle except at the extreme edge above and partially to the front edge of the visceral mass below. The absence of the regular channels on the gills and of striations on the palps leads to the inference that the ciliary action of the gill surface plays a smaller part in the collection of food in this form than in ordinary pelecypods. There is nothing corresponding to the peculiar bifid lappet noted in *Euciroa*.

Serial stained sections of a part of this specimen, including the outer limb and stem of the left ctenidium, the free, infolded lamina, and part of the mantle lobe above and below the point from which the lamina is given off inwardly, show that, in staining, the connective and glandular tissue of the mantle and nephridium contract out of all proportion to the denser tissues of the gill, foot, muscles, etc. The delicate columnar fibers transverse to the lumen of the nephridium are almost wholly lost, ruptured, or distorted out of recognition. By way of compensation, however, the sections showed conclusively that the free lamina, though connected with the outer edge of the gill, is absolutely distinct from it organically, and is continuous with and an undivided part of the tissues of the mantle lobe from which it springs. The ramification of the nephridium, which extends between the walls of the mantle and out into the lamina, does not extend ventrally between the mantle walls below the point where the lamina arises. The space below this point, between the walls of the mantle, is filled with connective tissue. The nephridial concretions, which are abundant in the recesses of the gland, are apparently of two sorts. One, which was noticed before the sections were made, is translucent, pale, or brownish and stains feebly. The other sort in the fresh animal has a more purple color, is more deeply embedded in the glandular epithelium, and, in the sections, stains black. The presence of free ova in the cavities of the nephridium I am unable to account for, but is unde-

niable. None of them seems to have undergone segmentation. The orifices of the genital glands are situated on the surface of the visceral mass, close to but not coalescent with each other, a pair on each side symmetrically above the opisthopodium. A large number of ova existed in the suprabranchial chamber, embedded in a large mass of transparent jelly, the office of which may be surmised to be their retention in the chamber during the ejection of water from the anal siphon. The ovary is distributed rather superficially anterior to and outside of the nephridial mass. The ova are spherical, covered with a transparent layer of epithelium distinctly pedunculated at the point where it separates from the ovary, but which is soon lost. The eggs are relatively large and perfectly visible to the naked eye. In the specimen the contents had been hardened and whitened by the alcohol, but showed no indications of segmentation. The jelly-like mass in which they were embedded after leaving the ovary was very posterior, gathered in and over the folds of the mantle lamina, chiefly on each side of the opening of the anal siphon, and not at all over the dorsal surface of the gills. Some of the jelly was taken out and put in a receptacle full of water, where strong currents of water directed upon it with a small syringe failed to dislodge the ova. This explains how, in species which incubate the eggs in the anal chamber, they may be retained there when the water in the chamber is expelled, a matter which otherwise would be something of a puzzle.

The differences between this genus and *Euciroa* and *Verticordia* are sufficiently conspicuous. No doubt the relation is more close with *Lyonsiella*. If the thick fleshy imperforate septum of *Verticordia* is in any way homologous with the reflected nephridial lamina of *Halicardia*, the relationship might be regarded as quite close. But the impression derived from the dissection of *Verticordia acuticostata* was that the septum there is an extension of the siphonal septum. I have endeavored without success hitherto to obtain another specimen of *Verticordia acuticostata* for the purpose of making microtomic sections which would probably settle the question. The most important result of these comparisons at present is the light it throws on the mutability of the breathing organs within relatively narrow systematic limits. No one who has studied many of the recent and fossil *Verticordiidae* can doubt that the three genera above mentioned are related, and descended from the same ancestral stock. Yet we find in one an archaic lamellar gill, in the second, a fleshy septum and a degenerate adnate gill, and in the third a gill which, morphologically, is homologous with the gill of *Anatinacea*, but here is specialized in a way to which no parallel is yet known, and with a septum partly made up of a reflected nephridial lamina. Is the result of the presentation of these facts to be the creation of three alleged "orders," or the recognition of the mutability of an organ which never should have been used as a sole basis for the higher systematic divisions? I believe the latter to



be the true answer, whatever the morphological equivalents of the septum may prove to be in any given case. The proposed order "*Sep-tibranchia*" seems to me founded merely on extreme specialization of organs which may be expected to vary almost infinitely and of which the intermediate and connecting stages will probably be found fully exemplified in the various genera of *Anatinacea* when exhaustively investigated. Toward that desirable state of our knowledge the preceding notes will contribute data of importance.

Genus LYONSIELLA, Sars.

LYONSIELLA ALASKANA, new species.

Plate xxv, fig. 2.

Shell thin, large for the genus, inequilateral, the anterior end shorter and more vertical, the posterior end more rounded; covered with a pale, yellow, silky epidermis considerably infolded around the margins of the valves; sculpture of fine, distant, radiating, elevated threads about half a millimeter apart near the margin; the interspaces crossed by silky lines of growth which are occasionally emphasized as if at resting stages of growth; interior faintly pearly; hinge line edentulous, with a large lithodesma shaped like a flattened shell of *Vaginella*, with a deep sinus in the wider (posterior) end; beaks moderately prominent, much incurved; lunule larger on the right valve, small, heart-shaped, polished; a narrow polished strip on the posterior dorsal edge of the valves may represent an escutcheon. Length of shell, 24; height, 24; diameter, 16 mm.

Station 2859, in 1,569 fathoms green ooze, southwest from Sitka in the Gulf of Alaska; bottom temperature, 34.9° F. No. 123500, U.S.N.M.

This species closely resembles externally *L. radiata*, Dall,\* from the Straits of Magellan, but is larger, with the anterior end more vertically truncate, the posterior end and base more evenly rounded, and the beaks more central and inflated.

For the purpose of comparison with *Halicardia* the soft parts of this species were examined. In a general way the arrangement of the parts is not unlike that in *L. papyracea*, Smith, as figured in the *Challenger* report (Anatomy of mollusks, pl. II, fig. 8). The anal siphon is short and smooth edged, with a somewhat granular exterior; the branchial siphon is surrounded by a single row of large tentacular papillæ, each tentacle being subtriangular, with a projecting barb-like point at each side near the base of insertion, the whole surface distinctly villous and slightly compressed in the same plane as the valves; there are ten of these papillæ on each side, diminishing in size anteriorly, with a small one in the median line in front; these and the anal siphon are surrounded by an area of nearly bare membrane (which I call the perisiphonal area) extending to the mantle margin; behind the anal siphon

\*Proc. U. S. Nat. Mus., XII, p. 276, pl. VIII, fig. 7, 1889.

on this area are three large conical papillæ, the largest and uppermost standing in the median line. The outer mantle margin is thin and smooth edged, covered in the natural state by a wide infold of the epidermis. The secreting margin of the mantle is thickened with a single row of conical short papillæ just within the edge; behind about every fifth, and in front about every eighth papilla is distinctly larger than the average, and a little more set back from the edge. The pedal opening is short and anterior. The foot, as in the *L. papyracea*, is relatively large, glandiform, and byssiferous. The inner opening of the branchial siphon is furnished with a circular smooth membranous valve. The mouth is very large and funicular, the opening radiately striate; the anterior palpi are indistinguishably merged with the membrane above them, and their outlines can not be traced; the posterior pair are adnate, short, wide, and apron-like, not separated by a median sinus below. From under them start the gills, which are attached by their outer margins to an infolded nephridial lamina, as in *Halicardia*; their inner margins are bordered by a rather wide smooth membrane, with crenulated edge, which appears to be attached in each case to that of the opposite gill behind the foot, but the attachment is so delicate as to rupture at the slightest strain, so that it leaves a doubt as to whether the junction all along the line is complete or not. Above the opposite border is a narrow recurved free membrane corresponding to the ascending limb of an ordinary gill, but which has no lamellæ, and is perfectly smooth. The main arterial stem of each gill extends to the siphonal septum to which both are anchored, not, as in *Halicardia*, being recurved to join each other midway between the keel of the foot and the siphonal septum. The inner edges of the gills at their commissure behind the foot are united firmly to the foot as in *Halicardia*. The heart is small, with insignificant auricles, and the ventricle is pierced by the rectum, which is large. The ovary, as in *Halicardia*, is enormous, of a yellowish color, crammed with ova, which are discharged in a glairy mucus which accumulates in the anal chamber. The structure of the gills recalls that of *Halicardia*, but they are thicker, with fewer and more projecting lamellæ, more or less zigzag in their course. Above it is seen that the longitudinal elements of the reticulum predominate over the transverse branches, the contrary being the case in *Halicardia*. The infolded lamina of the mantle in this species is longitudinally folded, and has a free edge, and subcylindric posterior free end almost exactly as in *Halicardia*. All parts of it are irregularly cavernous and filled with lobes of the ovarian gland bearing ova in all stages, which appear to be discharged into the anal chamber by a passage opening near the median line on each side of the visceral mass behind close to the nephridial orifice.

In Pelseneer's account of the various species of *Lyonsiella*, described in the *Challenger* report, no such free lamina of the mantle is described, and the gills are represented distinctly, both in text and figures, as

attached to the mantle in the ordinary way. It is hardly credible that he could have overlooked so prominent a feature, but there is nothing resembling it described by him. He figures an oval glandular spot on the mantle, of which he says, "There is on the mantle a glandular swelling comparable in its position to the hypobranchial gland of gastropods." But this statement in no way expresses the condition or relation of the parts in the present species, or in *Halicardia*, and hence we must suppose, if reliance is to be placed on Pelseneer's account, that the species he examined differs from *L. alaskana* and *Halicardia* in wanting the free lamina to which in these species the outer edges of the gills are attached, and in having the gills attached directly to the mantle.

The lithodesma of the very young *Halicardia* is shown by a specimen in the National Museum to be shaped like that of *L. alaskana* and *L. papyracea*, but in the adult *Halicardia* it has assumed a totally different form. The character of the branchial siphon, pedal opening, lithodesma, and details of the shell are sufficient to separate *Halicardia* from the *Lyonsiella* of the type of *L. alaskana* and, if we accept Pelseneer's account, the latter can not be united with *L. abyssicola*, Sars, which is the type of the genus *Lyonsiella*, but must be separated to form a separate group, which might be placed as a subgenus under *Halicardia*. But I must confess to doubts as to Pelseneer's accuracy, in this particular,\* sufficiently strong to make me feel it inadvisable (until his account is confirmed by new evidence) to name and separate the species allied to *L. alaskana*. In case they prove to agree with *L. abyssicola*, *Halicardia* will have to take its place as a subgenus under *Lyonsiella* as the older name.

Genus PECTUNCULUS, Lamarck.

PECTUNCULUS ARCODENTIENS, new species.

Plate XXVI, fig. 6.

Shell small, rather inflated, thin, high, and sculptured with about sixteen rounded, prominent ribs, with very narrow interspaces crossed by fine elevated threads; area small, wide, subtriangular; hinge line narrow, evenly arched with about eight teeth on each side of the beaks; basal margin narrow, indented by the sculpture, with obscure interlocking dentations on the inner face opposite the interspaces between the ribs; adductor scars distinct, on a slight raised area extending into the umbonal cavity. Height of shell, 21.5; breadth, 20; diameter, 13 mm.

Station 3472, in 295 fathoms. No. 107014, U.S.N.M.

Although the single valve obtained is dead and has lost its color, and the surface is somewhat eroded, yet its characters will not permit us to refer it to any described species. None of the coarsely ribbed species combine transverse reticulation with so thin and rounded a shell, and it is quite peculiar in the evenly-rounded arch of its hinge plate.

\* Pelseneer has since admitted the incorrectness of his first account of the attachments of the gill in *Lyonsiella*. Compare Arch. de Biol. xi, 1891, p. 215, foot note 5.

The species nearest allied to this is probably *P. gealei* Angas, from Australia, but it has more numerous ribs and differs otherwise.

This concludes the series of Hawaiian mollusks, the following species being chiefly from the northwest coast, especially from the great plateau of Bering Sea, which is remarkable for having, at comparatively moderate depths, a fauna which seems entirely distinct from that of the shores, and yet is not an abyssal fauna, properly speaking. Members of this fauna, as will be observed in the notes on distribution, often reach a remarkable distance to the southward in water of the temperature normal to them, and, in fact, there are one or two species which may prove to extend from Bering Sea to Cape Horn when sufficiently full explorations are completed.

#### NORTHWEST AMERICAN SPECIES.

These were mostly described in the Proceedings of the United States National Museum, XIV, pp. 186-190, July, 1891, and are now figured with a few additional notes. Some errors in the details of habitat as given in the original are here corrected, and a few new species are added to the list.

Genus BUCCINUM, Linnaeus.

#### BUCCINUM STRIGILLATUM, Dall.

Plate xxvii, fig. 9.

*Buccinum strigillatum*, DALL, Proc. U. S. Nat. Mus., XIV, 1891, p. 186.

Station 3076, off Tahwit Head, State of Washington, in 178 fathoms; temperature at bottom, 43.4° F.; and south to station 3170, off Bodega Head, California, in 167 fathoms, muddy bottom. No. 122550, U.S.N.M. Other specimens were dredged off Guadelupe Island, Lower California.

#### BUCCINUM ALEUTICUM, new species.

Plate xxvii, fig. 7.

Station 3219, south of Unimak Island, Aleutians, in 59 fathoms, sand; bottom temperature, 38° F. No. 122591, U.S.N.M.

Shell thin, six whorled, covered by a thin sparsely pilose, dehiscent epidermis; of a livid pinkish color with a white pillar and margin to the outer lip and a dark chestnut nucleus; sculpture of extremely fine, regular, close-set grooves, with equal or wider interspaces, regularly spaced on the last, but tending to pair on the earlier whorls; spire short, rather pointed; whorls full; suture deep, but not channeled; aperture moderate; pillar with a white callous ridge incurved upon it; siphonal fasciole distinct, bounded by a groove behind; outer lip slightly thickened, hardly reflected; throat livid brown; operculum small, subcircular with a subcentral nucleus and fan-shaped scar of attachment. Length of shell, 35; maximum diameter, 21 mm.

The very fine, even striation recalls that of *B. tenue* Gray, but the form is more like *B. cyaneum*.



## BUCCINUM OVULUM, new species.

Plate xxx, fig. 6.

Station 3491, near Anukhta Pass, Aleutians, in 248 fathoms, sand. No. 106997, U.S.N.M.

Shell small, thin, of about four and a half or five whorls; surface smooth, or with faint irregular spiral threads mostly obsolete; covered with a vernicose adherent olive-green epidermis; substance of the shell livid pinkish purple, with a white margin to the pillar and aperture; last whorl much the largest; suture deep but not channeled; nucleus eroded in all the specimens; pillar nearly straight, thin, with a deep, very short, hardly recurved canal; body sometimes with a thin wash of yellowish callus; operculum small, nearly circular, the nucleus subcentral, surface of attachment fanshaped, reflected by a depression in the concave outer surface. Length of shell, 25; maximum diameter, 20 mm.

This interesting and elegant species recalls *Volutharpa*, but seems more nearly related to the preceding species.

Subgenus SULCOSINUS, Dall.

Shell thin, with a deeply channeled suture, strongly reflected lip, and thick parietal callous deposit. Type *Buccinum taphrium*, Dall.

## BUCCINUM (SULCOSINUS) TAPHRIUM, Dall.

Plate xxix, fig. 6.

*Buccinum taphrium*, DALL, Proc. U. S. Nat. Mus., xiv, 1891, p. 186.

Station 3330, in Bering Sea north of Unalaska, in 351 fathoms, muddy bottom; temperature 37.8° F. No. 122548, U.S.N.M.

In the absence of the operculum and soft parts this remarkable shell can be only provisionally classified. It appears buccinoid, but differs from all true *Buccinum* by its channeled suture and prominent body callus. It may prove to be a wholly distinct genus, but for the present it seems best to refer it to *Buccinum* as a subgenus. Only a single specimen is known.

Genus CHRYSODOMUS, Swainson.

CHRYSODOMUS INSULARIS, new species.

Plate xxix, fig. 3.

Station 3489, in Bering Sea near the Pribilof Islands, in 184 fathoms, muddy bottom; temperature 38.5° F. No. 107000, U.S.N.M.

Shell large, solid, rather thin, with about six whorls exclusive of the (decollate) nucleus; whorls full, rounded, slightly excavated in front of the appressed suture; sculpture of, on the last whorl, three sizes of flattish rounded threads, alternating regularly in size, but on the upper whorls of only two alternated sizes separated only by shallow grooves; transverse sculpture of moderately prominent incremental lines; aperture ample, the pillar lip blotched with livid pink

and white, the pillar twisted, with a solid white inner edge and strong siphonal fasciole; canal moderate, slightly recurved; outer lip slightly crenulated by the sculpture, sharp, very slightly expanded; throat smooth, pinkish; epidermis very thin and translucent, closely adherent to the surface; operculum normal, light brown. Length of shell (decolate), 100; of last whorl, 80; maximum diameter, 56 mm.

This fine shell belongs to the typical group like *C. fornicatus* and *Clivatus*, but by its compact, even, and uniformly constant sculpture and details of form, seems sufficiently distinct. No male specimens were obtained, but the characters observed in the soft parts were normal.

CHRYSODOMUS PERISCELIDUS, Dall.

Plate XXVII, fig. 6.

*Chrysodomus perisclidus*, DALL, Proc. U. S. Nat. Mus., XIV, 1891, p. 187.

Station 2842, off the coast of Akutan Island, Aleutians, in the Pacific, in 72 fathoms pebbly bottom; temperature 41° F. No. 122643, U.S.N.M.

CHRYSODOMUS PHENICEUS, Dall.

Plate XXIX, fig. 1.

*Chrysodomus phæniceus*, DALL, *op. cit.*, p. 187, 1891.

Station 2862, off the British Columbian coast, in latitude 50° 49' north, in 238 fathoms, sand; bottom temperature, 44.7° F. No. 122657, U.S.N.M.

CHRYSODOMUS ITHIUS, Dall.

Plate XXIX, fig. 4.

*Chrysodomus ithius*, DALL, *op. cit.*, p. 188, 1891.

Station 3202, off Santa Cruz, Cal., in 382 fathoms, mud; temperature 41.1° F. No. 122649, U.S.N.M.

CHRYSODOMUS (SIPHO) HYPOLISPUS, Dall.

Plate XXVII, fig. 1.

*Chrysodomus (Sipho) hypolispus*, DALL, *op. cit.*, p. 188, 1891.

Station 3254, in Bering Sea, north of Unimak Island, Aleutians, in 46 fathoms, mud; bottom temperature 36.2° F. No. 122606, U.S.N.M.

CHRYSODOMUS (SIPHO) ACOSMIUS, Dall.

Plate XXVII, fig. 3.

*Chrysodomus (Sipho) acosmius*, DALL, *op. cit.*, p. 188, 1891.

Station 3329, in Bering Sea north of Unalaska, Aleutians, in 399 fathoms, sand; bottom temperature 37.7° F. No. 122635, U.S.N.M.

CHRYSODOMUS (SIPHO) HALIBRECTUS, Dall.

Plate XXIX, fig. 9.

*Chrysodomus (Sipho) halibrectus*, DALL, *op. cit.*, p. 188, 1891.

Station 3330, in Bering Sea, north of the island of Akutan, in 351 fathoms, muddy bottom; temperature 37.8° F. No. 122603, U.S.N.M.

## Subgenus ANCISTROLEPIS, D a 11.

Shell buccinoid, with a short twisted canal; operculum straight, claw-shaped, concave, with apical nucleus; penis on a stout stalk with the distal extremity enlarged, foot-shaped, solid, without curved or attenuated point; dentition like *Chrysodomus*; laterals with a larger outer and two smaller inner curved cusps; median with three rather long, slender, subequal cusps, the anterior edge of the base concavely sinuate; the radula disproportionately small. Type *Chrysodomus eucosmius*, Dall.

This group differs from *Chrysodomus* in its shorter canal, peculiar operculum, and degenerate radula; from *Liomesus* and *Beringius* in its cuspidate rhachidian tooth and narrow claw-like operculum. It seems a characteristic Aleutian type.

## CHRYSODOMUS (ANCISTROLEPIS) EUCOSMIUS, D a 11.

Plate XXIX, fig. 7.

*Chrysodomus eucosmius*, DALL., Proc. U. S. Nat. Mus., XIV, p. 187, 1891.

Station 2919, near Cortes Bank, California, in 984 fathoms, mud; bottom temperature 38° F.; stations 3227 and 3502 north of Unalaska in Bering Sea, in 225 and 368 fathoms, muddy bottom; temperature 38.6° F., and in several other localities on the Alaskan coast, in 60 to 350 fathoms, and off the coast of Oregon and California; south to station 2923, off San Diego, Cal., in 822 fathoms. No. 122670, U.S.N.M.

The figured type is only 33 mm. in length, but specimens less well preserved reach over 50 mm. The area by which the operculum is attached to the body, as in *Strombus*, is quite small and the point of the operculum stands off from the body.

## CHRYSODOMUS (ANCISTROLEPIS) MAGNUS, new species.

Plate XXIX, fig. 5.

Station 3254, in Bering Sea north of Unimak, in 46 fathoms, sand; and station 3255, near by, in 43 fathoms, sand; bottom temperature 37° F. Nos. 122674 and 122675, U.S.N.M. Also near the Pribilof Islands, in 59 fathoms; temperature 35° F.

Shell rather thin, with six whorls, covered by a thick pilose epidermis; whorls flattened or channeled near the suture and with a single strong keel at the shoulder, the surface covered with fine spiral threads crossed by rather prominent lines of growth; pillar short, normally much twisted and the coil pervious for one whorl, but some specimens attacked by annelids have it nearly buccinoid; aperture ample, the body with more or less callus laid over it, the outer lip not reflected; siphonal fasciole rather indistinct; operculum solid, black, rather short, concave, its outline like that of a half-shut fan. Height of shell, 75; maximum diameter, 50; length of aperture, 47 mm. Another specimen is 90 mm. in total length.

The substantial accordance of a second species in those characters which seemed to differentiate the first from *Chrysodomus* proper, decided me to institute the subgenus for them. The nucleus is more or less worn in all the specimens, but seems to be globular, regular yet swollen, and flattened at the summit.

STROMBELLA MELONIS, D a 11.

Plate XXVIII, figs. 2, 3.

*Strombella melonis*, DALL, Proc. U. S. Nat. Mus., XIV, p. 187, 1891.

Station 3227, in Bering Sea north of Unalaska, in 225 fathoms, mud; bottom temperature 38.6° F. No. 122714, U.S.N.M. Also in 46 fathoms.

For those who reject the name *Strombella* the species here referred to it will, of course, be placed in the genus *Volutopsius*, Mörch.

STROMBELLA FRAGILIS, D a 11.

Plate XXVIII, fig. 4.

*Strombella fragilis*, DALL, *op. cit.*, p. 187, 1891.

Station 3252, in Bering Sea north of the Aleutians, in 29½ fathoms, muddy bottom; temperature 44.8° F. No. 122710, U.S.N.M.

This species has since been received from stations 3251, 3253, 3254, and 3300, all in the eastern part of Bering Sea, in 15 to 50 fathoms, muddy bottom. It is very variable in its irregularities of plication and contour, but preserves a tolerably constant general aspect.

STROMBELLA MIDDENDORFFII, D a 11.

Plate XXVIII, fig. 1.

*Strombella middendorffii*, DALL, *op. cit.* p. 186, 1891.

Station 3253, in Bering Sea north of the eastern Aleutians, in 36 fathoms near the Pribilof Islands; bottom temperature 35° F.; also on the south side of the Aleutians in the Pacific south of Unimak Island, in 61 fathoms, sand. No. 122709, U.S.N.M. This species is probably that which Middendorff referred to under the name of *Tritonium norvegicum*, to which the present shell bears a superficial resemblance.

Genus BERINGIUS, D a 11.

*Beringius*, DALL, Sci. Res. Expl. Alaska, 1879, pl. II, legend. Proc. U. S. Nat. Mus. 1886, p. 304.

*Jumala*, FRIELE, Norwegian N. Atl. Exp. I, p. 6, 1882 (Type *J. Turtoni* Bean); Ann. N. Hist., Nov. 1893, p. 352, *olim*.

*Ukko*, FRIELE, in Norman, Ann. N. Hist., ser. 6, XII, p. 352, Nov. 1893.

The name *Beringius* was used by me in 1879 for the *Strombella* with edentulous rhachidian tooth, my type being *Chrysodomus crebricostatus*, Dall (1877). It was not defined until 1886, while in 1882 Friele applied and properly defined his name *Jumala*. In 1893, finding that *Jumala* is the word used by the Christian Lapps to designate the Deity, at Dr.



Norman's suggestion the name was withdrawn and *Ukko* proposed in its place. But, as I fully defined my genus *Beringius* in 1886, if *Jumala* for any reason fails, *Beringius* is prior to any subsequent name, and I therefore adopt it. It seems that when Herr Friele used the name *Jumala* he was under the impression that it was applied solely to one of their ancient pagan deities by the Lapps.

The following species probably belong to the genus *Beringius*, but I have not yet been able to examine the dentition.

BERINGIUS FRIELEI, new species.

Plate XXVII, fig. 8.

Station 3497, in Bering Sea near the Pribilof Islands, in 86 fathoms; temperature 38.7° F. No. 106988, U.S.N.M.

Shell resembling *B. Turtoni* in size, but with a more regularly tapered spire and deeper suture; the epidermis of a redder brown and not polished; very adherent; the sculpture is of close-set pairs of flattened spiral threads, each pair separated by a sharp channeled groove, as wide as a thread, from the next pair, and a very narrow but sharp groove between the two threads composing the pair; transverse sculpture only of fine incremental lines; nucleus lost; aperture snow white within; not lirate, though the external sculpture is reflected slightly close to the edge of the outer lip, which is slightly expanded; canal very short and wide; whorls six and one-half without the nucleus; operculum normal, very large, closing the aperture. Length of shell, 124; whorl, 80; maximum diameter, 55 mm.

This splendid shell differs from *Tritonium schantaricum*, Middendorff in being larger, in its paired sculpture and nonlirate throat. I suspect *T. schantaricum* belongs rather to the group of *Sipho spitzbergensis* than to *Beringius*. It is named in honor of Mr. Herman Friele, of Bergen, Norway.

BERINGIUS ALEUTICUS, new species.

Plate XXIX, fig. 2.

Station 3481, near Amukhta Pass, Aleutian Islands, in 248 fathoms, sandy bottom. No. 106999, U.S.N.M.

Shell of about five whorls (the nucleus is lost), solid, heavy, smooth, except for faint incremental lines and occasional obscure spiral streaks; whorls rounded, covered with a yellow-brown epidermis above the suture; the part anterior to the sutural line on the last whorl is marked by paler, opaque straw color; suture deep, not channeled; the pillar heavy, white, short; the siphonal fasciole, if any, removed by erosion; canal hardly differentiated from the aperture; pillar lip white, callous; outer lips smooth, simple, slightly expanded; length of (decollate) shell, 65; of last whorl, 48; maximum diameter, 36 mm. The operculum rather narrow, normal, and yellowish amber color.

This splendid species may prove not to be a *Beringius*, but I have not had an opportunity to examine the dentition, and it seems conchologically more like that genus than like *Sipho*.

MOHNI A FRIELEI, D a 11.

Plate XXIX, fig. 8.

*Mohnia Frielei*, DALL, Proc. U. S. Nat. Mus., XIV, p. 186, 1891.

Station 2860, in the North Pacific off Queen Charlotte Sound, British Columbia, in 876 fathoms, green mud; bottom temperature 36.5° F. No. 122656, U.S.N.M.

This is the second species of Friele's interesting genus.

TROPHON (BOREOTROPHON) DISPARILIS, D a 11.

Plate XXVII, fig. 4.

*Trophon (Boreotrophon) disparilis*, DALL, *op. cit.*, p. 189, 1891.

Station 3048, in the Pacific off Gray's Harbor, Washington, in 52 fathoms; bottom temperature 41° F. No. 122559, U.S.N.M.

This species has also been dredged in the Aleutian region; off San Diego, Cal.; at station 3431, in the Gulf of California off Mazatlan, in 995 fathoms, mud, bottom temperature 37° F.; and station 3392, in the Gulf of Panama, in 1,270 fathoms, hard bottom, temperature 36.4° F. (Nos. 123021-2, U.S.N.M.) This very remarkable range of distribution is explained by the temperature and the absence of any marked ridges in the sea bottom which might serve as barriers to southward migration. I see no reason why it might not be found all the way south to Cape Horn in water of the proper temperature.

TROPHON (BOREOTROPHON) SCITULUS, D a 11.

Plate XXVII, fig. 5.

*Trophon (Boreotrophon) scitulus*, DALL, *op. cit.*, p. 188, 1891.

Station 3227, in Bering Sea north of the eastern Aleutians, in 225 fathoms, green mud; bottom temperature 38.6° F. No. 122557, U.S. N.M.

PUNCTURELLA MAJOR, D a 11.

Plate XXVI, fig. 4.

*Puncturella (galeata)*, GOULD, var. ? *major*, DALL, *op. cit.*, p. 189, 1891.

Station 3262, in Bering Sea north of Akutan Island, in 43 fathoms, sand; temperature 41° F. No. 122543, U.S.N.M.

SOLEMYA JOHNSONI, D a 11.

Plate XXV, fig. 1.

*Solemya Johnsoni*, DALL, *op. cit.*, p. 189, 1891.

Stations 3399, on the coast of Ecuador, in 1,740 fathoms; 2799, 3360, 3381, and 3382, in the Gulf of Panama, in 1,672-1,793 fathoms; 3010 and 3434, in the Gulf of California, in 1,000-1,588 fathoms, the temperature in all cases ranging between 35.8° and 36.4° F. No. 106886, U.S.N.M.

This species has since been dredged in the deep water of the Pacific as far north as the Straits of Fuca. It is named in honor of Prof. O. B. Johnson, of Washington University, Seattle, Wash.

CRYPTODON BISECTUS, Dall.

Plate XXVI, figs. 2, 5.

*Cryptodon bisectus*, DALL, Proc. U. S. Nat. Mus., XIV, p. 189, 1891.

*Venus bisecta*, CONRAD, Geol. U. S. Expl. Exp., p. 724, pl. 17, fig. 10, 1850.

*Thyatira? bisecta*, MEEK, S. T. checklist Mio. fos., p. 8, 1864.

*Conchocele disjuncta*, GABB, Pal. Cal. II, p. 27, pl. 7, fig. 48, 1869.

Station 2855, in the Pacific off the south coast of Alaska Peninsula, in 69 fathoms, mud; temperature 44° F; also in Puget Sound in deep water, Prof. O. B. Johnson; and in the Miocene and Pliocene beds of Oregon and California. No. 122556, U.S.N.M.

CALYPTOGENA PACIFICA, Dall.

Plate XXV, figs. 4, 5.

*Calyptogena pacifica*, DALL, *op. cit.*, p. 190, 1891.

Station 3077, in Clarence Strait, Alaska, in 322 fathoms, mud; bottom temperature 42.4° F. 122549, U.S.N.M.

This shell is also found in the Tertiaries of California.

LIMOPSIS VAGINATUS, Dall.

Plate XXV, figs. 3, 6, 7.

*Limopsis vaginatus*, DALL, *op. cit.*, p. 190, 1891.

Station 3330, in Bering Sea north of the eastern Aleutians, in 351 fathoms, sand; temperature 38.2° F. Also in the Pacific south of Unimak Island, in 1865, at a depth of 80 fathoms, by W. H. Dall. No. 122547, U.S.N.M.

A rather eroded valve retaining the epidermis of this extraordinary shell was obtained with a sounding cup by me in Alaska about thirty years ago. The hinge being destroyed, I felt so much doubt as to its true character that it was left undescribed, and only when the fresh specimens of the *Albatross* were obtained was it possible to identify the earlier find.

Class BRACHIOPODA.

With the species obtained at the Hawaiian Islands I have included a few dredged by the *Albatross* elsewhere in the Pacific to avoid scattering data on this very interesting group.

Family RHYNCHONELLIDÆ.

Genus FRIELEIA, Dall.

Shell resembling *Hemithyris*, Orbigny, from which it is distinguished by having the inner upper margins of the crura extended toward each

other and united to the upper edge of a rather prominent median septum, forming a spondylium, and in having the brachia consisting of a much smaller number of coils. Type *Frieleia halli*, Dall.

FRIELEIA HALLI, new species.

Plate XXIV, figs. 6, 9, 10, 11, 12, 13.

Shell of moderate size, thin, translucent, yellowish gray, dorso-ventrally somewhat compressed, slightly impressed in the median line below, but the basal margin hardly, if at all, flexuous; surface smooth, polished, except for faint, irregular radial markings and delicate incremental lines, occasionally modified by accidents of growth; pedicle valve pointed above, rounded at the lower corners, with a sharp, short beak slightly recurved, below which is a nearly circular peduncular orifice, bounded below by two well-marked subtriangular deltidial plates, which do not quite meet in the median line; cardinal margin below them evenly arched and passing without an angle into the lateral margins of the valve, which for some distance are almost straight; the margins then round evenly into the base, which in many specimens is nearly straight, in others slightly excavated mesially; the whole of the margins are nearly in one vertical plane; teeth much as in *Hemithyris psittacea*, short, stout, projecting at right angles to the plane of the valve margins, and slightly recurved, below supported by slender buttresses, which rise from the valve and extend upward into the cavity of the beak, leaving narrow recesses between the buttress and the side of the valve; in the interior of the beak there is no mesial septum, and the thinness and translucency of the polished valve are such that hardly any trace of muscular impressions is left on the shell; these impressions, if visible, would extend only three-fourteenths of the distance from the cardinal margin toward the base of the valve, while in *H. psittacea* the proportion is about eight twenty-firsts; the interior of the valve under moderate magnification shows with great clearness the reticulated outlines of the prisms of shelly matter forming the internal layer of the shell, but there are no other internal markings; brachial valve hardly less inflated than the other, roundly pointed above, with a well-defined, slender, sharp-edged medial septum extending six-fifteenths of the distance from the cardinal apex toward the base; teeth long, diverging at an angle of about  $120^{\circ}$ , obliquely transversely striated, the sockets behind them deep, internally transversely grooved; lamella supporting the teeth deep seated, extending obliquely from the sides of the valve; crura starting from the cardinal margin at the inner ends of the teeth, extending in a straight line obliquely downward and forward, united to the teeth for about half the whole length by an excavated lamina; the free ends of the crura slightly wedge shaped, parallel sided, and abruptly truncate at the ends. From the upper part of the inner edges of the crura on each side an excavated lamina is given off, which



reaches the median line above the septum, to which and to each other the laminae are solidly attached, forming a narrow spondylium. The front edge of the spondylium is indented mesially and there is an impressed mesial line extending upward, on each side of which, in old specimens, the laminae are made prominent by a callous deposit. Behind the spondylium the attached surface of the septum is widened, so as to support part of each lamina as well as their line of junction. On either side of the septum, between it and the supporting dental lamina, a pointed recess extends below the spondylium toward the cardinal margin. The surface of this valve, like that of the other, is too polished to retain much of the muscular impressions. The muscles, however, are inserted on each side of the septum and above its lower end, much as in *H. psittacea*. An average specimen measures 17 mm. high, 16 mm. wide, and about 10 mm. in antero-posterior diameter.

Stations 2871, 2919, 2923, and 2929, in 559, 984, 822, and 623 fathoms, from latitude 47°, off Grays Harbor, Washington, to the Pacific Ocean off San Diego, Cal., on a bottom of fine mud and sand, attached to dead *Echinus* spines. Bottom temperature 38° to 39° F. No. 123148, U.S.N.M.

The species is named in honor of Prof. James Hall, State geologist of New York, whose contributions to our knowledge of the brachiopoda are second in importance only to those of the late Thomas Davidson. The name which I have adopted for the genus is given in honor of Herman Friele, esq., of Bergen, Norway, to whom we owe the proof of the remarkable features which characterize the development of the long-looped Terebratuloids.

The anatomy of *Frieleia* when compared with that of *Hemithyris* presents few essential points of difference. The brachia are very delicate and make only about four turns. The base upon which they are inserted is circular, forming, when dilated, a cylindrical tube. The cirrhi alternate, as in *Hemithyris*. The number of coils is about four, which is very much fewer than in *H. psittacea*. The attachments of the muscles are relatively much the same in the two groups, but in *Frieleia* the muscles are smaller and their points of insertion on the body of the valve rather posterior, none exceeding the limit indicated by the point of the septum. The ovaries recall those of *H. psittacea*, but are less extensive. They are of a yellowish-white color. The nephridia are four in number, situated essentially as in *Hemithyris*, but more delicate, smaller, and paler than in *H. psittacea*. The end of the intestine forms a small bulb, slightly inclined to one side, but not as lax or as large as in *H. psittacea*. The blood sinuses are quite narrow, but in general distributed much as in the last-mentioned form. The mantle edge is very thin, very sparsely furnished with short setæ, which appear perfectly smooth, transparent, and very sharply pointed, but under a high power show regular transverse markings. The peduncle is short and of a brownish color. There were several of the specimens dredged alive

which had closed their valves on the tips of the brachia, confirming the observations of Morse that these organs may be protruded beyond the valves. Fischer reports the same fact with regard to *Hemithyris cornea*, dredged off the African coast by the *Talisman*.

The differences which separate this group from *Hemithyris* are sufficiently obvious, though perhaps they would have been regarded formerly as of not more than subgeneric rank. When the closeness with which the lines have been drawn among the fossil genera are considered, the relative rank of this one seems fully generic. The nearest relative of *Frieleia* among fossil *Rhynchonellidae* is probably to be found in the genera *Camarotoechia* and *Leiorhynchus*, Hall, a plicated group of forms which flourished in the middle and later Devonian and early Carboniferous periods. In the former the crural laminae, separate in the young state, are united by the deposit of callus on a cup-like expansion of the medial septum in the old individuals. In the very young *Frieleia* the crura lie on the summit of an arch of which one limb joins the side of the valve and the other unites with the keel of the septum, leaving a triangular surface of which the apex is on the septum, the base formed by the cardinal margin and the sides by the inner limbs of the two arches. As the shell grows this condition is modified, so that the anterior edge of the incipient spondylium is free from the septum and overhangs it. In well-developed full-grown specimens the suture of the spondylium is entirely coalescent and the separation indicated only by the notch in the front edge and the groove on the upper surface. In young or imperfectly developed adolescent specimens the notch may be, and frequently is, deeper; but in none, young or old, does the connection with the septum fail or is the suture fully open to the cardinal border. The thickening due to age sometimes almost develops a cardinal process on the apex of the brachial valve. As in all articulate brachiopods, the comparative elongation and inflation, or widening and compression, varies with different individuals. One specimen has the peduncular foramen completely closed in the median line below. Another, owing to some accident in youth, has a deep mesial groove in both valves from about the middle of the shell, giving the specimen almost the look of a *Bilobites*. Another has repaired the damage done by an extensive fracture with a sheet of shell substance, which shows that the secretion of shelly matter is not confined to peripheral parts of the mantle. The prismatic structure of the new shell deposit is similar in all respects to that of the old. Many of the shells are bored by an agency which produces results like the borings of *Cliona*. The shells are very free from sessile organisms, only a few Polyzoa or arenaceous foraminifera being observed. A few dead valves were noticed which seemed to have been pierced in the visceral region by some carnivorous gastropod, a misfortune from which brachiopods as a rule are remarkably free.

Genus HEMITHYRIS. Orbigny.

HEMITHYRIS BEECHERI, new species.

Plate xxxi, figs. 1, 2, 3, 4.

Shell nearly white, smooth, marked only by faint lines of growth, much inflated, wide, short, with a very deep wide median sinus in the front margin of the brachial valve and a corresponding projection of the pedicle valve; brachial valve with a much incurved apex and no median septum, though in an old specimen the deposit of shelly matter between the muscular impressions may give rise to an obscure prominence simulating a septum; teeth strong, the sockets long, deep, deeply transversely grooved, crural plates excavated, divided to the apex in the medial line; height of brachial valve, 15.5 to 16; width, 16.5 to 19 mm. The depth of this valve is about 12 mm.

Station 3473, in 313 fathoms off Honolulu, Hawaiian Islands. No. 107009, U.S.N.M.

Although only three brachial valves and some fragments of this species were collected, from which the slender crural processes were broken, there is no doubt that the material represents a new species. The only species with which it need be compared is *H. lucida*, Gould, which is a relatively much narrower, more compressed, and less flexuous shell of a very much smaller size. It is Japanese in habitat, as far as yet known, and is peculiar in having, normally, the foramen completely closed below by deltidial plates. Judging by the lines of growth, which agree on all the specimens, the proportional width of *H. Beecheri* is quite as great in the young as in the adult, but the young of the size of adult *H. lucida* would exhibit no mesial flexure worth mentioning.

The species is named in honor of Prof. Charles E. Beecher, of Yale University, whose contributions to our knowledge of brachiopoda are well known.

HEMITHYRIS CRANEANA, new species.

Plate xxxi, figs. 5, 6.

Shell small, translucent gray, very thin, with a flexuous anterior margin and almost smooth surface; lines of growth faintly indicated and by close inspection with a lens occasional irregular, radiating, very slightly elevated markings (such as occur more or less on all shells usually called smooth) may be discerned on the polished surface; pedicle valve pointed above, with the sides slightly rounded and the basal margin slightly concave; this valve is rather more inflated than the brachial valve, but not extremely so; foramen subtriangular, wide below, the deltidial lamellæ obsolete; teeth small, very short, cross-striated, and close to the foramen; cavity of the valve smooth; the muscular impressions have left no trace, but they are crowded close up under the foramen; there is no indication of a septum. Brachial valve rounded-triangular, the basal margin gently, evenly arched upward; a feeble mesial septum about one-third as long as the valve separates

the hardly visible muscular impressions, which are all above the lower end of the septum; armature of the hinge diminutive and feeble; teeth strong for their size, with very short sockets behind them; crural laminae concave, the crura short, thin, spatuliform, with their broad sides parallel with the antero-posterior plane of the shell, their distal ends broader, rounded, not denticulate; the crura are separated clear to the cardinal margin; there is no obvious cardinal process. Length of shell, 16; width, 14; antero-posterior diameter, 9.25 mm.

Station 3362, in 1175 fathoms, mud, off Cocos Island, Gulf of Panama; bottom temperature 36.8° F. No. 122861, U.S.N.M.

A single specimen of this modest little species was obtained. The only species with which it need be compared is *Rhynchonella cornea*, Fischer, which is regularly finely striated and has a more angular outline and less flexuosity at the base. The minor details of the crural plates and crura are also different. *Hemithyris lucida* is much more flexuous in front than the present species. In short, although its characteristics are in no respect striking, this little form can not be united with any other yet described. It is respectfully dedicated to Miss Agnes Crane, the editor of Dr. Davidson's posthumous papers on Brachiopoda, to whose care and energy the students of Brachiopoda are much indebted.

### Family TEREBRATULIDÆ.

#### Subfamily TEREBRATULINÆ.

Genus TEREBRATULA (Lhwyd) Anctorum.

Subgenus LIOTHYRINA, Oehlert.

LIOTHYRINA CLARKEANA, new species.

Plate xxxi, figs. 9, 10.

Shell small, thin, perfectly smooth, polished, of a very pale translucent straw color, rather convex, of suboval outline, conspicuously punctate; pedicle valve with a short beak and rather large not quite complete foramen, on either side of which is a wide, subtriangular deltidial area; the inner slopes of these triangles form the lower edge of the foramen, their bases the cardinal border, their inner angles nearly touch and are united by a cartilaginous deposit; teeth short, strong; cardinal border arched; sides rounding evenly into the rounded basal margin which recedes slightly from the plane of the lateral margins, but is not flexuous; cavity of the valve without any septum, the muscular impressions not conspicuous, situated in the upper fifth of the valve; brachial valve flatter, with a minute but distinct cardinal process, strong teeth and small short incomplete loop; in the cavity of the valve is a very feeble elevated line which may be regarded as a median septum, but which does not reach the apex of the valve and extends forward only as far as the adductors. Height of the shell, 12; width, 10; diameter, 6 mm.



Station 3362, in 117.5 fathoms, mud, off Cocos Island in the Gulf of Panama; bottom temperature, 36.8° F. No. 107275, U.S.N.M.

A single specimen of this modest little shell was obtained. It differs from *L. davidsoni*, Adams, in its incomplete foramen and less flexuous margin; it is less inflated and somewhat smaller. From the young of *L. uva*, Broderip, which is (notwithstanding it has been called "smooth") a finely regularly microscopically striate shell, it may be distinguished by its smooth surface. *L. arctica*, Friele, is less like it than *Davidsoni* is; and, in short, while the shell has no very marked characters, it can not be safely referred to any described species. Though small, by the solidity of its hinge armature and the manner in which the foramen is worn by the peduncular motion, it would seem to be an adult shell.

Though the shell was in a dry condition when taken up for study, the soft parts were well preserved, and present the peculiarity of having the lateral bands of brachia quite close to one another and rather long; the space between them is smooth and occupied by a stretch of membranous tissue, while the central whorl of brachia is below, and, looking vertically down upon the valve placed horizontally, is invisible, the cirrhi, of course, being contracted by drying. It is only on looking sidewise at the valve that the coil is seen under the membrane above mentioned and lower than the lateral brachial loops. On soaking the remains in fresh water they expanded considerably and assumed a fairly natural elasticity, but the relative position of the median brachial coil remained the same. The external appearance of this shell is almost exactly like that of *Macandrevia cranium* of the same size. The species is named in honor of J. M. Clarke, esq., associate of Prof. Hall in the revision of the Paleozoic Brachiopoda.

It is not likely that this species can be related to *Liothyryna stearnsii*, Dall and Pilsbry, which is a native of Japan (pl. xxx, figs. 8, 9, 11), as that species has a complete foramen, but the figures are given for comparison with the other species.

Genus TEREBRATULINA, Orbigny.

TEREBRATULINA CAPUTSERPENTIS, Linnaeus.

Plate XXXII, figs. 2, 5.

*Terebratulina caputserpentis* var. *unguicula*, DAVIDSON, Mon. Rec. Brach. Pt. I, p. 25, 1886.

*Terebratula unguicula*, CARPENTER, Proc. Zool. Soc., 1865, p. 201, figs. 1-4.—DALL, Am. Journ. Conch., VI, 1870, p. 102.

Stations 2849, 3311, 3330, 3350, and many others, in from low water to 500 fathoms, temperature 40° to 44° F., from the southern part of Bering Sea southeast to the coast of California in latitude 33° N., and southwest to Japan and Korea. Also the North Atlantic, the upper Tertiary rocks of Europe, etc. Figured specimen No. 123155, U.S.N.M.

For some time I was disposed to regard the North Pacific form as

distinct from that of the Atlantic, following Carpenter, like whom I had only the stunted specimens from shallow water. But the deep-water dredgings of the *Albatross* having supplied a sufficient series of normally grown specimens of all ages and sizes, I have convinced myself, after a thorough comparison of many specimens from each region, that there is no good ground for a separation of them, even varietally. The Pacific form is the typical *T. caputserpentis* (not the eastern American *septentrionalis*) and neither in the shells nor in the soft parts does there appear to be any marked or constant difference. They could not be separated if once mixed in the same tray.

TEREBRATULINA KIIENSIS, Dall and Pilsbry.

Plate XXXII, figs. 8, 9.

*Terebratulina (unguicula, CARPENTER var.?) kiiensis*, DALL and PILSBRY, *Nautilus*, v, p. 18, pl. 1, figs. 4, 5, 1891.

Stations 2871, 3316, and 3205, in 559 fathoms, off the entrance to Fuca Strait; in 309 fathoms off the island of Unalaska in Bering Sea; and in 240 fathoms off Santa Cruz, Cal.; temperature, 38° to 44° F. Also from the coast of the province of Kii, Japan, Stearns; and from the Philippine Islands, NE. from Mindanao, in 82 fathoms, *Challenger* expedition. Figured specimen No. 128463, U.S.N.M.

This fine brachiopod, which when young approaches closely some broad varieties of *T. caputserpentis*, is shown by the *Albatross* material to be a distinct species. It may be known by its rounder outline, larger size, and the fact that the sculpture of the peripheral parts of the shell becomes obsolete, and is represented by grooves with flattened, much wider interspaces, instead of the rounded threads, characteristic of the surface of *T. caputserpentis* at all ages, and *T. Kiiensis* when young. The extension of its range, made known by the *Albatross* dredgings, is very remarkable and interesting.

Family TEREBRATELLIDÆ.

Genus EUDESIA, King.

This name was proposed at the same time as *Waldheimia*, King (= *Magellania*, Bayle), which was discarded as preoccupied. Subsequently it has been treated as a subgenus of the newer name *Magellania*. Beecher has shown that the austral forms typified by *Magellania*, on account of their different development, must be separated in a different subfamily from those of the northern hemisphere. *Eudesia* belongs with the latter. These again are separable into at least two generic groups, *Dallina*, of Beecher (apparently a descendant of *Antiptychina*, Zittel), which includes those with a continuous cardinal plate, strong median septum in the brachial valve, and no buttresses to the teeth of the pedicle valve. The other group comprises *Eudesia* and *Macandrevia*, and has the cavity of the pedicle valve under the hinge separated into three cavities by two buttresses which support

the teeth. In the brachial valve the cardinal plate is divided medially by a sinus. The cardinal process is obsolete, and the medial septum either wholly absent or represented only by a short, low ridge not attached to the cardinal buttresses, and not extending forward into the cavity of the valve between the buttresses. As *Eudesia* is much the older name it must be retained for these forms, unless *Macandrevia* exhibits characters strong enough to give it generic independence. So far as known, the only differences between them consist in the smooth surface of the valves and the feebleness of the brachial septum in *Macandrevia*. These can hardly raise the latter above subgeneric rank, as the plication of the valves is often inconstant in the same species, while the same species (and doubtless the same individual) at different ages will show a septum more or less developed, from quite obsolete in the young, to quite perceptible in the senile stage. I have verified this on the type of *Macandrevia*, though the septum is never prominent. If the beak of the brachial valve of an old individual were to be ground off, a septum would be perceptible there very much as figured by Oehlert for the beak of *Eudesia cardium*. Consequently I feel obliged to regard *Macandrevia*, at least for the present, as forming merely a subgeneric group under the genus *Eudesia*. As regards the partly austral species about to be described, since there is no means of deciding whether their development agrees with those forms referable to Magellaniæ or not, and as the adult shells exhibit no characters which could be regarded as diagnostic of a genus different from *Eudesia*, I feel obliged for the present to refer them to that group. It may be observed that there is nothing to prevent the free migration of northern forms into the south Pacific along the coast of the Americas. The writer has already the evidence to show that several species, in deep water, do extend from Bering Sea south to the vicinity of the Galapagos Islands and, in the case of one species, *Solemya johnsoni*, Dall, more than a thousand miles farther south, with the known great range of many brachiopods, there would be no apparent reason why species of the Panamic region, for instance, belonging to the northern type of development should not extend their range southward, if opportunity arose. I regard it then, as quite likely, that the species I refer to may be Macandrevian in their development as well as in their adult state, though, for the mass of characteristically austral species, the reverse might be the case.

Subgenus MACANDREVIA, King.

Type *Terebratula cranium*, Müller.

MACANDREVIA AMERICANA, new species.

Plate XXXII, figs. 1, 4, 7.

*Eudesia fontaineaua*, DALL (not ORBIGNY) Proc. U. S. Nat. Mus., XII. 1889, p. 231.

Shell of moderate size, rounded ovate, brownish white, smooth externally except for numerous incremental lines best visible under a lens; margins not flexuous; pedicle valve moderately arched, thin, with a

recurved short beak, rather large foramen incomplete below to the extent of about one-fourth its circumference, with a small obsolete deltidial plate on each side; teeth strong, short, supported each by a strong buttress with a recess behind it, and in old specimens with a smooth deposit of callus on the surface of the valve between the two buttresses; no median septum, the muscular impressions faint, situated in the upper fourth of the valve; brachial valve flatter, orbicular, with a small very low cardinal process produced downward, three times its width, on the surface of the beak between the crural plates, as a low ridge rounded above; crural plates strong, supported by buttresses for half their length, rather close together, supporting a thin delicate brachidium, longitudinally grooved near and at the recurvation, with a few spinules on the outer edge, the hæmal border of the bight of the loop showing a small projection opposite the crural process of each side, the brachidium reaching three-fourths of the distance from the cardinal border to the basal margin and over all one-third as wide as the valve; pallial sinuses following much the same course as in *M. venosa* but straighter, less branched, and of a whitish instead of reddish brown color. Height of shell, 22; width, 19; diameter, 9.5 mm.

Station 2783, in 122 fathoms mud, bottom temperature 48°F., off the west coast of Patagonia, in latitude 51° 2' south; and station 3360, in 1672 fathoms, sand, temperature 42°F., in the Gulf of Panama. Nos. 87547 and 122859, U.S.N.M.

When first examined one of these specimens was erroneously supposed to be the young of *Terebratula fontaineana*, Orbigny, a species which should doubtless be referred to *Magellania venosa*, Solander, as a synonym. Later and more careful study of a second specimen has enabled me to correct my mistake. From the young of *M. venosa* the incomplete foramen enables it to be discriminated, without examining the interior of the shell. In a general way this species looks very much like an adolescent specimen of *Laqueus jeffreysii*, in general outline, but is flatter.

MACANDREVIA CRANIELLA, new species.

Plate xxx, fig. 1.

Shell much resembling in size and form the specimen figured by Davidson,\* below referred to, but rather more rectangular with a less prominent beak, and a narrower and more slender brachidium. Surface of shell smooth, except for numerous strong concentric lines of growth and prominent punctation. Under a lens a microscopic radial sculpture is visible on parts of the shell, resembling the fibrous surface of a worn *Rhynchonella* rather than regular striation. Form of shell rounded, rectangular, with a low beak and large foramen; pedicle valve rather inflated, the side and basal margins slightly excavated, the basal corners rounded but slightly prominent, from which the obscure rectan-

\*See *Macandrevia* sp., DAVIDSON, Mon. Rec. Brach., I, pl. XII, fig. 13, 1889.



gularity of the shell arises; teeth strong, foramen large, incomplete, the deltidia almost linear, but long; dental buttresses strong, receding as they approach the arch of the valve; brachial valve flatter; teeth strong, with very oblique buttresses; brachidium four-fifteenths the length of the valve, barely one-third as wide as the valve, slender, with a single spine at the point of recurvation, and a slight thickening, but no septum, at the cardinal apex; muscular impressions small and confined to the upper fourth of the valve. Height of shell, 17; width, 12; diameter, 9 mm.

Station 3362, in 1,175 fathoms, mud; temperature, 36.8° F.; in the Gulf of Panama. No. 122858, U.S.N.M.

This species resembles *Magellania* (*Waldheimia*) *wyvillei*, Davidson, but wants the septum and cardinal process of the brachial valve of that species, which also has less oblique, shorter, and wider deltidia. It has much resemblance also to *Macandrevia cranium*, but is a more rectangular, plump, and compact shell, and appears not to reach the size of *M. cranium*. *M. tenera* has a shorter loop and more obvious septum in the apex of the brachial valve. It is also a smaller species when adult.

MACANDREVIA DIAMANTINA, new species.

Plate xxx, fig. 5; plate xxxii, figs. 3, 6.

Shell smooth polished, dorso-ventrally compressed, flexuous, of a rounded lozenge or "diamond"-shaped outline; surface with faint incremental lines, but no radial sculpture, waxen white; pedicle valve sub-pentagonal, widest near the middle, the converging sides below produced, the basal margin concave; beak short, wide, the foramen incomplete below, with well-developed deltidia on each side; teeth strong, supported by wide buttresses, forming wide recesses on each side; muscular impressions indistinct, situated in the upper third of the shell; no median septum exists in this valve. The genital glands are of a reddish brown color, shining through the shell as two short parallel streaks on each side of the adductor impressions; brachial valve wider than high, with the base flexuous upward; teeth strong, with very oblique buttresses hidden under the dental plates and forming small foveolæ; cardinal process short, stout, prominent, but not produced into a septum; brachidium very slender, extending to the basal third of the valve, the transverse limb at the bight of the loop being wider than any part of the lateral limbs, the bight itself being, of course, narrower, as usual; there are two or three spinules at the recurvation; the genital glands in this valve show as a single brown streak on each side of the attachment of the adductors. It is, however, longer than the paired streaks of the pedicle valve. Height of shell, 18; width, 17; diameter, 7 mm.

Station 3362, in 1,175 fathoms, mud; temperature, 36.8° F.; in the Gulf of Panama. No. 122860, U.S.N.M.

This elegant little species recalls *Liothyryna wyvillei*, Davidson, in its form, though more lozenge-shaped and less sharply flexuous.

It is sufficiently distinct from all described recent species to make no comparisons necessary. Only two specimens were obtained.

? MACANDREVIA ———.

At station 3476, in 298 fathoms, near the port of Honolulu, a single specimen of a brachiopod in the cistelliform stage was obtained. It is, of course, too young to determine the species or even the genus to which it belongs. However, it may pretty certainly be stated that it is not a young stage of the common Hawaiian species usually known as *Ismenia* or *Muhlfeldtia sanguinea*, Chemnitz,\* and probably indicates the presence of a species in the Hawaiian fauna which has not yet been enumerated from it. In this connection an apparent misapprehension may be corrected. The name *Frenula* was proposed by me in 1871 for a brachiopod, which I named subsequently *Ismenia jeffreysi*, and which has since proved to be the ismeniform stage of *Laqueus rancouverensis*, Davidson. I joined with it the *Ismenia sanguinea* (Chemnitz) Gray, because of the identity of form of the brachidium in both. Gray had referred *Anomia sanguinea*, Chemnitz, to *Ismenia*, King (part). But it appears that the original *Ismenia* of King is not of this character, and the name must be kept for *Terebratula pectunculus*, Schlotheim, for which it was proposed. *Frenula* having been proposed for a young stage of my earlier subgenus *Laqueus* (type *Terebratula californica*, Koch) can not be applied to the species *sanguinea*, which represents in its adult condition the stage which in *Frenula* proper is only a phase of development. Both the loop and surface of the *sanguinea* differ distinctively from those of *Muhlfeldtia truncata*, and if they are placed in the same genus the former requires to be separated subgenerically. I would therefore propose for the *Anomia sanguinea*, Chemnitz, the subgeneric name of *Frenulina*, a conclusion in which the late Dr. Davidson acceded in letters received from him before his premature and lamented decease. By a *lapsus*, in a footnote to Beecher's Revision of the Families of Loop-bearing Brachiopods,† it is stated that "*Megerlina jeffreysi* was given to a stage of *Laqueus*," etc. Here *Frenula* is meant, *Megerlina* being based on *Kraussina lamareckiana* by Deslongchamps. It has also been stated by Oehlert‡ that *Frenula* was applied to a "stage of *Ismenia sanguinea*," an error doubtless inherited from an obscure remark by Deslongchamps to the same effect. These misapprehensions, I hope, will be cleared up by the statement of facts I have just given.

Genus LAQUEUS, DALL.

To the species belonging to this group may be added *T. blanfordi*, Dunker, of Japan. I have received some very fine adult specimens which show conclusively that this species has the loop of *Laqueus*.

\* As Chemnitz was not strictly binomial in his nomenclature, it is probable that Gmelin's name of *sanguinolenta* should be adopted for this species.

† Trans. Conn. Acad., IX, p. 383, March, 1893.

‡ Fischer, Man. de conchyliologie, p. 1321.

Others obtained by Mr. Frederick Stearns in Japan showed the same features. The loop is a very solid one as a whole, but the connecting bands which unite the upper with the lower branches of the brachidium are narrow and rather frail; they had probably been lost in the specimen figured by Van Iterson in Part II of Davidson's Monograph, pl. XV, fig. 12.

LAQUEUS CALIFORNICUS, Koch.

*Laqueus californicus* (Koch), DALL, Am. Journ. Conch., VI, p. 123, pl. VII, fig. f; pl. VIII, figs. 9, 10, 1870.

Off San Pedro in 30 fathoms, Oldroyd.

The original locality of this species is the coast of California. Cooper dredged specimens in the vicinity of the Santa Barbara Channel in 90 fathoms. It was on one of these that my earlier observations were based. Subsequently, from moderate depths of water, a smaller, somewhat stunted form was collected from the Queen Charlotte Islands and the coast of British Columbia. The color of the southern form is of a warm reddish brown and the shell is quite thin, the foramen small and delicate. The northern form is of a dirty livid yellowish white, or pale brown; usually it has a large foramen and heavier shell than the Santa Barbara shell. The latter, too, when compared with a large series, is wider near the cardinal border giving it a more rectangular form, while the northern shell is more attenuated, and the sides slope to the umbo in a straighter line from the point of greatest width.

The Queen Charlotte Island shell was separated by Davidson as a variety *vancouveriensis* (more correctly *vancouverensis*), but his specimens were stunted, being from relatively shallow water. The dredgings of the *Albatross* have shown that the northern shell also occurs in the south in the same region and depth as the typical *californicus* and without transitions in color and form. It will, therefore, be necessary to separate the two forms as distinct though allied species.

LAQUEUS JEFFREYSI, Dall.

*Frenula jeffreysi*, DALL, Am. Nat., v, p. 55, 1871 (ismeniiform stage). Am Journ. Conch., VII, p. 65, pl. XI, figs. 7-10, 1871.

*Megerlia jeffreysi*, DALL, Sci. Res. Expl. Alaska, p. 48, 1877.

*Laqueus californicus* var. *vancouveriensis*, DAVIDSON, Mon. Rec. Brach., p. 113, pl. XVIII, figs. 10-13b, 1887 (adult).

Stations 2862, 3194, 3339, 3350, etc., in 75 to 238 fathoms, from the Aleutian Islands to a point off Estero Bay near San Luis Obispo, Cal., the bottom temperatures varying from 37° to 48° F. The depth at which the species is found increases southward, but the temperature was highest off Point Arena, Cal., where several specimens were dredged in 75 fathoms. Fine specimens have also been collected in Puget Sound.

The small size of the specimens, first separated as a variety by Dr. Davidson, is due to their station. The *Albatross* in deeper water got specimens even larger than the original *californicus*, and from that to the earliest stages. These showed conclusively that the shell which I

had described under the specific name of *jeffreysi* is the ismeniiform stage of the shell afterwards named *rancouveriensis*.

The fact that specimens of *Terebratalia transversa* become more reddish and bright colored when living in the southern part of their range, and the stunted size of the first adult specimens of *jeffreysi* collected in the north, led me to regard them as belonging to a northern race of the ruddier *californicus*; but since specimens of *jeffreysi* from the vicinity of San Luis Obispo show no tendency to take on ruddy tints and preserve the characters of the northern specimens, though attaining an equal or even greater size than *californicus*, it is evident that the expected transition does not take place, and the form may properly be separated as a species (though nearly related to *californicus*) under the first name by which it was described and figured. Before the development of the loop in *Terebratellidæ* was fully understood, the similarity of certain specimens of the ismeniiform stage of *Dallina septigera* to those of *L. jeffreysi* led me to question whether the latter might not be common to the two oceans, but later when the various stages through which *D. septigera* passes became better known this suggestion was obviously not required to explain the presence of the supposed *Frenula* in the Atlantic Ocean.

The genus, or subgenus, *Laqueus* appears to be strictly confined to the shores of the north Pacific, where the following species occur:

## JAPAN.

*Laqueus pictus*, Chemnitz.  
*Laqueus blanfordi*, Dunker.  
*Laqueus rubellus*, Sowerby.

## NORTHWEST AMERICA.

*Laqueus jeffreysi*, Dall.  
*Laqueus californicus*, Koch.

## Genus TEREBRATALIA, Beecher.

## TEREBRATALIA OBSOLETA, Dall.

Plate xxx, fig. 7.

*Terebratella occidentalis* var. *obsoleta*, DALL, Proc. U. S. Nat. Mus., XIV, 1891, p. 186.

*Terebratalia obsoleta*, DALL, in BEECHER, Dev. *T. obsoleta*, Trans. Com. Acad. IX, p. 392, 1893; type of genus.

Stations 2983 and 2984, in 58 and 113 fathoms, sand, northwest from Cerros Island, Lower California, and 3044 in 58 fathoms off Abreojos Island, Lower California; bottom temperatures, 50° to 56° F. Nos. 122545, 123140-43, U.S.N.M.

Shell scarlet, radiately streaked with pale yellow, especially in the channels between the ribs; surface polished, smooth except for rather distinct incremental lines and, in adult specimens more or less distinct, partially obsolete radial ribs, which appear near the margin, but do not extend to the earlier half of the shell; in senile specimens a larger proportion of the shell is ribbed; pedicle valve with a rather low beak and wide, incomplete foramen; deltidial plates well developed but widely separated; valve wider (as a rule) below the middle, the



arch of the base cut into three subequal parts by two especially strong ridges (corresponding to channels on the brachial valve), between which the surface of the valve may be more or less ribbed radially, but is always flattened or depressed, corresponding to an upward flexure of the basal margin: teeth strong, supported by deeply receding buttresses; no medial septum: the adductors with widespread ends, rather distant from the medial line, confined to the upper third of the valve; pallial sinuses large, divaricating near the margin from five principal trunks on each side; the genital glands yellowish, extending in narrow bands along the sinuses nearly to their fureation; peduncle short, dark brown; brachial valve flatter, with a wide, low cardinal process, little prominent; teeth strong without buttresses, medial septum short, very thin and high, subtriangular: brachidium unusually slender; pallial sinuses numerous, much branched with a medial trunk nearly reaching the margin. Height of average specimen 30; width 30, diameter 17 mm. Old specimens attain a larger size. One dead pedicle valve measures 47 mm. high, 43 wide, and 20 mm. deep.

The varied forms which the brachidium assumes during development have been fully illustrated and described by Beecher in the paper already cited. The first specimens received were in poor condition, and it was thought possible that the species might be identical with *T. occidentalis*. Subsequently a fine lot of material from the vicinity of Carros Island showed that the two species were perfectly distinct. *T. obsoleta* has no very near relative in the North Pacific. The colors recall the *T. coreanica*, *Laqueus pictus*, and *Frenulina sanguinea*, all quite distinct as to form. In form the nearest species is the *T. rubiginosa*, Dall, which is only known from the type in the National Museum, collected by the United States Exploring Expedition, and labeled as from the Cape of Good Hope. It is possible that this locality is erroneous, but the species has a different sculpture from *T. obsoleta*, and has only a faint reddish suffusion in the general brownish coloration. The peculiarly slender, rather wide, and arched brachidium is somewhat similar in the two species. It should be said that an occasional specimen of *T. obsoleta* has the foramen completed by a junction of the deltidia. *T. rubiginosa* is figured for comparison. Pl. XXX, figs. 3, 4.

TEREBRATALIA TRANSVERSA, Sowerby.

Plate XXXI, figs. 12, 13.

*Terebratula transversa*, SOWERBY, Thes. Conch., I, p. 261, pl. LXVII, figs. 114-115, 1846. Not of GOULD, 1860.

*Terebratella transversa*, DALL, Sci. Res. Expl. Alaska, p. 47, 1877; Proc. Acad. Nat. Sci. Phila., 1877, p. 157; DAVIDSON, Mon. Rec. Brach., p. 79, pl. XVI, figs. 6-12, 14, 14a, 1887 (*ex parte*).

*Terebratula caurina*, GOULD, Proc. Bost. Soc. Nat. Hist., III, p. 347, 1850; Moll., U. S. Expl. Exp., p. 468, pl. XLIV, fig. 582, 1852.

Stations 2858, 2961, 2964, etc., in 10 to 230 fathoms, from the Aleutian Islands to Catalina Island, California. Oregon, United States Exploring Expedition.

This is the most common and variable species of the Northwest coast and attains a notable size, especially in the deep, quiet waters of Puget Sound. The original *transversa* was described from a rather smooth specimen, while Gould's type was strongly radiately ribbed. Dr. Davidson would use both names in a varietal sense, retaining the older for the species, but the grades of variation are so numerous that it is doubtful how far this would be justified, as it sometimes happens that one-half the shell is smooth and the other half ribbed. One feature, however, is constant in all the multitude of specimens I have examined; the flexure of the middle of the valves, though often feeble, is always concave in the brachial valve and convex in the pedicel valve. The young specimens from Monterey, Catalina Island, and other southern localities are frequently suffused with reddish or crimson about the margin and on the backs of the ribs. The ribs, when well developed and normal, vary from 18 to 40, bifurcating or intercalary toward the margin. The specimen figured is young, and chosen because it is of the same width as the specimen of *T. occidentalis*, with which it is intended to be compared, and also is, for the species, very strongly ribbed. These specimens are often found near extreme low-water mark, but it is probable that they never attain their full growth in such situations. The completely adult specimens appear confined to deeper water. They sometimes reach the size of 50 mm. high and 58 mm. wide, with a diameter of 31 mm. This species is figured in the Proceedings of the Academy of Natural Sciences of Philadelphia for 1891 on pl. IV, figs. 6 and 7, but unfortunately the numbers in the text are 8 and 9, which refer to the figures of *T. occidentalis*. As in the text referred to, the attempt was made to separate the present species from *T. occidentalis*, which had become confused with it, this was doubly unfortunate, but as the writer saw no proof of the plate it was beyond his power to remedy. The present refiguring, it is hoped, will finally clear up the confusion.

This species is easily distinguished from *T. occidentalis* in the adult state if any attention be given to the diagnostic characters, but there are others from which it is less sharply distinguished. From *Dallina grayi*, Davidson, of Japan, the southern reddish specimens of *transversa* externally are with difficulty distinguished. In fact, one might fancy that the two species were descendants of one ancestor, which, for some reason, in Japan continued its evolution to the *Dallina* stage, while those in America ceased when they arrived at the *Terebratalia* stage. *D. grayi* in the adult stage has hardly any flexure, and in the variety *transversa*, Davidson, the flexure is double, but in the young, and in such of the adults as show the flexure clearly, the two medial riblets are convex in the brachial valve, complemented in the pedicel valve by a corresponding depression. In *Terebratalia transversa*, Sowerby, the flexure is wider, and the converse of what occurs in *D. grayi*. There is another *Terebratalia* in Japan with much the same sculpture as *T.*

*transversa* which has the flexure, though obscure, in the same sense as *T. transversa*. This is the *T. gouldii*, Dall,\* of which, for comparison, figures are given (pl. XXX, fig. 2; pl. XXXII, fig. 10). *T. gouldii* was first described from a specimen in the *Magasella* stage, in 1871, but a comparison of specimens twenty years later showed that the adult form was a *Terebratalia*. But *T. gouldii* is a thinner and flatter shell, with the ribbing finer and more regular, as well as more distinctly marked, than in *T. transversa*. It is possible that future search may reveal *T. gouldii* on the American shores of the Pacific, as *Terebratulina kiiensis* has been found so distributed. At present only a few specimens are known. The color is of a livid grayish white, much like many specimens of *T. transversa*.

#### TEREBRATALIA OCCIDENTALIS, Dall.

Plate XXXI, figs. 7, 8.

*Terebratella occidentalis*, DALL, Proc. Cal. Acad. Sci., IV, p. 182, pl. I, fig. 7, 1871; Proc. Acad. Nat. Sci. Phila., 1873, p. 184, and 1891, p. 173, pl. IV, figs. 8, 9 (not 6 and 7).

*Terebratella transversa*, var. *occidentalis*, DAVIDSON, Mon. Rec. Brach., p. 79, pl. XVI, fig 13 (only), 1887.

Stations 2922 and 2981, in 45 to 47 fathoms, sand, off San Clemente Island, California, in 1889. Monterey, Catalina Island and vicinity, Dall, Cooper, and Canfield, chiefly from the beach. Nos. 401, 123144, and 95850, U.S.N.M.

This species is not known from north of Monterey. It seems to be a rare shell, and all the specimens yet examined are radiately ribbed with about ten very conspicuous ribs, more or less tinged with carmine, while the channels between them (and the body of the shell) are pure white. The mesial flexure is exactly the reverse of that in *T. transversa*, the brachial valve having it strongly convex, and the pedicle valve concave. The extreme dimensions yet observed are those of the specimen figured here; height 26, width 30, diameter 22 mm. The figures representing this species in the paper referred to under the last species were transposed with those representing *T. transversa*, as indicated in the synonymy.

#### EXPLANATION OF PLATES.

##### PLATE XXIII.

Fig. 1. *Halicardia flexuosa*, VERRILL, about twice natural size; diagram of the body from below; the mantle, *i*, *i*, *i'*, severed and turned back to expose the parts; *a*, position of the anterior adductor; *p*, *p'*, adnate palpi; *f*, pedo-visceral mass, supporting the functional foot with byssal groove and the fin-like opisthopodium below (behind) it, and surrounded by the branchial septum; *s*, siphonal septum; *v*, circular valve of the incurrent siphon; *x*, cavity of the siphon; *c*, posterior commissure of the mantle lobes. Drawn by W. H. Dall; page 697.

\* Proc., Phil. Acad. Sci., 1891, p. 167.

Fig. 2. *Euciroa pacifica*, DALL, about twice natural size; diagram showing a vertical cross section of the animal behind the foot; *o, ó*, subumbonal parts of the visceral mass, showing the superficial region occupied by the genital glands, between which are seen the dorsal mantle margin and the proliferations which enfold the teeth; *c*, pericardial chamber, with *h*, the ventricle of the heart lying over on the right side and partly hiding *v'*, the right auricle, while *v*, the left auricle, is fully exposed; below the ventricle is seen the rectum *r*, which here passes through the floor of the pericardium and is cut through in the nephridium below; *s, s*, cross section of the thick connective tissue formed by an infolding of the mantle below the pericardium, from the lower internal wall of which fine reticulated fibers radiate upward; this lamina would seem analogous to the free nephridial lamina in *Halicardia* (fig. 3, *s' n'*), but is attached to the visceral mass and shows a jelly-like solidity into which no ramifications of the ovary extend; below this descend the stems of the gills (with two tubular blood passages), supporting the transverse gill-laminae, on the faces of which the radiating lines represent, not plications, but radiating muscular fibers seen through the transparent epithelium of the plates; the gill plates are represented as if laterally extended, but in life they extend obliquely backward so that an exact section would cut through a number of plates without showing their outline; the darkly-shaded spaces above the gills are the anterior portions of the anal chamber; *f*, the foot, above which is seen the circular section of the retractor muscle; *m, m'*, lobes of the mantle, showing columnar muscular fibers in section. Drawn by W. H. Dall; page 688.

Fig. 3. *Halicardia flexuosa*, VERRILL, magnified about four diameters, diagram of the vertical cross section of part of the body and gills, taken behind the foot looking toward the siphons; *d'*, dorsal junction of the mantle, below which is *r*, the rectum in section; *d*, subumbonal visceral mass; *o r*, the cavernous nephridium in which are seen *p, q*, the branches of the retractor muscles, and *c v*, cavities in the general mass of the partly glandular and partly fibrous tissue; *c r*, roof of *a p*, the posterior part of the anal chamber; *s*, downward continuation of the nephridium; *s'*, point where the free lamina is given off internally; *t m*, part of the downward continuation of the mantle lobe of the left side, cut away below *m*; *n*, free vermiform posterior termination of the lamina; *n'*, free edge of the lamina, more anteriorly; below and to the right of this is seen the junction of the lower surface of the lamina and the outer margin of *e* the outer lamina of the left gill; *z*, papilla on upper surface of the siphonal septum; *b*, severed stem of the left gill with blood vessel in section, the stem recurves and joins *b'*, that of the right gill near *j*, the point where both are soldered to the posterior keel of the foot; *c*, inner lamina of the left gill, extending between *j* and *b*, and forming part of the roof of the peripodal chamber. Drawn by W. H. Dall; page 697.

Fig. 4. *Euciroa pacifica*, DALL, about three times natural size; diagram of the animal from below, with *i, i, i'*, the mantle severed and turned back to expose the parts; *a*, position of the anterior adductor; *p, p'*, the palpi; *f*, the foot surrounded by the coalescent gills; *s*, the siphonal septum; *x*, cavity of the incurrent siphon; below which are outlined the areas occupied by columnar muscular tissue and by dotted shading the glandular region of the mantle in front of the siphon. Drawn by W. H. Dall; page 688.

Fig. 5. *Halicardia flexuosa*, VERRILL; diagram of the heart and rectum much enlarged, for comparison with that of *Euciroa* (fig. 2, *h, v, v'*); *a*, the rectum passing through *r*, the ventricle, with *l*, the left and *r*, the larger right auricle. Drawn by W. H. Dall; page 697.

Fig. 6. *Halicardia flexuosa*, VERRILL, slightly enlarged; diagram of the soft parts removed from the shell, side view; *a*, median papilla above *b*, the anal siphon; *c-e*, the extremities of the pedal opening between the mantle lobes; the ends of the muscles are shaded. Drawn by W. H. Dall; page 697.



## PLATE XXIV.

- Fig. 1. *Spergo glandiniformis*, DALL; diagrams, *a*, *b*, *d*, natural size; *e*, slightly enlarged; *f*, about twice natural size; *h*, much magnified; *a*, front view of muzzle, showing relative position of tentacle; *b*, side view of animal crawling; *d*, front edge of foot from below; *e*, verge as it lies on the back of the animal with the point turned away from the head; *h*, teeth, the upper pair are placed in the natural position as they appear on the radula; the base of the tooth is shaded with dots; outside of it is a narrow fibrous band by which the teeth are attached to the radula; the blades are unshaded; from camera lucida sketches by W. H. Dall; page 680.
- Fig. 2. *Spergo glandiniformis*, DALL, shell, alt. 46 mm.; page 680.
- Fig. 3. *Halicardia flexuosa*, VERRILL, slightly enlarged; diagram of the soft parts as removed from the shell, showing the siphonal extreme of the body; *b*, end of the left branch of the retractor of the foot; *d*, left end of the posterior adductor muscle. Drawn by W. H. Dall; page 697.
- Fig. 4. *Euciroa pacifica*, DALL, about natural size; diagram of the soft parts removed from the valves; *a'*, right end of anterior adductor muscle with *e* above it, being the end of the right branch of the protractor of the foot; *c*, area shaded to show the genital gland or ovary as seen through the mantle; *m*, surface of the area occupied by columnar muscular tissue between the surfaces of the mantle; *g-g*, extent of pedal opening between the mantle lobes; *a*, posterior adductor with below it at the mantle-edge the short siphonal retractor muscles. Drawn by W. H. Dall; page 688.
- Fig. 5. *Euciroa pacifica*, DALL, much enlarged, diagram of the palpi and lappet; *s*, the double sacs above *p*, the anterior palpi; *l*, the fleshy median lappet; *p*, the posterior palp, folded on itself. Drawn by W. H. Dall; page 692.
- Fig. 6. *Frieleia halli*, DALL; view of the valves from the side, alt. 20 mm.; page 714.
- Fig. 7. *Euciroa pacifica*, DALL, umbonal view of valves; page 688.
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- Fig. 9. *Frieleia halli*, DALL; basal view of brachial valve, showing crura, buttresses, and septum in profile; page 714.
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- Fig. 11. *Frieleia halli*, DALL; interior of pedicle valve; alt. 20 mm.; page 714.
- Fig. 12. *Frieleia halli*, DALL, enlarged view of cardinal region of brachial valve, showing crura, spondylium, and septum; page 714.
- Fig. 13. *Frieleia halli*, DALL, view of hæmal side; alt. 20 mm.; page 714.

## PLATE XXV.

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- Fig. 2. *Lyonsiella alaskana*, DALL; 24 mm.; page 703.
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- Fig. 4. *Calyptogena pacifica*, DALL, interior of right valve; 48 mm.; page 713.
- Fig. 5. *Calyptogena pacifica*, DALL, exterior of the same valve; 48 mm.; page 713.
- Fig. 6. *Limopsis vaginatus*, DALL, internal view of left valve retaining the pilose epidermis; 34 mm.; page 713.
- Fig. 7. *Limopsis vaginatus*, DALL, external view of left valve; 34 mm.; page 713.

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- Fig. 2. *Cryptodon bisectus* (CONRAD), DALL; side view; 50 mm.; page 713.
- Fig. 3. *Dentalium complexum*, DALL; 78 mm.; page 686.

- Fig. 4. *Puncturella major*, DALL; 57 mm.; page 712.  
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