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OUR NORTH-AMERICAN ECHIURIDS.

A CONTRIBUTION TO THE HABITS AND GEOGRAPHICAL RANGE OF THE GROUP.

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ONLY four species of Echiurids, representing three of the five known genera, have been reported from the North American coast up to the present time. These are as follows: *Thalassema mellita* Conn was found at Beaufort, Va., living in empty sand-dollar tests, and its structure and morphology were most admirably worked out (2). *Thalassema viridis* Verrill has been reported from nodules of blue clay at a depth of seventy-seven fathoms off Head Harbor, Campobello Island (16). *Bonellia sülmii* Selenka was dredged from deep water off the coast of Nova Scotia and was described and named in the *Challenger Reports* (12).

The fourth species, *Echiurus chrysacanthophorus* Pourtales, has been reported by several authors from various localities on the New England coast. Each of these four was established as a new species by its discoverer and has been found nowhere else. The Bonellia species was based upon a single badly mutilated specimen, *T. viridis*, and the species of Echiurus upon a very limited number of specimens, no one of which in the latter species was perfect, leaving *T. mellita* to stand alone beside the well-known and thoroughly studied European forms.

In the present contribution I am able to add American localities for two of the well-known Old World species, and when

the results of the recent Harriman Alaskan Expedition are published another even better known European form will be found among them.

It is hoped also to clear up the cloud of doubt which has hung about the questionable American *Echiurus chrysacanthophorus*, for the reports on this species have contained so many gross errors and conflicting statements, and so little accurate description, that the determination of the exact species has been impossible.

This has been due to a variety of causes, chief among which may be mentioned two. First, it is essentially a shore species, frequenting muddy shallows where the water is too deep or too roily for the shore collector and not deep enough for dredging. Consequently only a limited number of specimens have been obtained.

Again, so far as known, every one of these was so mutilated in the getting as to render a full description impossible. The part most easily injured is the delicate proboscis. This breaks off upon the slightest provocation, and leaves no scar that can be detected even with a good hand lens.

Hence it is difficult to obtain a specimen with the proboscis intact even under favorable circumstances, and absolutely impossible by dredging. It was this denudition of the proboscis with no resultant scar which led the discoverer of the species, Couthouy, to mistake it for a holothurian, and to describe it as *Holothuria chrysacanthophora* in 1838 (3).

The same mistake was made by Gould in 1841 (5), who says: "This is not unlikely to be *H. forcipata* of Fabricius. Several specimens which I have seen were all taken from fishes' stomachs in a mutilated state. Some of the essential characters, therefore, remain yet undetermined. The surface is light colored and appears to be naked, except that there are several long, flexible, sharp-pointed spines about the mouth[1] of a shining golden yellow. One specimen is five or six inches in length."

Pourtales rectified this mistake in 1851 and located it correctly among the Gephyrea, giving it a name which it has since

[1] Really the anus.

borne, *Echiurus chrysacanthophorus* (8). But he also adds: "I have seen but a single specimen of this species. The one I have before me answers very well to the characters assigned to *Echiurus Gaërtneri* by Quatrefages. It wants likewise the spoon-shaped appendage," *i.e.*, the proboscis (*ibid.*).

But Quatrefages himself admitted in 1865 that the species Gaërtneri was based "upon individuals which had been rolled about by the wind," and he adds: "It is very possible that the appendage was broken off" (10). This proved to have been the case, and in 1880 Greef included the species Gaërtneri as one of the synonyms of *E. Pallasii* Guerin, but he retained the doubtful species chrysacanthophorus (7).

A species of Echiurus has been dredged by Professor Verrill at various points along the New England coast, and has been reported conditionally as *E. chrysacanthophorus*. But Verrill wrote me in 1895 that in all his dredging (over 1000 localities) he had met with this species "in very few instances, and *never*[1] a perfect specimen." Hence he wisely refrained from attempting any detailed description of it, and from any comparison with foreign species.

Finally Shipley, in 1896 (13), and again in 1899 (14), rejects the species altogether as being inadequately described, and the locality, "North Atlantic," which he assigns to *Echiurus Pallasii*, doubtless signifies the Norwegian and Greenland shores, from which it has been reported by other authors.

Such being the condition of affairs, it seems fitting to describe the species accurately, to determine it definitely, and to add a few observations upon its habits which may be of generic interest. This is rendered possible by the fact that it has been the good fortune of the author to obtain a large number of absolutely perfect specimens and to keep some of them under observation in aquaria for several weeks, while others were successfully preserved, — a by no means easy task.

The material was all obtained at Casco Bay, on the Maine coast, during the summers of 1895–98. It is also hoped that the photographs which accompany these notes may prove of assistance in locating the species.

[1] The underscoring is his.

Habits. — This species lives in the mud near and below ordinary low-water mark. It can be best obtained during the few days of each month when the tides run lowest, at which time it can be dug in the same way as the common clam (mya).

It is most abundant in close proximity to mussel beds where the mud is soft and very black with organic matter.

I am aware that this habitat is radically different from that given by Greef and others for *E. Pallasii*, but I find a ready explanation in the fact that sand beaches are the rare exception rather than the rule along the Maine coast, so that the animal has simply accommodated itself to its environment.

Its home is a simple burrow formed by pushing aside the mud. The manner in which this is done was repeatedly observed both in its native haunts and in an aquarium.

If not already in that position, the animal turns until it rests upon its ventral surface. This brings the two large anterior setae in contact with the mud. The proboscis is now turned upward and backward, until it lies along the dorsal surface of the body, with its own ventral surface outermost, but protected somewhat by a rolling in of its edges. The proboscis remains inert in this position and *takes no part whatever in the burrowing.* This is in strong contrast to the active locomotor use of the proboscis described by Rietsch in a specimen of *Bonellia minor* (11). By a series of muscular contractions, which include both the longitudinal and circular muscles of the body walls and the special muscles which move the ventral setae, these latter are thrust forward until they project in front of the body almost horizontally.

At the same time the base of the proboscis is drawn backward and somewhat upward, so that the anterior end of the body becomes wedge or chisel shaped, the ventral surface being flattened and extending farthest forward, with the two setae projecting from its anterior edge. These setae are then turned downward and thrust into the mud as far as possible. Being curved, they furnish an excellent leverage, and the body is drawn toward them by a contraction of the longitudinal muscles.

This contraction passes slowly backward along the body until the posterior end is reached, which is moved forward

thereby half or three-quarters of an inch. The two anal rows of setae now serve to hold it in position, while the anterior end is again thrust forward and downward into the mud, and the ventral setae are fastened in a new position. This process is repeated until the animal finally disappears beneath the surface, leaving a circular opening equal in diameter to the body at its greatest lateral contraction. The whole process is extremely slow, and fully forty minutes are consumed in getting the posterior end of the body out of sight beneath the surface.

The burrow proceeds diagonally downward for ten to eighteen inches, then runs horizontally from six inches to two or three feet, and finally turns vertically upward again toward the surface.

When the animal reaches the surface the anterior end of the body is pushed out far enough to free the proboscis. This is then restored to its normal position and the body is withdrawn again into the burrow.

Spengel notes (15) that each burrow of the species (*E. Pallasii*) observed by him at Nordenay possessed two openings close together and each surrounded by a low wall. But those burrows were made in hard sand, while these are in soft mud, and consequently we should expect to find differences. These burrows at first have two openings, but the original entrance soon fills up through the caving in of its walls and the washing in of mud from the surface. The entire diagonal portion is often filled in this way and is never opened again, leaving this end of the burrow blind. These burrows also, when first formed, have low walls around the openings, caused by the pushing aside of the mud, but they quickly disappear.

The Echiurus assumes a position just below the surface, holding itself in place by the two rows of anal bristles (*cf.* Shipley). The mud then washes into the burrow and forms a plug one to two inches thick, with a small opening about the size of a lead-pencil at the center. Through this opening the proboscis is thrust out in search of food when the tide is in, and is then the only portion of the animal which is visible. It is capable of great extension, as was the proboscis of *B. viridis* described by Eisig, and often reaches a length of five or six inches. The

free end moves about in every direction and carefully searches the surface around the opening. Having found a particle of food, the edges are rolled in ventrally toward each other, if not already in that position, and form a more or less closed tube. The whole ventral surface (which is now the interior of the tube) being ciliated, there is generated a current which quickly carries the food toward the mouth. The proboscis often assumes a similar tubular shape when it is not elongated, as can be seen in Fig. 2, so that the curling inward of the edges is independent of the strong contraction of the circular muscles which produces the extension.

Often also it rolls itself into a tight coil, commencing at the tip and curling over ventrally as though it were grasping some object, but nothing save a few food particles is to be found in it, which are much too small to occasion any such effort.

The proboscis is very sensitive over its entire surface, but especially so on the ciliated ventral portion, and the slightest irritation there results in a quick withdrawal.

As would be inferred, such an appendage is of extreme importance to the animal, and yet it breaks off upon the slightest provocation. Whether such a separation is necessarily fatal or not, and whether the animal possesses the power of regenerating its proboscis, could not be definitely determined.

It hardly seems probable, however, that the animal could live for any length of time without it. But it was found that the proboscis itself was so highly innervated that it retained its vitality, and to a marked degree its sensitiveness also, for a long time after separation, a week or more if kept in fresh sea water. When the tide goes out, though there is always water left in the burrow, the proboscis is withdrawn and all indications point to the conclusion that the animal retreats to the lower part of its burrow.

Like other gephyreans, this species secretes a thick mucus, which lines the burrow walls and penetrates the mud for some distance, giving it greater firmness and solidity.

This mucus, as in so many other cases, oxidizes the iron in the mud, so that the walls of the burrow are a rusty brown color and stand out in sharp contrast to the surrounding black.

Movements and Locomotion. — In life, even when out of its burrow, the creature is constantly altering its outward form by energetic contractions of the skin muscles, as noted by Greef (6). Deep constrictions appear at various places, which move now forward, now backward, that portion of the body just in front of or behind the constriction increasing proportionately in size. The proboscis is also kept in constant motion, coiling up and uncoiling, rolling inward from the edges and unrolling or stretching out to a considerable distance and then being withdrawn. In its burrow the animal cannot turn around, but can move either forward or backward at will and with equal rapidity. This motion is accomplished by a series of wave-like contractions and relaxations in the circular and longitudinal muscles of the body wall, the one alternating with the other, and both together producing a fairly rapid gliding motion. The necessary rigidity is given to that portion of the body wall which for the time being serves as a fulcrum, by the pressure of the liquid in the body cavity, as first noted by Quatrefages (9). Andrews has clearly stated (1) the essential factors in the mechanism of *Sipunculus Gouldii* which bring about such "hydrostatic locomotion," and several authors have described similar motion in other gephyreans.

But no one, so far as known, has suggested any other mode of moving about. Indeed, one of the best recent text-books distinctly states that "the gephyrea are only capable of a very slow creeping motion" (Parker and Haswell, p. 461).

It seems never to have been suggested to any one, the present author included, that this same rhythmic contraction of the body walls would furnish an excellent means for swimming.

Hence it was quite a surprise, on visiting an aquarium after dark during the second summer, to find three or four specimens swimming about in it freely. The body was elongated to twice its ordinary length, while the proboscis was elongated even more in proportion and its edges were rolled downward and inward so as nearly to meet along the median line and form a long narrow tube which seemed to take an active part in the swimming.

The resultant motion was peculiar, being gyratory or cork-

screw-like, the anterior end always moving ahead, but it was perfectly free in any direction and quite rapid.

Besides assisting in locomotion the proboscis also seemed to serve as a steering organ, and its extreme sensitiveness rendered it very effective in avoiding obstacles.

The fact that this swimming took place only at night suggests that these animals are more or less nocturnal in their habits, and it may be that they can move about much more freely than has been hitherto supposed. At all events this is probably the mode of locomotion used at or near the breeding season, and it readily explains the large numbers of specimens which are thrown up on the beach after a storm at such seasons.

This species is well known to the clam-diggers along the coast and is sometimes used for bait in deep-sea fishing, but not often, and is never sought designedly for that purpose.

Determination of Species. — After a careful comparison of the descriptions given by Couthouy and Pourtales with that of *E. Pallasii* by its discoverer and subsequent zoölogists, and with the description which follows, there seems no possible doubt that those authors fell into the same error concerning our American species which trapped Quatrefages on the European form, *viz.*, they described an *Echiurus Pallasii* which had lost its proboscis as a new species. Accordingly *Holothuria chrysacanthophora* Couthouy, 1838, and *Echiurus chrysacanthophorus* Pourtales, 1851, must go to swell the long list of synonyms already appended to *Echiurus Pallasii* Guérin-Méneville.

Echiurus Pallasii Guérin-Méneville. — Synonyms: *Holothuria chrysacanthophora* Couthouy, 1838. *Echiurus chrysacanthophorus* Pourtales, 1851.

External Morphology. — Body like that of all known echiuroids, spindle-shaped, tapering slightly at either end; 10–30 cm.[1] long (including the proboscis, 3–6 cm. long) and 3–6 cm. in diameter at the center (Figs. 1 and 2).

[1] This figure is much larger than that usually given for *E. Pallasii*, but is the result of careful measurement and is good evidence in favor of Shipley's statement (13). "It seems probable that *E. forcipatus* of Reinhardt is identical with *E. Pallasii*, though bigger" (*cf.* p. 175).

Color uniform gray or grayish-yellow, shading into a deep orange on the interior of the proboscis. Entire surface of the body rough from being covered with small blunt papillae, which are unequal in size. The larger ones are more globular and are quite regularly arranged in transverse rows in which the individual papillae are so close together that they touch one another. There are twenty-two or twenty-three of these rows, and between them are scattered the smaller papillae, which are more conical in shape and seldom show any arrangement in rows.

Both kinds of papillae are more sharply defined and nearer together toward the ends of the body. There is also usually a bunching of the papillae around the anterior setae where they are larger than elsewhere on the body.

There is a pair of large, shining yellow, hooked setae, one on either side of the ventral mid-line, 16–20 mm. behind the base of the proboscis. These setae are about 20 mm. long and curve toward the posterior end of the body. They are retractile and can be almost wholly withdrawn into the body cavity. The posterior end of the body is surrounded by two rows of yellow setae, somewhat shorter than the anterior pair and perfectly straight. They also are retractile, and in most preserved specimens are withdrawn into the body cavity. In the animal shown in Fig. 4, however, they were extended to their full length. The rows are quite near together (3–5 mm.) and not more than 4 mm. from the anus, which is central and terminal. These posterior setae incline backward and assist the animal in moving about. The anterior row is made up of eight or nine setae, the posterior one of seven or eight.[1]

Reserve setae are present for both rows and for the ventral pair. The setae alternate in the two rows, but neither row is entire, a space being left on the ventral mid-line.

In the posterior row this space corresponds to the omission of one seta, in the anterior row to the omission of three.

There is a papilla around the base of each seta, much larger than those on the body. The spaces between these basal papil-

[1] The fact that these different numbers may be found in individuals otherwise exactly alike is still further evidence that Reinhardt's species, forcipatus, is not well grounded.

lae and the intervals on the ventral surface, up to within 1 mm. of the mid-line, are filled in with ordinary large papillae.

Proboscis large, 3–6 cm. long and 1–3 cm. wide. It is capable of being extended to 12 cm. with a corresponding diminution of its width. It is cylindrical at the base, but quickly opens into a half tube which is broadened at the tip into a shovel form (Fig. 1). The exterior is a brighter yellow than the body and perfectly smooth. The interior is rich orange and completely ciliated, but in most specimens examined it lacks the longitudinal brown stripes noted by Greef in *E. Pallasii* (6). In several specimens, however, they showed up faintly against the orange background.

The skin also on the interior of the proboscis is thrown up into longitudinal ridges, the intervening furrows between which are darker in color than the ridges themselves (Fig. 3). The mouth opens through the center of the cylindrical base. A well-defined ridge runs outward from the mouth along the dorsal mid-line toward the tip of the proboscis. This ridge is somewhat brighter in color than the rest of the interior, but is completely concealed unless the proboscis is opened. The tip of the proboscis sometimes has a well-marked chocolate-brown edge.

The ventral nerve cord and blood vessel show plainly through the skin (*cf.* Figs. 1 and 2), and when the body is extended the dark-colored intestine can be seen at points where it touches the inner surface of the body walls. The sexes are alike externally, with no appreciable difference in size (*cf.* Figs. 1 and 2).

But when sexually ripe, Greef says that the golden eggs or the white semen in the nephridia show through the body wall enough to distinguish the males from the females (6).

Internal Morphology like that of all echiuroids. The alimentary canal is several times the length of the body and is looped irregularly. It is suspended from the body walls by thin muscular strands instead of a continuous mesentery, and upon the slightest perforation of the body walls it is extruded through the orifice by a violent contraction of the muscles.

This alimentary canal may be divided into three regions or parts, called respectively the fore, mid, and hind gut.

The foregut is very short, and contains a pharynx and oesophagus which are often bright orange in color like the inside of the proboscis. The remainder of the foregut is usually larger in diameter and has been called the crop. The midgut constitutes the bulk of the alimentary canal and is distinguished by a groove lined with vibratile cilia which runs along its dorsal side. Opening into this groove at either end is a collateral intestine, much smaller in diameter than the midgut and seemingly analogous to that in echinoderms.

The hindgut is somewhat larger than the midgut and forms near the anus a cloaca into which open two anal vesicles, one on either side. These are quite long, simple sacs, light brown in color, which vary greatly in length in different individuals (40–70 mm.). They open into the body cavity by ciliated funnels, which are most numerous near the base of the sacs, and one of which is terminal.

Both males and females have two pairs of nephridia, which open on the ventral surface on either side of and close to the nerve cord. The mouths of these nephridia are raised into large papillae on the external surface of the body, and can be plainly seen, the anterior pair just behind the ventral setae, and the second pair 5 or 6 mm. farther back.

At the base of each nephridium on the inner side is a ciliated funnel opening into the body cavity, through which the sexual products enter the nephridium when sufficiently ripe.

They are then discharged through the external papillae into the water. When free from eggs the nephridia are 15–20 mm. long and spindle-shaped, with a diameter of 3–5 mm. at the center. Probably when filled with ripe eggs or sperm they increase proportionately in size.

The *Sexual Products* are doubtless formed, as stated by Greef, from small cells near the posterior end of the ventral nerve cord, which are covered with peritoneum. But reproduction certainly does not take place in this locality (Casco Bay) in July and August, as well as in midwinter, *viz.*, it does not occur twice a year. All my specimens were secured in June to August, and not one of them contained ripe sperms or eggs.

But two specimens were obtained September 4 and placed in an aquarium. One of these, which proved to be a female, was injured in the digging, and while being put into the aquarium some nearly ripe eggs escaped through the rent in her side. These furnished the necessary stimulus for the uninjured male and he soon sent out ripe sperms in large quantity from the nephridia.

This would indicate a breeding season for that locality of September to November.

In the female just mentioned the nephridia were perhaps one-eighth full of eggs; all the rest of the eggs were free in the body cavity. This was the only specimen in which any eggs were found in the nephridia, but they may sometimes be found in the body cavity in June, and probably require a long time for development. When ripe (*i.e.*, those from the receptacles) the eggs are spherical, about 0.3 mm. in diameter and nearly opaque, but until fertilization the large germ nucleus can be plainly seen through the yolk granules.

The spermatozoa have a peculiar bullet-shaped head, a short cylindrical middle piece, and a long, very delicate tail. Their vibratory movements are rapid and very strong, and they retain the power of motion for a long time after being discharged into the water.

Just enough description has been here given to fix the species definitely, but considerable work has already been done on the morphology and histology of the body organs and on the origin of the sexual products, and it is expected that the near future will afford an opportunity for a careful study of the complete life history of this interesting species.

Through the courtesy of Dr. W. R. Coe, of the Sheffield Biological Laboratory at Yale University, I have received specimens of an Echiurus secured by him in Alaska, while on the Harriman Alaskan Expedition during the summer of 1899.

This species was found abundantly at many different localities along the Alaskan coast south of the Peninsula and on adjacent islands, nearly always in rich black mud.

It is of considerable interest to note that it proves to be the same species here described, *viz.*, *Echiurus Pallasii*, and that

its habits, so far as observed, correspond exactly with those just given. Its burrow is horseshoe-shaped, the two ends opening at the surface, and around each is a little mound formed by the pushing aside of the mud. The iron ingredients of the mud in the walls of the burrow are also discolored by the mucus secreted by the animal and show as a rusty brown.

In size the Alaskan specimens surpass those from Casco Bay, and the same shovelful of mud often reveals giants and pigmies of the species side by side. But this is simply in accordance with the general results of the expedition, for gigantic specimens of nearly every native species were found.

The number of setae in the anal rings of four specimens selected at random were counted. In three of these there were eight setae in the anterior ring and seven in the posterior, but in the fourth specimen the numbers were nine and eight respectively.

The fact that specimens from two such widely separated localities agree perfectly in carrying the maximum of size beyond 30 cm. and also in the variation of the number of setae in the anal rings, is a third argument, and quite a strong one, against the validity of the species forcipatus.

There seems to be no discernible connection between the number of the setae in the anal rings and the size of the animal; a small specimen is just as likely to possess the larger number.

On the contrary, there is something of a connection between the size of the individual and the temperature of its environment; in general, the colder the water the larger the average of the species. Such a fact strongly corroborates the statement made by Shipley (14) that "this genus is a denizen of the colder seas," and indicates that an Arctic environment is most congenial to its development.

These two new localities also go far toward rendering this species cosmopolitan. It has already been reported from the North Sea, where it was originally discovered, the English Channel, and the coasts of Norway, Sweden, Denmark, Holland, and Belgium. To these can now be added the American North Atlantic and North Pacific, and it may be expected as

one of the results of further investigation in the Asiatic North Pacific.

Thalassema erythrogrammon Max Müller. — I obtained a specimen of this Thalassema through the kindness of Dr. E. A. Andrews of Johns Hopkins University.

It was taken at Green Turtle Cay, off Great Abaco Island, the Bahamas, in the summer of 1886, and when alive was of a flesh color with reddish longitudinal stripes, the proboscis lighter in color, the papillae whitish. The body was raised into longitudinal ridges between the muscle bundles whose prominence varied with the degree of contraction. The specimen was hardened in Perenyi's fluid, and yet the muscle bands show a decided pink-brown color at the present time and stand out very distinctly, as can be seen in the photograph (Fig. 5).

It was excellently preserved in a normal condition and measures 16 cm. in length (including the proboscis, 3 cm. long) and 2.4 cm. in greatest diameter. Body spindle-shaped, with bluntly rounded ends, and after preservation *not* perceptibly furrowed by the longitudinal muscle bands. Papillae in dense placques at the posterior end of the body; no smooth area in the immediate vicinity of the anus. Longitudinal muscles in sixteen bands about 1.5 mm. wide, with interspaces 4.5–7 mm. wide at the center of the body, except the two bands on either side of the ventral mid-line which are close together.

Proboscis so fleshy as to be nearly a solid cylinder, 1 cm. in diameter at the base, thus bringing the mouth to the extreme ventral surface; less fleshy and not broadened toward the tip.

The two setae were so far withdrawn into the thick skin as to be wholly invisible from the external surface, but could be all the more plainly seen on the interior.

The specimen proved to be a ripe male, and the three pairs of nephridia were enormously swollen and packed with sperm.

They increased in size from in front backward, the respective lengths being 3.2, 4.5, and 8.2 cm. The two posterior pairs were constricted at intervals and looked much like a string of sausages; the anterior pair opened 3 mm. in front of the ventral setae, and all three pairs were furnished with spirally coiled internal openings.

Anal glands 9 cm. long, simple, very thin walled, and *without* visible funnels. Intestine filled with the powdered shells of small lamellibranchs.

The chief interest in this specimen centers in the new locality. It has been reported hitherto only from the Red Sea, the Isle of Bourbon, the Malay Peninsula, and New Guinea, about as far distant as possible from the Bahamas. But it evidently belongs to the West Indian fauna and adds one more to the Atlantic species of this genus. Again, this is one of the species in which the number of muscle bands has been given as invariable and fourteen in number. The occurrence of sixteen bands in the present specimen shows that, like most of the other species, the number varies within narrow limits. The position of the anterior nephridia in front of the anal setae, as in *T. caudex* Lampert, is also worthy of note.

STATE NORMAL SCHOOL,
WESTFIELD, MASS.,
March 8, 1900.

LITERATURE CITED.

1. ANDREWS, E. A. Anatomy of Sipunculus Gouldii Pourtales. *Stud. Biol. Lab. Johns Hopkins Univ.* Vol. iv.
2. CONN, H. W. Life History of Thalassema mellita. *Stud. Biol. Lab. Johns Hopkins Univ.* Vol. iii. 1884–87.
3. COUTHOUY, J. P. Description of New Species of Mollusks and Shells. *Bos. Journ. Nat. Hist.* Vol. ii. 1838.
4. FORBES AND GOODSIR. Natural History of Thalassema and Echiurus. *Edinburg New Phil. Journ.* Vol. xxx. 1841.
5. GOULD, A. A. Report on the Invertebrata of Massachusetts. Boston, 1841.
6. GREEF, R. Die Echiuren (Gephyrea armata). *Acta Ac. German.* Vol. xli, pt. ii. 1879.
7. GREEF, R. Ueber Echiuren und Echinodermen. *Archiv für Naturgesch.* 46 Jahrg. 1880.
8. POURTALES, L. Gephyreans of the Atlantic Coast of North America. *Amer. Asso. Adv. Sci. for 1851.* Vol. v. 1852.
9. QUATREFAGES, M. DE. Mémoire sur l'Echiure de Gaertner. *Annal. des Sci. Nat.* Ser. 3, T. vii. 1847.

10. QUATREFAGES, M. DE. *Histoire Naturelle des Anneles.* T. ii, Géphyreens. Paris, 1865.
11. RIETSCH, M. Études sur les Géphyriens armés ou Échiuriens. Thesis, Geneva, 1886.
12. SELENKA, E. *Challenger Reports.* Vol. xiii. 1885.
13. SHIPLEY, A. E. Gephyrea and Phoronis. *Camb. Nat. Hist.* Vol. ii. London, 1896.
14. SHIPLEY, A. E. On a Collection of Echiurids from Loyalty Islands, New Britain, and China Straits, with an Attempt to Revise the Group and to Determine its Geographical Range. *Zoöl. Results*, etc. Camb. Univ. Press, pt. iii. 1899.
15. SPENGEL, J. W. Ueber die Organization des E. Pallasii. *Zoöl. Anz.* Bd. xl.
16. VERRILL, A. E. Recent Additions to the Marine Invertebrata of the Northeastern Coast of America. *Proc. U. S. Nat. Mus.* Vol. ii. 1879.

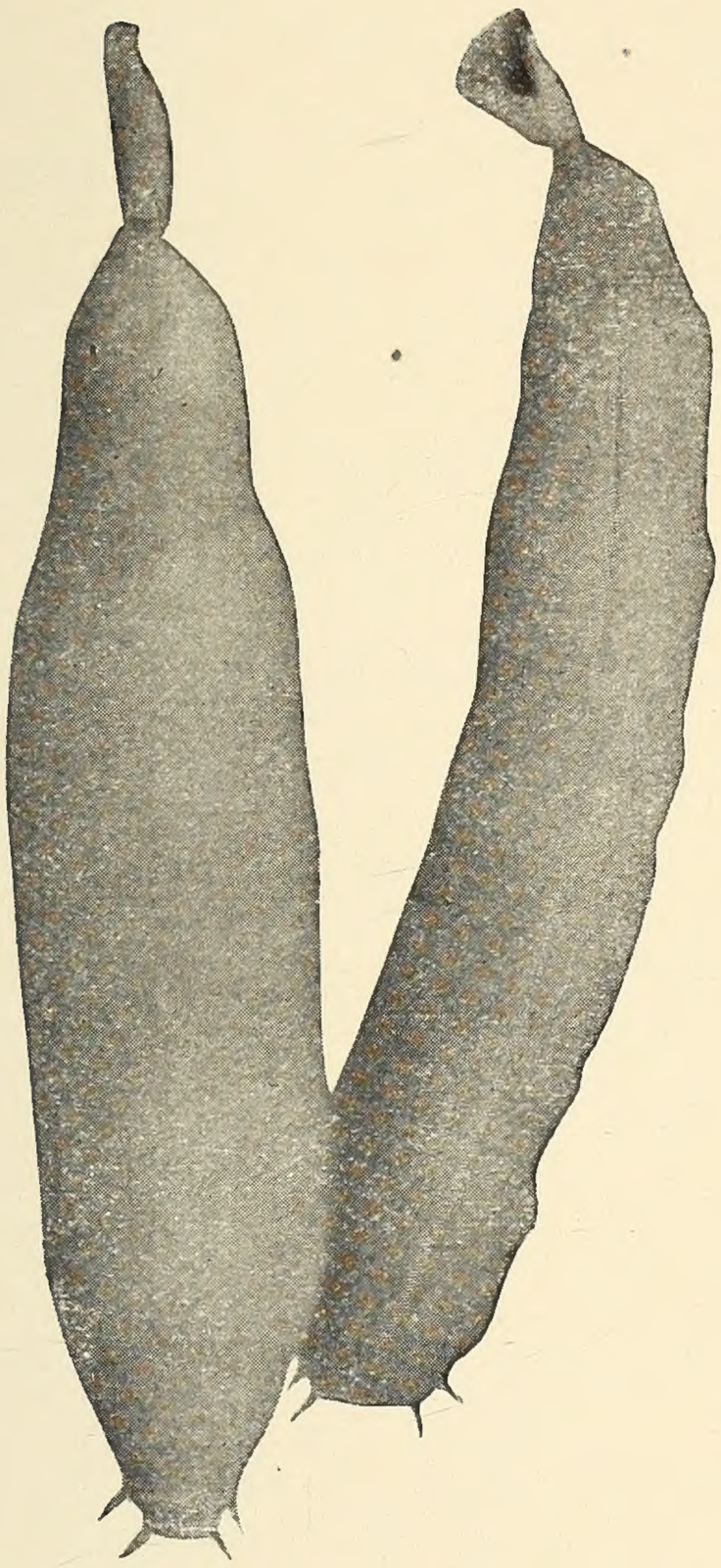

FIG. 1. — A male (right) and female (left) *E. Pallasii* in a normal state of contraction in sea-water. × ½. Photographed from life.

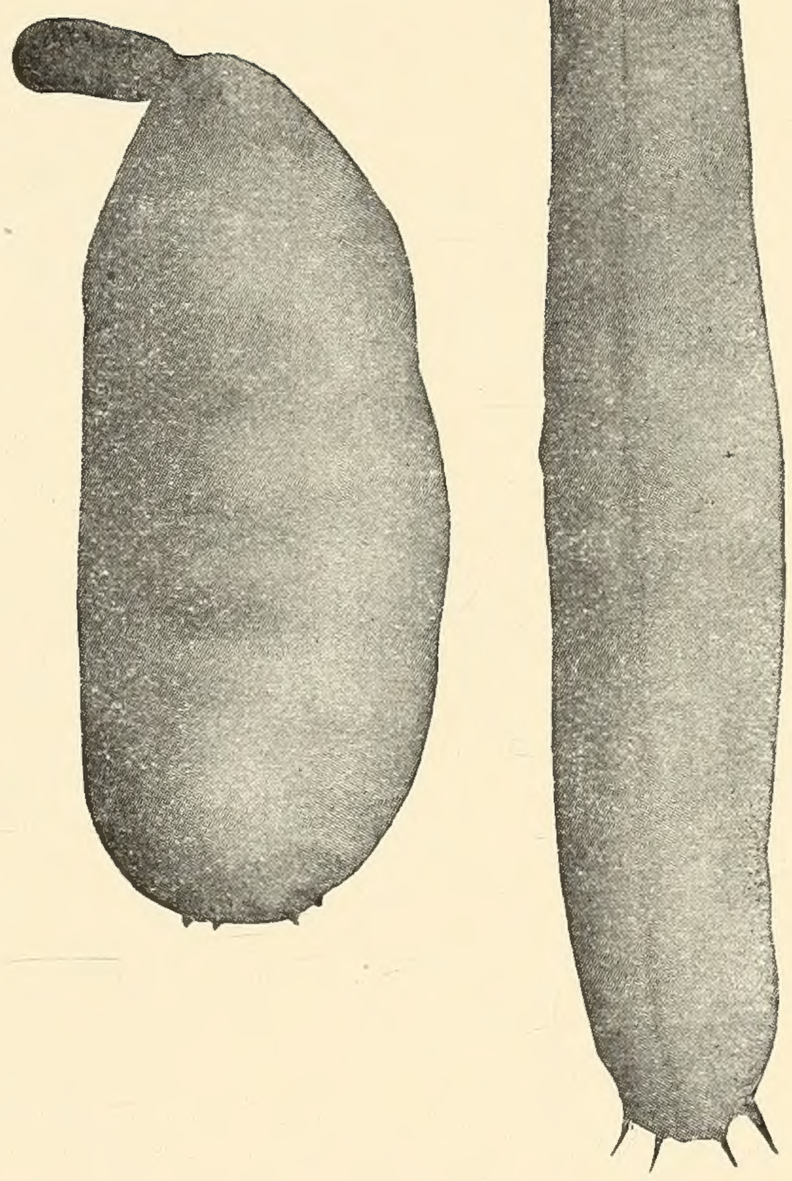

FIG. 2. — The same pair in the same position, but with the female contracted under irritation. × ½. Photographed from life

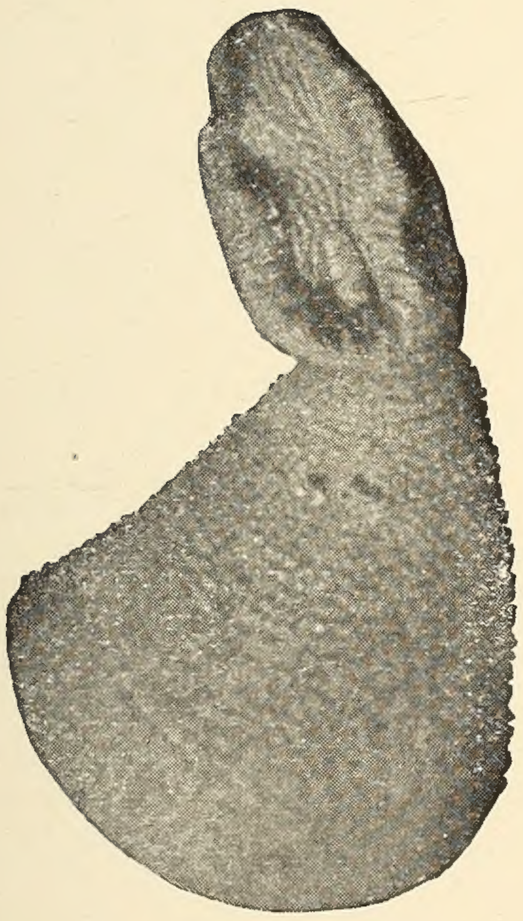

FIG. 3.— Ventral view of proboscis and anterior body. Photographed from preserved Alaskan specimen. Life size.

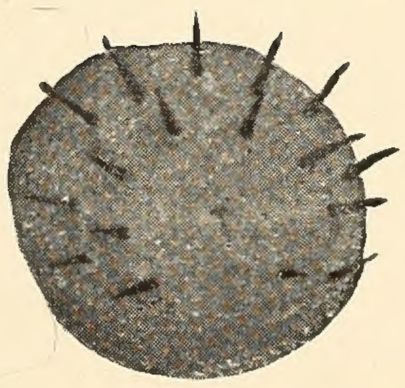

FIG. 4. — Anal rows of setae. Photographed from preserved specimen. Life size.

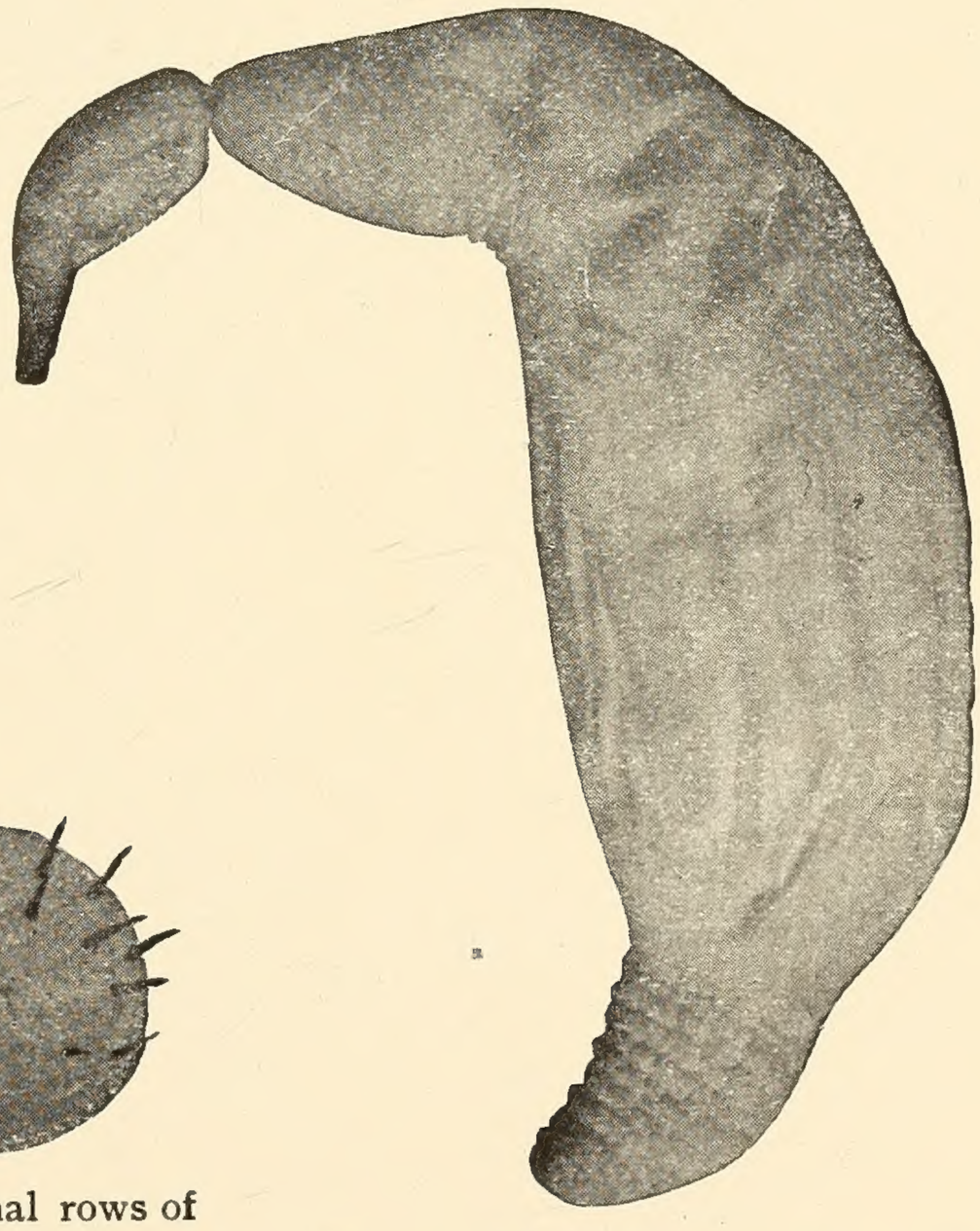

FIG. 5. — *Thalassema erythrogrammon.* Photographed from preserved specimen. ⅔ actual size.