

COMUNICACIONES ZOOLOGICAS DEL MUSEO DE HISTORIA NATURAL DE MONTEVIDEO

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Volumen II

FURTHER ARCHIANNELIDS FROM BRAZIL

EVELINE DU BOIS-REYMOND MARCUS *

I. SACCOCIRRUS PUSSICUS, n. sp.

Figures 1-10

At the beach of the island of São Sebastião, 100 km. East of Santos, lives a species of *Saccocirrus* in coarse and middle-grained sand between tide-marks. It was collected in great numbers with a fish as bait in January and March, and much less numerous in September 1948.

The living worms attain 30 mm. in length and about 0,4 mm. in diameter. The fertile segments in mature worms may be a little thicker. The number of segments is up to 120 in my preserved material. The intersegmental septa are not muscular. The colour is whitish with orange or brownish tints, probably due to the colour of the intestine. The caudal appendages (Fig. 3) have 6-12 adhesive papillae each.

The setae in a bundle are 0,22-0,28 mm. long and 5-7 in number. They belong to two similar types (Fig. 4). The flexible hair-setae of *S. gabriellae* and the other species are absent. There are finer setae of 2 μ in diameter and thicker ones of 3 μ . The former are longer; their end widens gradually to form a 8 μ long, 4 μ broad, concave blade with a notch in the tip. The thicker and shorter setae are oar-shaped, 15 μ long, 6 μ broad, concave, and terminate with a straight line. In the budding zone 7 to 11 segments are non-setigerous.

The tentacles are 0,06 mm. in diameter and up to 1,6 mm. in length. Bent backwards, they attain the twelfth segment. The ampullar apparatus is like that in the other species of the genus, but the wall of the transverse canal that connects the ampullae contains more nuclei.

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The brown eyes are round and a single pair. No accessory eyespots were seen. The ciliated sensory pits (Fig. 1, c) lie dorsally in the furrow between the prostomium and the mouth-segment. The stomato-gastric nerves unite in the third setigerous segment. The adhesive skin-glands form an uninterrupted belt in each segment. Their secretion is basophilic. Equal glands occur in the caudal papillae. A second kind of skin-glands has granular contents that do not tinge with eosine as in *S. gabriellae*.

The threeleft mouth (Fig. 1, m) is limited by two unciliated external lips in front, that are separated by ciliated pouches from two ciliated internal lips. The transverse hind lip is also not ciliated.

The muscular pharyngeal sac (p) occupies the second and third setigerous segment. The oesophagus (g) contains intensely eosinophilous glands in the specimens with the muscular pad intact. In these it reaches to the 6-8 setigerous segment. In a great number of the preserved worms the pharyngeal sac was missing, as in all specimens of *Saccocirrus* from Messina and Plymouth, that JÄGERSTEN studied (1947, p. 563). In the animals without a muscular pharynx the oesophagus extends to the 10-14 segment and does not stain as vividly as in complete worms. The intestine (h) has a distinct layer of muscle fibres, the circular ones are strongest in the region of the septa. The state of contraction varies, the gut can be a nearly straight tube or almost moniliform. The height of the epithelium depends of the digestive phase. A ventro-median furrow is densely ciliated (Fig. 5). Eosinophil glands (Fig. 6, e) occur through the whole length of the intestine except that of the budding zone.

The food of *S. pussicus* consists of Diatoms, Copepods, and detritus. Those captured with bait had often liquid of the fish-tissues in the intestine, some of them also blood-corpuscles, and even gill-tissue.

The nephridia in the sterile anterior and posterior segments (Fig. 5, n) are brachynephridia, wide, ciliated, straight funnels that open in front of the parapodium in males and females. They resemble those of the males of *S. papillocercus* (HEMPELMANN 1912, f. 6a). In the fertile segments the gonopores occupy the same position as the nephropores in the sterile segments. In the males the short, straight nephridium (Fig. 8, n) joins the male atrium. In the females (Fig. 9, w) the oviduct (coelomoduct) takes the place of the nephridium. The nephridiostome in the female, that HEMPELMANN described for *Saccocirrus major* (1912, f. 2, p. 268), and could not find in *S. papillocercus* (p. 272, f. 6d, stippled), was not confirmed by GOODRICH (1931, p. 312, footnote 1). Also in *S. gabriellae* I did not find a nephridiostome in the fertile female segments, nor does it exist in *S. pussicus*.

No difference in size or colour was noted between males and females (Fig. 1, 2). The gonads are paired as in *papillocercus* and *major*, not developed on one side only as in *gabriellae*. In males and females they begin in the 24-36 segment, and end in the 45-73, so that a great number of segments in the hind part is sterile as in *S. gabriellae*, and different from *papillocercus* and *major*.

The testes lie in the angle between the dorsal longitudinal muscle layer and the diagonal fibres (Fig. 6, j). The masses of developing sperms are surrounded by coelomic folds that form a heart-shaped sperm-sac (t) ventral to the intestine in each segment, closed in front and divided backward. The outer corners of this sac pierce the septum of the segment and constitute seminal vesicles (Fig. 2, v) that are separated from the sperm-sac by a constriction. According as the vesicle fills, its inner end is pushed from its original position on the limit of the following segment forward into the sperm-sac to which the vesicle belongs. Finally it touches the anterior septum of the segment on the opposite side. The seminal vesicle is continued into a cuticularized ductus ejaculatorius that connects it with the bulb of the penis (y). This nearly spherical bulb consists of big cells, part of which secretes, the rest stores, a coarsely granular acidophilic secretion. The outer half of the penis is covered with a cuticular ring provided with ca. 60 fine spines, both ends of which are free (Fig. 10). It projects into the male atrium. The atrium also receives a nephridial canal (Fig. 8, n) from the anterior segment. The male pore (x) opens in front of the parapodium.

A strange feature of the males of *S. pussicus* is the different development of the male ducts on both sides of a segment (Fig. 2). They are rarely of the same size, generally one is rudimentary, the seminal vesicle is small and empty, the granular secretion is wanting, and the cuticular ring of the tip of the penis is missing. The one-sided rudimentation of the efferent duct does not hinder the evacuation of the respective sperm-sac, because this communicates with that of the other half of the segment.

The ovaries (Fig. 1, 7) have the same position as the testicles. The mature segments contain 4-5 full-grown free oocytes of 0,06-0,08 mm. in diameter on each side. The female pores (x) lie on the same spot as the nephridiopores of sterile segments, and as the male gonopores, that is, in front of and slightly ventral to the parapodium. Thus the ventro-lateral muscle is divided into a large ventral portion and a very narrow dorsal part (Fig. 5-7, d). The straight, ciliated gonoduct begins with its internal opening (coelomostome) beside the base of the ovary, pierces the septum, and runs backward and outward to the gonopore.

Contrary to *S. gabriellae*, *papillocercus* and *major*, *S. pussicus* has no spermathecae. Copulation takes place by hypodermic injection into any sterile or fertile segment (Fig. 1, 5, q), where the contents of one male seminal vesicle are deposited between the body-wall and the intestine. In several cases sperm-masses were also seen injected into male worms, even in testes-bearing segments. The sperms disperse gradually and migrate through the body. Some wander forward and are stored in certain regions of the peritoneum of the sterile segments (Fig. 5, s), others are incorporated by coelomic cells in the wall of the fertile segments (Fig. 7, 9, s). Perhaps the dorso-lateral peritoneal pads that agglomerate the wandering sperms represent the rudiments of spermathecae, although these pads also occur in the sterile segments. The storage of sperms in these pads is certainly the phenomenon described as "cystospermatogenesis" in the "hermaphrodites" of *Protodrilus* (PIERANTONI 1908, p. 113, t. 7: f. 18, t. 9: f. 18-22). Already GOODRICH (1931, p. 316-317) interpreted PIERANTONI's description correctly as phagocytosis. My findings in *Saccocirrus pussicus* support his view, that the supposed hermaphroditism in *Protodrilus* was based upon a misunderstanding of the sperm-resorption in females (see below: female organs of *Protodrilus*).

The rest of the spermatozoa penetrate between the ovocytes and enter the young ones (Fig. 7, o). The smallest inseminated ovocyte measured 19μ in diameter. A small percentage of the biggest ovocytes are in the first (Fig. 7) or second (Fig. 9) maturation division. The male nucleus is in a resting phase, while the female meta- and anaphases show nine short chromosomes of slightly different shape. Reduction is effected by the first division. With 18 diploid chromosomes *S. pussicus* has the same number as V. B. DE BAEHR has established for *S. major* (1920, p. 386).

Discussion. — *Saccocirrus pussicus* had a slightly different appearance from *S. gabriellae* (D. B.-R. MARCUS, 1946) at the first sight. The study of the specimens revealed profound differences, though the size of the worms and position of the fertile segments is nearly the same. From *S. papillocercus* and *S. major* both Brazilian species differ by the situation of the fertile segments and the female genital pores. Therefore *S. pussicus* must be compared in detail only with *S. gabriellae*. The chief divergences from *S. gabriellae* are the following:

- 1) The setae are of two rather similar types, against three in *S. g.*
- 2) All specimens of *gabriellae* had a complete muscular pharyngeal sac, while in the most *S. pussicus* it was entirely missing, although the worms were preserved very carefully.
- 3) The gonads, that are developed only on one side of the body in *S. g.*, are present on both sides in *S. p.* as in the Mediterranean *S. papillocercus* and *S. major*.

4) The shape of the penis, slender and without spines in *S. g.*, is nearly spherical and with a cuticular ring beset with spines in *S. p.*

5) The female genital pores lie in the same position as the sterile nephridiopores dorso-laterally in front of the parapodia in *S. p.* In *S. g.* they lie ventro-laterally near the nerve-cord.

6) The female lacks spermathecae in *S. p.*; instead copulation is performed by hypodermic injection like in *Dinophilus*. *S. g.* has spermathecae as *S. papillocercus* and *S. major*.

II. PROTODRILUS CORDEROI, n. sp.

Figures 11-16

With the first fish that was laid out as bait for worms on the beach of the island of São Sebastião (100 km. East of Santos) in January 1948, we caught some twenty *Protodrilus*. We looked for more specimens carefully at the same place for many times during our three stays (I, III, & IX, 1948) on the island, and succeeded to find them again on exactly the same spot in September 1948. The animals live in rather fine sand (diameter of the grains 0,2-2 mm.) near the upper tide-mark, a few cm. beneath the surface. In January the sexual specimens were only old females with ovocytes in the wall and in the lumen of the intestine. Also in September the greatest part (ca. 80) of my lot of nearly 100 worms were females with a small number of big ovocytes in the wall and lumen of the intestine. Three specimens were males with ripe sperms, about a dozen had young gonads, and one was a young female.

The body-shape (Fig. 11, 12) is so typical that the worms were immediately recognized generically, but the species is different from the European ones and therefore new. I dedicate it to Prof. Dr. Ergasto H. Cordero, Director of the Museum of Natural History, Montevideo.

The living worms attain a length of up to 6 mm., preserved ones measure 1-2,5 mm. and have a diameter of 0,06-01 mm. They have 20-40 segments, the limits of which are often slightly contracted. The head is round, and the tentacles are separated by a small prominence, that JÄGERSTEN (1940, p. 2) calls "die Schnauze". The slender tentacles (15 μ broad) are 0,18-0,25 mm. long and directed forward in creeping; if bent backward they would attain the third segment. Their anterior border is beset with a loose row of softly waving cilia. The ampullar apparatus of the tentacles is small. The hind end of the worm (Fig. 12) forks into two short and pointed adhesive appendages (25-40 μ) that touch each other in the middle, ventrally to the anal opening.

The worms are colourless and without eyes and statocysts; they have no setae. On the sides of the head there are two ciliated pits (c) that coalesce with the ciliated area around the mouth. This is continued as a median ciliated furrow (d) along the whole ventral side. There are no lateral rings of cilia on the segments. The ventral ciliation and the sensory hairs were observed in the living worms. Sensory hairs are scattered over the body, only on the caudal appendages they are numerous. JÄGERSTEN (1940, p. 5) estimates the distribution of the ciliar tufts as of little taxonomic value, as previous authors have only described them summarily.

Basophilic skin-glands of various shapes, that are colourless in the living worm, occur on both sides of the ventral furrow and scattered over the rest of the body. The pharyngeal sac (p) is typical of the genus (JÄGERSTEN 1947, p. 557). The extension of the salivary glands (g) varies, they reach the 5, 6, 8, 9, 10, or, in the biggest specimens, even the twelfth postpharyngeal segment. Their cytoplasm stains intensely blue and their secretion is eosinophil (Fig. 13).

The nephridia (n) are all brachynephridia (after GOODRICH 1931, p. 309: coelomoducts). My material is not sufficient for a description of the anatomy of the male worms. For the females I confirm GOODRICH's opinion (1931, pp. 316-317) against PIERANTONI (1908, p. 113), that they are true females and not hermaphrodites. The paired segmentary ovaries lie in the lateral coelomic chambers with the growing oocytes behind the ovogonia. The larger oocytes are separated from the ovary and fix themselves in the wall of the intestine that they gradually penetrate. Then they lie between the muscle-layer and the intestinal epithelium (PIERANTONI 1908, p. 116, t. 6: f. 13, 24, t. 7: f. 3). The latest available stages show single big oocytes without any traces of insemination in the lumen of the intestine in the middle region of the body (Fig. 14, 16). In the many females of *P. corderoi* I have never found sperm cells, as PIERANTONI and GOODRICH have described them in *Protodrilus*, and I in *Saccocirrus pussicus*, probably because I did not see worms in the right period of the year. I presume that my many observations of oocytes in the lumen of the intestine are due to elimination of unfertilized eggs, that are perhaps partly digested. The expulsion of ripe eggs through the anal opening, that SCHULZ (1937) observed in one case, was caused by rupture of the wall of the intestine due to the pressure of the mass of eggs in the coelomic cavity. Generally the Baltic worms freed their eggs through the dorsal body-wall of the last segments.

Discussion. — *Protodrilus corderoi* is a *Protodrilus* without ciliary belts on the trunk segments, without setae, with two caudal appendages, without eyes, with colourless skin-glands, with lateral sensory pits, and salivary glands

not beyond the twelfth segment. As is shown by REMANE's *key* (1932, pp. 29-33), *P. corderoi* has all these characters in common with *P. spongioides* Pierantoni, 1903 from a freshwater aquarium at Naples, that was never found in natural conditions. *P. spongioides* has statocysts, is much bigger (20 mm. long, 0.4 mm. broad), has macronephridia, and hook-shaped skin-glands.

III. DINOPHILUS GYROCILIATUS O. Schmidt

Figures 17-28

In the same way as OSCAR SCHMIDT 100 years ago discovered the first *Dinophilus* (1848) when he studied Turbellaria, I found my material examining the sand-inhabiting Turbellaria of the bay of Santos and its neighbourhood. The first South-American record of *Dinophilus* is that by SCHMARDA (1861, p. 10), who obtained a colourless *Dinophilus*, *D. sphaerocephalus*, in the brackish water of Guayaquil (Ecuador). Probably this species is a synonym of the present one.

METSCHNIKOFF (1881, pp. 299-300) was the first author who described the sexual dimorphism of *D. gyrociliatus* and the occurrence of large and small eggs. He also observed that the large eggs give rise to females, the small ones to males, that are dwarfs. They measure 0.05 mm., that is, approximately one thirtieth of the full-grown females (1, 3 mm.), have no eyes, and a quite rudimentary gut without mouth and anus, represented only by a small group of cells in the anterior part of the body (NACHTSHEIM 1919, p. 53). In these males the ciliation of the body is restricted to the ventral surface and an anterior ring. KORSCHIELT (1882) who ignored METSCHNIKOFF's observations (KORSCHIELT 1887, p. 962) gave the first full description of *D. gyrociliatus* with excellent plates.

BEAUCHAMP (1923, p. 758) who revised the Dinophilidae in FAUVEL's Faune de France (1927, p. 442) and REMANE (1932, p. 33) consider the three whitish or colourless species of *Dinophilus* with dimorphic ova and dwarf males as belonging to the same species, viz. *D. gyrociliatus* O. Schmidt, 1857. This species was first found in the port of Naples and later on reported from various localities on the Mediterranean, the European and North American coasts of the Atlantic, as well as from many sea-water aquaria.

The other species of *Dinophilus* (see JÄGERSTEN 1943; 1944) are orange-coloured or red, and their males and females differ only by the gonads and efferent organs; their eggs are monomorphous. The example of *Dinophilus* figured (f. 339) and described in the textbook of PARKER & HASWELL (1940) belongs to this group. Therefore the text ought to have considered that the two sets of eggs (p. 375) refer to *D. gyrociliatus*, not to *Dinophilus* in general.

The genus belongs to the Archiannelida, of which *Saccocirrus gabriellae* and *Nerilla mediterranea* were previously described from Santos (DU BOIS-REYMOND MARCUS 1946; 1947). The Archiannelida are a probably artificial group uniting the Annelida of simple structure. Most of them are small, all are aquatic *, chiefly marine. The parapodia are reduced in some of the families, absent in others, f. ex., in the Dinophilidae. These are further characterized by the ciliation of the ventral side, the small number of segments, and the absence of tentacles and chaetae. The species of the genus *Dinophilus* have two eyes (absent in the dwarf males of *D. gyrociliatus*), a pointed hind-end, and besides the ventral cilia, ciliated rings that can be interrupted in the dorsal median line (after REMANE 1932). The worms are able to swim by means of their cilia and live in sea and brackish water, in sand, on mud, and between algae. In the bay of Santos and on the coast of Guarujá near Santos I found *D. gyrociliatus* chiefly in shelly sand, but also in fine sand.

The morphology of *D. gyrociliatus* is known through the papers of KORSCHOLT (1882), NELSON (1907), BEAUCHAMP (1910a; for coelome see JÄGERSTEN 1944, p. 32), SHEARER (1912), NACHTSHEIM (1919), and others. Therefore I only give some drawings (Plate IV) in order to evidence the determination of my material and to facilitate the identification for future workers interested in the problems of the worm's reproduction. As no visible cause for the different growth of the male and female-producing eggs can be seen (NACHTSHEIM 1919, p. 58; SHEN 1936, p. 228), and the oocytes are only inseminated after their differentiation, the chief problem of *D. gyrociliatus* shows to be of developmental and not of genetic order. As NACHTSHEIM (1919, p. 116) emphasized, this is the central question of analytical embryology, the problem of determination. It remains just as obscure here as in the formation of sperms and eggs in the hermaphrodite gland of a snail, in the zooid of a Bryozoan, or in the histological or cytological differentiation of any organ.

NACHTSHEIM (1919, p. 64) observed that in both kinds of eggs two polarocytes are extruded and the 20 chromosomes are reduced to 10. SHEN's study (1936) confirms NACHTSHEIM's results. Hereafter both large and small oocytes are fertilized in the same and normal manner. WILSON (1940, p. 808) assumes that the female is the digametic sex; and WADDINGTON (1939, p. 230) supposes that all oocytes possess an XY pair whose members are not distinguishable

* I follow MICHAELSEN (1928, p. 104, 110) and STEPHENSON (1930, p. 779) in considering the "terrestrial Archiannelid" *Parergodrilus heideri* Reisinger (1925) as an Oligochaete of the family Enchytraeidae.

cytologically. The sexual dimorphism (dimegaly) of the eggs may be correlated with a differential maturation, so that in the large eggs the Y is passed into the polocyte, while in the small ones it is the X which is extruded (WADDINGTON, l.c.).

With exception of REMANE's skilful synopsis (1932, p. 20) all the text-books consulted, written in English, French and German, HEMPELMANN's Archiannelida in KÜKENTHAL's Handbuch (1931, p. 83), and even FAUVEL's chapter in the Faune de France (1927, p. 443), omit BEAUCHAMP's important observation (1917) of males originating from large eggs. BEAUCHAMP found these worms nearly as incomplete as dwarf males, viable for at most a few days, but with mobile sperms. They seem unable to copulate (ibid., p. 57). An other type of worms discovered by BEAUCHAMP (ibid., p. 56) are dwarfs in which the sperms that are develop in normal newly hatched males are wanting. These might be cryptical females, but as they do not have any gut and therefore are short-living, an ovary does not become recognizable. In the normal newly hatched female the ovary is not visible. Sections of the big males and the dwarfs without sperms were not described. The existence of such forms complicates the problem of progamic sex detemination still more.

The anomalous males and asexual or immature dwarfs also implicate some uncertainty in the problem of geographical forms and parthenogenesis in *Dinophilus gyrociliatus*. The ratio between large and small eggs differs in populations from different localities and can be modified by external factors (TAUSON 1929; TZONIS 1938). As far as I know, the anomalous types have hitherto not been considered in such countings.

The statement that "unfertilized eggs do not divide at all" (WILSON 1940, p. 808) is not exact. Parthenogenesis occurred in the population of the sea-water aquarium at München (NACHTSHEIM 1919, p. 109-110), although the embryos died before hatching. Various monstrosities arose in consequence of serparation of blastomeres in the unfertilized eggs. BEAUCHAMP obtained up to four generations of parthenogenetic worms with material from Roscoff (1910); with those from Monaco such breeding was less successful. Both authors found large and small eggs in the parthenogenetic cocoons, and BEAUCHAMP saw the extrusion of two polocytes (1910, p. 740). He thought that the numerical reduction of the chromosomes continues in the parthenogenetic generations, and that therefore malformations are frequent and the lines become extinct. It is true that BEAUCHAMP's experiments were carried out before he discovered the large males (REMANE 1932, p. 21). He destroyed the small eggs or separated the males in the moment of their hatching. By this method he certainly did not exclude from his "incotestament

vierges" cocoons (1910, p. 740) large eggs containing anomalous males, the impotency of which is not yet proved. But as BEAUCHAMP later on (1923, p. 758) maintained his earlier results, and these differ only by degree from NACHTSHEIM's (1919, pp. 106-109) who used cocoons with one egg, I believe that they will be confirmed by any population with the same constitution as that of Roscoff.

TUN HUI SHEN (1936) repeated BEAUCHAMP's and NACHTSHEIM's experiments on parthenogenesis and removed the small eggs from the cocoons to obtain unfertilized females. The 8633 eggs that these produced went through the cleavage and part of the following stages, but died before hatching (l.c., p. 225) My experiences with a small number of unfertilized eggs had the same result.

MAX HARTMANN's school did not read the later papers of BEAUCHAMP (1917; 1923), and SHEN (1936) and TZONIS (1938) still judge the sex of the eggs after their size (1938, p. 540). They consider the altering of the proportion of large and small eggs as an altering of the sex-ratio.

I myself incurred in the same error when I tried to determine the ratio in my population after NACHTSHEIM. The results were rather varied: the first 100 cocoons contained 329 eggs, 109 of which were small and 220 big. The same females were transferred to another watch glass, and two days later 100 new cocoons had 428 eggs, 124 small and 304 big ones. The third lot of 100 cocoons from the same worms again two days later consisted of 510 eggs, of which 136 were small and 384 big. The ratio of the three successive countings was: 1:2; 1:2,45; 1:2,82.

During the development of these eggs, that were generally fastened to the bottom of the glass and not to the border and the surface of the water (NACHTSHEIM 1919, p. 24), some of the big eggs assumed a different aspect from the majority, in which the curved females were recognizable by their two dark eyes (Fig. 23) and the yolk in their intestine. The abnormal embryos were spherical and contained a big, transparent vacuole. Generally they had no eyes. When they hatched, they proved to be giant males, 0,14 mm. long and 0,11 mm. in diameter, with a ciliated area on the top and on the ventral side, and a penis similar to that of the dwarf males in shape and size (10 μ). They swam about for several days, contrary to those described by BEAUCHAMP (1917, p. 57). Immediately after hatching their testicles contained only a small number of spermatogonia in synaptic phases, but after a certain time they developed ripe sperms that moved about actively. They had neither mouth nor anal opening, and the rudimentary intestine contained some yolk. I could not observe whether they were able to copulate.

Different from these spherical and eyeless giant males were two of the vacuolized embryos. They had one eye, several short anterior lobes (Fig. 26), and resembled larvae of *Saccocirrus* or *Protodrilus*. Sections revealed them to be neotenic females, on the whole developed like the giant males, but with one unpaired ovary. Comparison with NACHTSHEIM's figures (t. 3, f. 12-19) proved, that the ovary of these just hatched females is further developed than in newly hatched normal ones (i.e., f. 12-17). It corresponded to the "young females" (i.e., f. 18-19), in which the oocytes are already growing and incorporating others.

The measurements of the eggs in my population were, in microns: 120×80 ; 90×80 ; 110×60 ; 110×110 , and so on, for the big ones; 30×40 and 40×40 for the small ones. Besides big and small eggs I also found a few of intermediate size (perhaps a dozen in several hundred cocoons) of 70×90 to $60 \times 65 \mu$. Further cultures must evidence, whether the worms hatching from these eggs are males and females, as BEAUCHAMP (1917, p. 57) obtained them. Also great numbers of small eggs have to be studied exactly to see, whether part of them hatch asexually as potential females, as in BEAUCHAMP's populations (ibid., p. 56). Every population comprises a number of cocoons with eggs that do not develop or stop after the first phases. These are parthenogenetic eggs produced by females that had not copulated in the moment of hatching, due to an unfavorable sex-ratio. The dwarf males are not able to copulate more than once (BEAUCHAMP 1910, p. 740), and most cocoons have more females than males.

The complication of the mode of sex-determination in *Dinophilus*, that has puzzled so many investigators before me, and is not yet explained, induces me to repeat SÖDERSTRÖM's words: "Ich will nicht verbergen, dass ich eine gewisse Achtung vor *Dinophilus* habe".

IV. POLYGORDIUS ESCHATURUS, n. sp.

Figures 29-34

Together with *Saccocirrus pussicus* on the beach of the island of São Sebastião we found long and thin worms that twisted up into a spiral knot when they were touched. Their two short tentacles and bulb-shaped hind ends characterized them as *Polygordius*, and as the two caudal appendages on the tip of the bulb do not occur in any of the previously described species, this one is new.

The worms attain a length of 40 mm. and a diameter of 0,21 mm., the bulb is about 0,3 mm. wide. The tentacles measure 0,15-0,22 mm., and the caudal appendages 0,05-0,07 mm. The number of segments is 120-180; in the preserved specimens they are a little

shorter than high. The colour is white or a light blood shade, the worms have no eyes. The mature segments are whitish due to the masses of germ-cells.

The solid tentacles (after HANSTRÖM 1928, p. 336: palps) are not contractile. They are connected at their bases and do not leave an apical field between them. On the level of the ventral fold (Fig. 31, 32, f) between prostomium and peristomium there are two dorso-lateral ciliated pits (p). The transverse fibres of the cuticle are distinct in tangential sections. Skin-glands (e) are scarce, a little more frequent near the head, and a belt of adhesive glands (a) disposed in longitudinal groups surrounds the caudal bulb. The caudal appendages (x) on both sides of the anal opening are mere epithelial papillae without lumen and muscles. COWLES (1903, p. 127) described sections of the anal filaments of *P. appendiculatus* identically.

The large mouth (Fig. 29, m) opens into a strongly ciliated cavity that is sub-divided by a dorso-median fold into two deep anterior pouches (Fig. 32). Behind the lower lip lies a small pharyngeal sac (Fig. 31, q) with thin epithelial walls and no muscular bulb, just as in the other species of the genus (JÄGERSTEN 1947, p. 563). Above it the intestinal tube runs backward. The tube gradually diminishes in diameter and the cilia in length, except in a ventro-median field, where they remain a little longer. The height of the epithelium varies after the digestive phase. The muscle-layer of the wall is recognizable. There are no conspicuous intestinal gland cells. The contents of the gut are often diatoms and detritus (HEMPELMANN 1906, p. 568), never sand. Several of our baited worms were filled with fish-juice, but not with blood-corpuseles as *Saccocirrus*. The anal opening lies on the hind tip of the caudal bulb. It is closed by a strong sphincter muscle and flanked by the short caudal appendages.

The body-cavities of *Polygordius lacteus* and *P. neapolitanus* have been studied by HEMPELMANN (1906, pp. 534-546, textf. 1-9). In *P. eschaturus* the peripharyngeal cavity is much smaller than in the mentioned species. It occupies only the space limited by the dorso-median fold that separates the halves of the mouth-cavity (Fig. 32, z). On the level of the lower lip this fold expires, and the cavity is filled up by an unpaired organ (Fig. 31, 34, o) that I suppose to be a supra-oesophageal ganglion, as such is known from *Polychaetes* (HEIDER 1925, f. 7, g; f. 16, g). The connection with the stomatogastric nerves (h) is distinct, while the tract coming from the brain and running in the ligament below the dorsal vessel is difficult to see. Neither FRAIPONT nor HEMPELMANN (1906, p. 585) have seen this ganglion; the latter states that a communication of the pharyngeal nerves with the brain does not exist, and assumes that

these nerve-fibres belong to cells situated in the fibrous cover of the oesophagus. In the present species the two stomatogastric nerves originate together from the unpaired dorsal ganglion and run side-wards, backwards, and downwards around the oesophagus, and unite short behind the mouth. The brain does not show any divergences compared with HANSTRÖM's detailed study of that of *Polygordius lacteus* (1928).

The blood vessels correspond to those of *P. lacteus* (HEMPELMANN 1906, t. 25, f. 1) and do not wind in loops as in *P. triestinus* (l. c., t. 29, f. 57). The dorsal vessel is surrounded by a number of longitudinal muscles, that are strongest in the anterior part. In the fertile segments it leaves the dorsal mesenterium and lies in the space between the muscle-layer and the epithelium of the intestine. In this region it has the character of a blood-sinus and does not cover more than the sixth part of the circumference of the gut. In *P. lacteus* it comprises the dorsal half of the gut. In *P. lacteus* it comprises the dorsal half of the gut (HEMPELMANN 1906, p. 574). The nephridia were not observed in the living worms.

The reproductive organs develop in the segments behind the twentieth to twenty-eighth, farther forward than in *P. lacteus*, for which HEMPELMANN (1906, p. 574, 601) gives segment 40 as the first fertile segment. They are produced in all posterior segments with exception of the hindmost developing ones. The free germ-cells accumulate in the hind end of the body and fill all the young segments of the whole budding-zone, leaving only the perirectal cavity empty. The worms were mature in January and March 1948. We did not find any specimens with regenerating hind ends (HEMPELMANN 1906, p. 603, f. 21).

This is the first record of *Polygordius* from South America. Giant endolarvae have already been observed from the South Atlantic in the collection of the "Valdivia" (WOLTERECK 1905, p. 156, note). Larvae and adult worms of *P. appendiculatus* are also known from the North American Atlantic coast (COWLES 1903, pp. 125-128; HEMPELMANN 1908, p. 667).

LIST OF THE SPECIES OF THE GENUS *Polygordius*

- P. lacteus* Schneider, 1868
[FRAIPONT 1887, p. 86; HEMPELMANN 1906, p. 528].
- P. apogon* (McIntosh, 1873)
[FRAIPONT 1887, p. 87].
- P. villoti* Perrier, 1875
[FRAIPONT 1887, p. 87].

- P. erythrophthalmus* Giard, 1880
[FRAIPONT 1887, p. 88].
- P. appendiculatus* Fraipont, 1887
[FRAIPONT 1887, pp. VII, 88].
- P. neapolitanus* Fraipont, 1887
[FRAIPONT 1887, pp. VII, 89].
- P. ijimai* Izuka, 1903
[IZUKA 1903, p. 137].
- P. triestinus* Woltereck, 1905
[WOLTERECK 1905, p. 159; HEMPELMANN 1906, p. 605].
- P. ponticus* Salensky, 1905
[SALENSKY 1905, p. 135].
- P. pacificus* Uchida, 1935
[UCHIDA 1935, p. 119].
- P. eschaturus*, n. sp.

Of the earlier described species *P. epitocus* Davydoff 1905 is no longer listed in HEMPELMANN'S synopsis (1931, p. 157). REMANE (1932, p. 29) considers *P. villoti* Perrier 1875 and *P. erythrophthalmus* Giard 1880 as uncertain. In the following key I did not succeed to dispose *epitocus*, that is "in nothing different from the common species" (abstract by E. SCHULTZ, Zool. Zentralbl., v. 15, no. 554), and *P. ponticus* Salensky 1907, the description of which is not available for me (see HEMPELMANN 1906, p. 530; 1908, p. 649, 666). *P. lacteus*, *apogon*, *neapolitanus*, and *ponticus* were all considered as synonyms by various authors. FAUVEL (1927, p. 416) and REMANE (l. c.) separated *lacteus* with red and *neapolitanus* with lemon-yellow blood. HEMPELMANN states the colour of the blood as greenish-grey for *lacteus* (1906, p. 563). The larva of *P. ponticus* Salensky is a modified endolarva (HEMPELMANN 1908, p. 666), so that an identification with *neapolitanus* does not seem conclusive. In 1906 HEMPELMANN (p. 528) united also *lacteus* and *neapolitanus* that he later on separated again (1931, p. 157). WOLTERECK'S crossing experiments of *lacteus* and *neapolitanus* (1905, pp. 159-160) are regarded as argument in favour of the identity of the species by HEMPELMANN (1906, p. 610) But as the development did not continue after the initial phases, I rather see a proof of specific difference in these experiences.

KEY TO THE SPECIES OF *Polygordius*

- | | | |
|---|--|-------------------|
| 1 | With a ciliated area on the pygidium | <i>villoti</i> |
| | Without a ciliated area | 2 |
| 2 | Hermaphrodite, hind end not widened to form a bulb | <i>triestinus</i> |
| | Separate sexes, hind end bulb-shaped | 3 |
| 3 | Pygidial bulb without appendages | 4 |
| | Pygidial bulb with appendages | 8 |

4 Adult worms without eye-pigment	5
Adult worms with eye-pigment	7
5 Length up to 30 mm.	<i>pacificus</i>
Length up to 100 mm.	6
6 Blood red; development by endolarva	<i>lacteus</i>
Blood yellow; development by exolarva	<i>neapolitanus</i>
7 Eye-pigment black	<i>apogon</i>
Eye-pigment red	<i>erythrophthalmus</i>
8 Three pygidial appendages	<i>ijimai</i>
Two pygidial appendages	9
9 Appendages pre-terminal	<i>appendiculatus</i>
Appendages terminal	<i>eschaturus</i>

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