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TURBELLARIA FROM MADEIRA AND THE AZORES [1]

By Eveline Marcus and Ernst Marcus [2]

The worms described in the following were collected by Drs. Per Brinck and Erik Dahl from February to April 1957. Though the bulk of the collection, 198 worms of the Tricladida Paludicola, were all immature, and therefore could not be determined, the rest contains morphological and zoogeographical novelties, as was to be expected as our knowledge of the turbellarian fauna, particularly of the Azores, is so meagre.

The material is deposited in the collection of the Zoological Institute of the Lund Unversity.

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1) Report No. 3 from the Lund University Expedition in 1957 to the Azores and Madeira.

2) Zoological Institute of the University of São Paulo, Brazil.

LIST OF MATERIAL

Order *Rhabdocoela*, Suborder *Typhloplanoida*

Family *Typhloplanidae*, Subfamily *Phaenocorinae*

Phaenocora brincki spec. nov. (see p. 17)

Order *Seriata*, Suborder *Proseriata*

Family *Otoplanidae*, Subfamily *Otoplaninae*

Otoplana intermedia Du Plessis 1889 (see p. 20)

Family *Nematoplanidae*

Nematoplana spec. Occurrence: Azores, São Miguel; São Pópulo, 7.5 km. E of Ponta Delgada, subsoil water, altitude 31 m., 12. III. 1957, Loc. 10, 1 immature worm.

The genus is known from the Western Baltic Sea, North Sea, Mediterranean Sea (Ax 1956b, p. 58), and the coast of Brazil (Marcus 1949, p. 63; 1950, p. 67). In the Bay of Kiel it occurs with great constancy in coastal subsoil water (Ax 1951, p. 371). In the nematoplanids *(Nematoplana, Tabaota)* the pharynx degenerates in the female phase, and the worms cease to take food.

Order *Seriata*, Suborder *Tricladida (Euseriata)*

Section *Maricola*

Family *Procerodidae*, Subfamily *Procerodinae*

Procerodes dahli spec. nov. (see p. 20)

Procerodes sameha spec. nov. (see p. 22)

Section *Paludicola*

Family *Planariidae*

? *Phagocata* spec. Occurrence: Madeira, Ribeira da Lapa, E of Pico do Serrado, altitude 900 m., in a stream, 27. IV. 1957, Loc. 132, 9 immature worms.

The animals have the typical appearance of a member of the genus *Phagocata* (Hyman 1937, pp. 302, 305, fig. 6), rounded anterior end without conspicuous auricles, and two eyes. The back is light brown. Without copulatory organs the genus cannot be distinguished from *Planaria*.

Dugesia spec. Occurrence: Azores, São Miguel, Santa Maria, and Flores, from 10 different localities, mostly in springs, 2. III.–14. IV. 1957, Locs. 7, 22, 23, 29, 32, 34, 49, 55, 57, 108, a total of 189 immature worms.

The back is blackish, the belly in most samples lighter. Auricles are distinct, sensorial spots frequent. Several specimens have regenerating heads or tails and eccentrically located pharynges. Hence reproduction by fission can be inferred.

Section *Terricola*

Family *Rhynchodemidae*, Subfamily *Microplaninae*

Microplana terrestris (O. F. Müller 1774) (see p. 24)

Microplana hovassei (Beauchamp 1934) (see p. 26)

Microplana perereca spec. nov. (see p. 28)

Family *Rhynchodemidae*, Subfamily *Rhynchodeminae*

Rhynchodemus bilineatus (Mecznikow 1866) (see p. 30)

Family *Geoplanidae*

Kontikia spec. (see p. 31)

Family *Bipaliidae*

Bipalium kewense Moseley 1878. Occurrence: 1) Madeira, Funchal, in a ravine, 19. IV. 1957, Loc. 4, 1 immature specimen.
2) Azores, São Miguel; from 7 different localities, chiefly under stones, 1.–25. III. 1957, Locs. 18, 22, 25, 34, 60, 63, 111, a total of 14 immature worms and fragments.

To the numerous out-of-doors localities in tropical and warm temperate countries (du Bois-Reymond Marcus 1953, p. 69) the Cape Verde Islands are to be added (Luther 1956, p. 2).

Phaenocora brincki spec. nov.

Figs. 1–5.

Occurrence: Azores, São Miguel; in a pond 1 km. SE of Lagoa do Congro, 16. III. 1957, Loc. 33, 19 worms.

The preserved animals are up to 2.2 mm. long, 1.5 mm. broad, and 0.9 mm. high. They are colourless and have no eyes, as verified in clarified mounts and sections. The dark ventral vitellaria shine through the skin (Fig. 2). The body is narrowed from the middle to the pointed anterior end; the hind end is sometimes pointed, sometimes nearly round. The back is highest in advance of the middle, the belly is flat and sharply bordered.

The limits of the epidermal cells are distinct. Their cilia are not preserved, as on the whole the histological condition of the worms is not quite satisfactory. The rhabdites have evidently been discharged from the lacunae appearing within the cells (Gilbert 1935, p. 295, note). Rod tracks are developed but are little conspicuous; they open concentrated at the tip.

The mouth is situated behind the foremost fifth of the body. The length of the pharynx exceeds one fourth of the body, but this muscular organ shrinks less than the parenchyma, hence it is generally proportionally bigger in preserved than in living animals. The epithelium of the external pharyngeal pouch is nucleated, contrary to *Ph. bresslaui* and *Ph. evelinae* (Marcus 1946, pp. 67, 73). The border of the pharynx has no papillae or denticles. The nuclei of the inner epithelium of the pharynx are scarce. Of the 48 inner circular muscles 10 belong to the grasping border. The inner sphincter contains 12 fibres. The outer circular fibres apposed to the septum are about 60. They are followed by about 40 fibres of the compact external sphincter and a third group of 8 fibres located still farther outward between the sphincter and the pharyngeal mouth. There are about 50 inner longitudinal muscles separated by radial fibres. The inner pharyngeal pouch is shallow. Here the homogeneous, compact epithelium of the pharynx passes to the loose and vacuolized tissue of the intestine.

The excretory stems and pores are developed as usually in *Phaenocora*, the nephropores lying at the end of the second third. Zoochlorellae are not present.

The testes are dorsal to the vitellaria and begin farther behind. The genital aperture (w) lies under the posterior border of the pharynx, a little in front of the middle of the body. The length of the muscular copulatory bulb is about 150 μ. The seminal vesicle (s) receives the efferent ducts (e) from both sides. The vesicle is separated from the granule vesicle (g) by a very strong sphincter (d). The granule vesicle is cylindrical and has a high storing epithelium. The ejaculatory duct (p) was seen in evaginated state only. Its tip projects into the inferior atrium (j).

The ovary (o) and the common vitelloduct (v) open side by side at the limit between the female genital canal (y) and the genito-bursal duct (l). The epithelium of the female canal consists of high, club-shaped cells. The wide superior

atrium (a) which lodges the cocoon bears small pear-shaped lobes (r) on both sides. Neither in gravid nor in non-gravid atria are there lamellate elements in the pyriform appendages. The inferior atrium (j) is small, though well separated from the superior atrium. A curved, rather long genito-bursal duct (l) leads to the small spherical bursa (b). The bursal-intestinal duct (x) has some diverticula (k) slightly below its inner, high-celled valve. The latter communicates (q) with the intestinal syncytium (i).

The species is named for Professor Dr. Per Brinck (Lund).

DISCUSSION

An unarmed ejaculatory duct which in retracted condition lies within the granule vesicle (Gilbert 1935, p. 367, type 3) occurs in the following species of *Phaenocora: Ph. gracilis* (Vejdovsky 1895, p. 28); *Ph. alticola* Ruebush 1939, p. 50; *Ph. bresslaui* Marcus 1946, p. 66; *Ph. evelinae* (*ibid.*, p. 72); and *Ph. chloroxantha* (*ibid.*, p. 77).

Ph. alticola differs from *brincki* by its extremely large bursa. *Ph. gracilis* and *chloroxantha* have a broadened posterior body with a truncate hind end. This systematically useful character (Gilbert 1935, p. 369) separates them from *brincki*.

Ph. bresslaui and *evelinae* have eyes. The presence or absence of these organs can be verified in total preparations and sections, even if the pigment is dissolved. Ruebush (1939, pp. 50-51) has exaggerated the difficulty to locate eyes, when the pigment is lacking. But the specific value of the eyes is restricted by their occasional occurrence in specimens of a blind species and absence in those of a species normally with eyes (Gilbert 1935, p. 369). Without knowledge of the annual cycle of a given species one cannot evaluate taxonomically the presence *(evelinae)* or absence *(bresslaui, brincki)* of zoochlorellae, because they change with the season according to illumination (Vejdovsky 1895, p. 130; Luther 1921, p. 5).

The seminal vesicle of *brincki* is separated from the granule vesicle by a constriction which differs from the diaphragm of *bresslaui* and *evelinae*. Other differences, as the more longish granule vesicle and stronger cuticle of the ejaculatory duct in *brincki*, are possibly correlated with the conditions shown by the male copulatory organ, invaginated in *bresslaui* and *evelinae*, evaginated in *brincki*.

The female genital organs of *bresslaui* and *evelinae* have almost no *(bresslaui)* and no *(evelinae)* genito-bursal duct. Therefore we classified them in Gilbert's type 5 (1935, p. 350). In *Ph. brincki*, however, this duct is distinctly developed, and so its female organs belong to type 2.

The pyriform lobes (Vejdovksy 1895, p. 115) change widely in shape, when

a cocoon lies in the superior genital atrium (Marcus 1946, p. 75). Also the stages before and after gravidity offer different aspects of developing and regressive pear-shaped appendages. Therefore these organs are no good specific characters. A certain difference between *evelinae* and *brincki*, however, seems to exist. In *evelinae* a lamellate part exists in the non-gravid condition. In *brincki* lamellae were neither observed in gravid nor in non-gravid atria.

Otoplana intermedia Du Plessis 1889

Synonymy: Ax 1956a, pp. 669-673, figs. 20-34.
Occurrence: Azores, São Miguel: 1) Vila Franca do Campo, marine subsoil water, 28. II. 1957, Loc. 2, 2 mature worms; 2) São Pópulo, 7 km. E of Ponta Delgada, subsoil water, 31 m., 12. III. 1957, Loc. 26, a total of 2 mature and 3 immature worms.

Though the preserved animals were not longer than 1.3 mm., the sections revealed the accessory male genital canal characteristic of *Otoplana* and warranted the determination.

This is the first subterraneous finding of the species. Another *Otoplana*, *O. subterranea* Ax (1951, p. 294) has become the type of the genus *Pseudosyrtis* Ax (1956a, p. 768). With regard to the horizontal distribution, *O. intermedia* was until now only known from the western half of the Mediterranean Sea.

Procerodes dahli spec. nov.

Figs. 6 - 8.

Occurrence: Azores, São Miguel, Ribeira das Três Voltas, near Ribeira Chã, under stones in the eulittoral zone, 16. III. 1957, Loc. 35, 6 worms.

The preserved animals are up to 2.4 mm. long, 1.2 mm. broad, and 0.4 mm. high. In the smallest specimen these measurements are: 1.7; 0.6; and; 0.25. The anterior end is transversely truncate; the space between the auricles is about three times their breadth. Behind them the body widens, and its sides are nearly parallel, till they unite broadly rounded behind.

The eyes lie close behind the auricles and therefore far from one another and near the anterior and lateral borders. The light halos around the eyes are confluent with the light auricles. The dark pigment of the back (Fig. 6) is most intense in the middle of the head and in two lines which separate the centre of the back from the less pigmented sides. Two paramedian stripes are free of pigment, they disappear beside the pharynx. The belly is light or yellowish.

Rhabdites are more numerous in the dorsal than in the ventral epidermis; the height of the epithelial cells is the same.

As many other marine triclads (Marcus 1954, p. 73) also *P. dahli* contains *Steinella uncinata* (M. Schultze) in the pharyngeal pocket. The pharynx is placed nearer to the rear than to the anterior end. Its length is from one third of the body length in larger to one half in smaller worms. The external circular muscles (Fig. 7, ma) form a thicker layer than the internal ones (mi). In micra the height of the outer cilia is 3, the outer epithelium (ec) 5, the longitudinal muscles (mo) 8, the circular ones (ma) 33, the parenchymatous layer (iw) 50-60, the inner longitudinal fibres (mo) 8, the inner circular ones (mi) 30, the inner epithelium (ec) 5, the inner cilia 3. A precerebral diverticulum of the anterior intestinal branch occurs, but no communication between the posterior branches.

The ovaries are apposed to the posterior wall of the brain, the testes begin at the same level, and the yolk glands farther in front. The latter extend from the dorsal to the ventral side; the testes are principally dorsal to the lateral diverticula of the intestine.

The efferent ducts (e) unite at their entrance into the penis (p), whose bulb is weakly developed. The entire organ is about 0.15 mm. long and 0.1 mm. in diameter. The ejaculatory duct forms a seminal vesicle (s) nearly in the centre of the blunt penis.

The almost vertical common ovovitelline duct (v) has a spherical central chamber (oa) between the ental and ectal tubular parts. This chamber and the ectal tube receive the pink secretion of the shell glands (sa). The common ovovitelloduct opens into the female genital canal (y) from behind. The female genital canal rises from the lower part of the atrium (a) obliquely backwards and is continuous with a short bursal canal. The voluminous bursa (b) is lined with high epithelium containing sperm. Cement glands (cc) surround the genital aperture (w).

The species is named for Professor Dr. Erik Dahl (Lund).

DISCUSSION

The muscles of the pharynx of the Maricola have not yet received the attention one would expect in a Section of the Tricladida that constitutes a parallel to the Paludicola (Meixner 1928, p. 588). In the latter the pharyngeal musculature is important not only for the taxonomy of the two principal families (Kenk 1930, p. 150-151), but also for the separation of species (Marcus 1953, p.

16-17; 1955, p. 17). Böhmig (1908, p. 13) stated that in *Procerodes* the circular layers of the outer and inner muscles are stronger than the longitudinal ones. In *P. harmsi* the inner longitudinal muscles are stronger than the corresponding circular ones (Lehmensick 1937, p. 137). As the ovovitelline ducts enter the bursal canal separately in *P. harmsi*, this species should be classified as *Stummeria* Böhmig 1908. The most important observation concerning the muscles of the pharynx in *Procerodes* is that of Böhmig (1906, p. 400). He indicated the inner circular muscle layer as the thickest of all, after an examination of 5 species. His result has not been taken up in Wilhelmi's monograph (1909). Perhaps this is the reason why the descriptions of new *Procerodes* (Ijima & Kaburaki 1916; Kaburaki 1922; Kato 1943; 1955; and Hyman 1954b) do not contain any references to the muscles of the pharynx. Only the re-descriptions of *P. macrostoma* and *P. hallezi* (Marcus 1954, p. 40, 44) confirm Böhmig's observation of 1906, that the inner circular muscles are the strongest.

The thicker outer circular layer of pharyngeal muscles occurring in the present and the following species from the Azores might well represent a subgeneric character. But we prefer to wait for re-examinations of the known species before establishing a new subgenus.

The species whose copulatory organs are most similar to those of *P. dahli* is *P. littoralis* (Ström). Its inner circular muscles are the thickest layer, as is known from Böhmig's statement of 1906 and Wilhelmi's figure (1909, t. 14, f. 12). Also the copulatory organs of *littoralis* and *dahli* are slightly different. The course of the common ovovitelline duct is nearly horizontal in *littoralis*, whereas in *dahli* it is nearly vertical.

Procerodes sameha spec. nov.

Figs. 9-12.

Occurrence: Azores, São Miguel; Ribeira das Três Voltas, near Ribeira Chã, under stones in the eulittoral zone, together with *P. dahli*, 16.III 1957, Loc. 35, 2 worms.

The animals were preserved 2.9 and 2.2 mm. long and 1.2 and 2 mm. broad. Both are about 0.5 mm. high. The truncate anterior end bears two light auricles, whose distance from one another equals about twice their own breadth. The shape of the body resembles that of *dahli*, though one worm of *sameha* is nearly circular.

The position of the eyes and the colour are like in *P. dahli*, so that the species cannot be distinguished by external characters.

Dorsal and ventral epidermal cells contain rhabdites and are of equal height. The length of the pharynx (f) is 1.2 mm., the diameter 0.35 mm. The mouth (m) lies very near the hind end of the pharynx pocket, 1 mm. in front of the posterior end in the longer worm. The distance between the anterior border of the body and the root of the pharynx is shorter. The pharyngeal pocket lodges the same astomatous ciliate as in *P. dahli*. Fig. 10 shows that of the pharyngeal muscle layers the outer circular one (ma) is thickest. The diameter of the strata is in micra: outer cilia 4, outer epithelium (ec) 4, outer longitudinal fibres (mo) 9, outer circular muscles (ma) 30-40, parenchyma with glands (iw) 50, inner longitudinal muscles (mo) 10, inner circular fibres (mi) 20-25, inner epithelium (ec) 3, inner cilia 2. The inner epithelium lines a rather long oesophagus between pharynx and intestine. As in the preceding species the epithelia of the pharynx are of the sunk in type, with nuclei sunk beneath the muscle layers. The lateral diverticula of the gut are compressed by testes and yolk glands. The anterior intestinal branch (i) extends beyond the brain (Fig. 9, c). The posterior rami do not anastomose.

The gonads and the vitellaria are located as in *P. dahli*. The testes are about 15 on each side. The efferent ducts (e) form spermiducal or false seminal vesicles in the region of the pharynx. They rise behind it and unite 0.1 mm. ectally to their entrance into the penial bulb. This bulb is continuous with the penis papilla, so that a nearly cylindrical, proboscidiform copulatory organ is formed. It is 0.7 mm. long, 0.15 mm. thick, and extends from the dorsal wall of the pharynx pocket obliquely backwards to the ventral side, where it curves forward. The ciliated ejaculatory duct differs a little in diameter along its course, but does not dilate into a seminal vesicle.

The ovovitelline ducts unite to form the common ovovitelloduct (v) which has a spherical dilatation (oa) and rises vertically, entering the very short bursal canal from below. The shell glands (sa) open into the dilatation and farther ectally. The bursa (b) occupies the entire height of the body, is nearly spherical, and its high, vacuolized epithelium phagocytes sperm. The female genital canal (y) lies beside the atrium (a), on the same transverse level as the penis. The canal begins with a sharp deflection and runs as a straight duct to the ventral side. Its entrance (ea) into the atrium (a) is quite ventral, near the genital aperture (w). The latter is surrounded by cement glands (cc). On the male side the atrium, whose ciliated epithelium is nucleated, is widely distended by the long penis.

DISCUSSION

The most importante character of the new species is the thickness of the outer circular layer of the pharyngeal muscles. The copulatory organs of *P. plebeia* (Wilhelmi 1909, t. 15, f. 12) are similar to those of *sameha*. The pharynx of *P. plebeia*, more than one third of the body length (O. Schmidt 1861, p. 17) has not been studied in detail. We infer that its thickest layer of the pharyngeal muscle is the inner circular stratum, because *P. jaqueti* Böhmig (1906, p. 356) belongs to the material of Böhmig with thickest inner circular muscles (p. 400). In our opinion *P. jaqueti* from the Black Sea is identical with *P. plebeia* (O. Schmidt 1861, p. 17) from sometimes brackish, sometimes fresh-water springs in the bay of Argostoli, Cephalonia. At the time Böhmig described *jaqueti*, the results of Wilhemi's collecting in the bay of Argostoli (1908, p. 206; 1909, p. 321-323) had not been published yet, and so Schmidt's species could not be compared with *jaqueti*. Wilhelmi (1909, p. 263, 264) noticed the similarity of the copulatory organs in *plebeia* and *jaqueti*. The length of the pharynx is more than one third of the body length in *plebeia* and one third in *jaqueti*, but such a small difference is no specific character.

The penes of *sameha* and *plebeia (jaqueti)* differ in shape and length; furthermore the species from the Ionian and Black Sea has a distinct seminal vesicle, absent in *sameha*.

Microplana terrestris (O. F. Müller 1774)

Fig. 17.

Occurrence: Madeira: 1) Ribeiro Frio, 860 m., 7 km. SW of Faial. 21.IV 1957, Loc. 115, 1 worm; 2) Casa das Queimadas, 880 m., 24 IV. 1957, Loc. 122, 3 worms; 3) Ravine near Ribeira das Cales, 1200 m., 26. IV. 1957, Loc. 127, 1 worm; 4) 1 km. E of Encumeada, ca. 800 m., 28. IV. 1957, Loc. 135, 4 worms.
Further distribution: 1) Europe from Scandinavia (northernmost locality: Romsdalshorn, Norway, Lat. 62° 30′ N.) to the Balearic Islands and Creta, from Poland to Ireland, Literature: Arndt 1934, p. 380-381; Beauchamp 1941, p. 95 Gislén 1944, f. 1. 2) Madeira (Beauchamp 1957, p. 357). 3) United States of North America, Wisconsin (Hyman 1939, p. 431; confirmed 1943, p. 15; one specimen).

Of this well known species we only comment on some features of the copulatory organs (Fig. 17). The vesicle (s) within the bulb contains red staining secretion produced by extra-penial glands, and, in the present material, a lump of sperm besides, so that it may be called a seminal vesicle with more justification than

in other triclads. The pink staining glands (sa) opening into the female genital canal (y) have the same aspect as the so-called shell glands of other triclads. The sectioned worm does not have any cement glands except for some indistinct elements in front of the genital aperture (w). Perhaps these glands were spent by a recently laid cocoon. The bursa (b) is lined by a ciliated, not glandular, epithelium, hence it is not a true bursa (Freisling 1935, p. 8). It is connected with the intestine (i) by two bursal-intestinal ducts (x). This was already observed by Graff (1899, p. 236), Bendl (1908, p. 549-550), and Hyman (1939, p. 433) but also one asymmetrical duct may occur (Bendl 1909a, p. 297). Finally not only in young (Bendl 1909b, p. 54) but also in adult worms (Hyman 1954a, p. 12) may the «bursa» be closed, completely separated from the intestine.

DISCUSSION

Pantin established (1953, p. 216) *Microplana humicola* (Vejdovsky 1890) in the sense of Schneider's re-examination (1935) as type species of *Microplana*. «All systematic judgements of this sort ultimately rest on inductive inference» (Pantin *loc. cit.*, p. 214), and as this inference was made with an enlightened knowledge of the anatomy of the Rhynchodemidae, «it would be perverse to reject the identification of Schneider's organism with Vejdovsky's» (*loc. cit.*, p. 215).

M. humicola has no bursa (Schneider 1935, p. 189), and if this character is included in the diagnosis of the genus, one can separate the species with bursa (Hyman 1954a, p. 11) generically. We have already published our doubts as to whether her genus is a natural group (du Bois-Reymond Marcus 1957, p. 160), and Beauchamp (1957, p. 357) expresses the same opinion. The bursal dilatation of *M. terrestris* may be inconspicuous (Hyman 1939, f. 50 C, 7), and in *M. britannica* (Percival 1925, f. 6, 7, C) and *M. hovassei* (see in the following) an intestinal diverticulum can assume the aspect of a bursa. Therefore we continue to distinguish 3 groups of species in *Microplana* (Marcus 1953, p. 50 ff.): the most primitive one with well developed closed bursa, the second with genito-intestinal connection which may include a genital («bursa seminalis») or an intestinal dilatation («bursa intestinalis»), and the third with rhynchodemid female organs, that is, without bursa or genito-intestinal connection. The separation between the first and the second group is not strict; they should be maintained together and should be called *Microplana*. The third group might be set apart as a genus or subgenus.

Microplana hovassei (Beauchamp 1934)

Fig. 18.

Occurrence: Madeira: 1) Casa das Queimadas, 880 m., 24. IV. 1957, Loc. 122, 1 mature and 5 immature worms; 2) Ribeiro Frio, 1000 m., 8 km. SSW of Faial, 26. IV. 1957, Loc. 128, 1 mature worm.
Further distribution: Madeira (Beauchamp 1957, p. 357); Turkey, Baltaliman on the European side of the Bosporus (Beauchamp 1934, p. 206).

The two mature worms are 11 and 15 mm. long, while one of 9 mm. is immature. The breadth of the 11 mm. long animal is 2 mm., its height 1 mm. In all worms the back is transversely wrinkled, due to contraction; the belly is flat. The blunt fore end is slightly thicker than the rear. The anterior tip bears a transverse pit. The small eyes, about 18 μ in diameter, and 0.16 mm. apart from one another, lie 80 μ behind the pit; they were seen only in clarified worms. The mouth is located at 8.7 mm. and the genital aperture (w) at 9.8 mm.; the creeping sole is 0.5-0.7 mm. broad.

The colour of the back is a dark brown of irregular intensity, its limit against the light belly is a sharp, indented line. The anterior tip is not pigmented. The creeping sole appears as a still lighter median third of the ventral surface.

The dorsal epidermis has intra-epithelial nuclei and is 60 μ high. Also the 20 μ high ciliated cells of the creeping sole are nucleated. Voluminous, caliciform mucous cells and pigment are located in the dorsal epidermis, whose rhabdites are adenal. A little pigment occurs also in the parenchyma. The cutaneous muscles are simple layers. Also the glandulae and subepidermal nervous strata are thin, but the longitudinal muscles of the parenchyma are enormous: on the sides as much as 70 μ thick, ventrally 50-60 μ, and dorsally 40 μ. A special cephalic muscle is not developed. On the ventral side follow entally to the longitudinal parenchymal muscles the two nerve cords and between them and farther dorsally a few more longitudinal bundles.

The pharynx is about 1 mm. long; its inner muscles are constituted of alternate longitudinal and circular layers and much thicker than the outer ones. The outer and inner covering layers («Deckschicht») have sunk in nuclei. The number of the straight lateral intestinal diverticula is great, but as they are colourless at their roots and blackish only at their blind fundi, they could not be counted. About 18 endings per mm. occur, but in this number the few bifurcations of the diverticula are contained.

The small ventro-lateral testes lie dorsally to the ventral nerve cords in the prepharyngeal region and begin 3 mm. behind the fore end. The loose, broad

spermiducal bulbs rise behind the pharynx (f). There they are surrounded by some muscle fibres and lie within the wall of the atrium (a) developed thickest on the right and left side. The ental median confluence of these thickenings constitutes the inconspicuous penial bulb. Where the efferent ducts (e) pierce the muscle mass of the penis papilla, they are so thin that they become nearly unperceivable. A distinct penial lumen, 0.5 mm. in length, is formed by an inner narrow seminal vesicle (s) and an outer ejaculatory duct in the ectal part of the penis (p). This lumen has a muscular wall inside the penial parenchyma which is intermingled with muscle fibres. Between the parenchyma and the thin, nucleated epithelium of the penis there is as spongy tissue layer without nuclei and especially thick (about 40 μ) at the root of the papilla. A muscular cushion lies at the tip of the penis The sectioned worm had evidently contrated strongly when preserved, hence its 1.2 mm. long penis is curved more than those drawn by Beauchamp (1934, f. 1) and Battalgazi (1945, f. 2). The ectal part of the male atrium (a) has a thick layer of circular muscles and high, irregular epithelium.

The ovaries lie about 0.9 mm. behind the tip, between the 5th and 6th intestinal diverticulum. They are big and lobated; an anterior lobe might be a parovarium. The yolk glands begin a little farther in front, they are small. The ovovitelline ducts run close laterally to the nerve cords. In their rising courses (h) they receive the shell glands (sa) and unite in a spherical chamber about 0.12 mm. in diameter. Shell glands open also into the posterior part of this chamber.

The female genital canal (y) between the chamber and its opening into the atrium (a) is nearly 1 mm. long and provided with longitudinal and circular muscle fibres. Its epithelium is ciliated, of uniform height and thrown into longitudinal folds. The lumen of the chamber is continuous with that of a dorsal canal (u) which runs forwards and opens into a small dilatation (b). The latter may be called a bursa (Battalgazi 1945, p. 230), and the canal a bursal canal. The bursa communicates with the intestine (i). It lies between the splanchnic musculature and the intestinal epithelium. The bursal epithelium, although without included food particles, agrees with that of the intestine. Hence the bursa might as well be called an intestinal diverticulum (Beauchamp 1957, p. 359). In this case the bursal canal would be termed genito-intestinal duct.

DISCUSSION

The species is characterized by the male copulatory organ being almost entirely constituted by the free penis papilla. The same feature occurs in *Microplana*

britannica (Percival 1925, p. 353, f. 7 A, C), whose general morphology is very similar to that of *hovassei*, but whose colour is different. Two worms from Turkey, probably from Istambul (Battalgazi 1945), have the same exceptional penis. Some particularities of these animals which were carefully compared with *hovassei* led Battalgazi to consider them as a new species, *Rhynchodemus decennii*. The only character of Battalgazi's material actually in disagreement with *hovassei* is the very thick sphincter at the entrance of the female genital canal into the atrium. Whether this sphincter is a constant feature and justifies a specific separation can hardly be decided by comparison of the figures only. Strangely, Battalgazi did not include the sphincter in her comparative table of the two Turkish species. With Beauchamp (1957, p. 359) we presume the difference to be rather a gradual than a fundamental one. We also agree with Beauchamp that *M. hovassei* certainly will be found between the Bosporus and Madeira in Mediterranean or other European localities.

Microplana perereca spec. nov.

Fig. 19.

Occurrence: Azores, São Miguel, 3 km. S of Pico da Pedra, in a bush under a stone, 25. III. 1957, Loc. 64, 2 worms.

The sectioned animal was 13 mm. long, 1.5 mm. in diameter, had a blunt head; the mouth lay 7 mm. and the genital aperture 10 mm. behind the fore end. The small eyes are located far in front, close to the cephalic pit. Behind the eyes the white creeping sole begins without sharp limits; farther behind it is distinct and varies from one fourth to nearly half of the breadth of the body, evidently due to locally different contraction.

The back is greyish black without stripes and a little lighter towards the ventral side.

The musculature is weakly developed except for a thick parenchymal longitudinal layer ventral to the nerve cords. These cords are accompanied laterally by the ovovitelline ducts. The pharynx is about 1 mm. long. Its outer longitudinal muscles form simple layers, the inner ones constitute a much thicker stratum of alternating longitudinal and circular fibres. There are about 60 lateral intestinal diverticula on each side.

The small testes are ventral and end in front of the pharynx. The efferent ducts (e) rise gradually and without spermiducal bulbs towards the anterior side

of the enormous penial bulb, whose concentrically disposed longitudinal fibres (mo) they pierce, uniting on the surface of the inner, circular muscle layer (mi). The common efferent duct runs straight through the bulb and dilates to a small vesicle (s) in the penis papilla (p). A small muscular fold separates the vesicle from the ejaculatory duct, hardly discernible from the vesicle due to the nearly uniform lumen and ciliated lining.

The height of the bulb is 0.36 mm., its breadth and length 0.6 mm.; the papilla is 0.3 mm. long. The epithelium of the papilla is nucleated; the nuclei of the subepithelial circular and longitudinal muscle fibres lie chiefly in the penial parenchyma between longitudinal muscles and ejaculatory duct.

The atrium is common to male and female copulatory organs. A thick circular fold separates a smaller inner compartment (a) from the outer one (j), leading to the genital aperture (w). The pink staining cement glands (cc) open into the outer atrium.

The yolk glands extend backwards nearly to the posterior end. The ovovitelline ducts run parallel to the efferent ducts for a great part of their course. Flanking the penial bulb they rise (h) gradually and bend towards the median plane. Their transverse courses are surrounded by shell glands (sa) which enter the ducts close to their union as well as the following common ovovitelloduct (v). Shell glands open also into a dilatation (oa) of the common ovovitelline duct. The succeeding female genital canal (y) does not receive any shell glands, it is muscular, lined with ciliated epithelium, and opens into the innermost fold of the atrium.

DISCUSSION

The third group of *Microplana* (see discussion of *M. terrestris*) does not offer many criteria for specific separation according to the copulatory organs, due to the simplified female component. A detailed analysis of the pharyngeal muscles and those of the body will certainly reveal differences, as can be concluded from Fuhrmann's comparative study (1914) of European Rhynchodemids. Future descriptions should consider these elements. Till then the discussion of a new species, as the present one, must be based upon external characters. As all species of the third group have dorsal or lateral stripes or bands, it is easy to separate *perereca* from *thwaitesi* (Moseley 1875), *ceylonica* (Graff 1899), *atropurpurea* (Graff 1899), *voeltzkowi* (Graff 1899), and *graffi* (Geba 1909). *M. haitiensis* (Prudhoe 1949) and *M. ruca* Marcus 1954 have lateral light bands between dorsal and ventral surface.

M. perereca must further be compared with those species of *Microplana* whose female copulatory organs are not known, and whose position in one of the 3 groups is therefore not defined. Of these species (Marcus 1953, p. 51-52) *M. atrocyanea* (Walton 1912) can now be allocated to the second group (Hyman 1954a, f. 3 on p. 5). *M. teres* (Graff 1899) is still very little known, but it cannot be identical with *M. perereca*, because, though 25 mm. long and 2.5 mm. broad, it is immature. *M. albicollis* (Graff 1899) differs from *perereca* by its colour; in *M. richardi* (Bendl 1909b) the creeping sole is a little more than half as broad as the body; and in *M. carli* (Fuhrmann 1914) it is of the same colour as the rest of the body.

Rhynchodemus bilineatus (Mecznikow 1866)

Occurrence: Azores: 1) Faial, Horta, Ribeiro dos Flamengos, 31. III. 1957, Loc. 71, 2 worms; 2) Pico, São João, 9. IV. 1957, Loc. 103, 1 worm.

Further distribution: Europe, outdoor findings from England, Belgium, and France (Alsace); in greenhouses, flower pots and terraria in Germany, Czechoslovakia, and Austria.

Due to size, colour, sole, and copulatory organs the present animals were identified as *Rh. bilineatus*, though the characters that separate *bilineatus* from *sylvaticus* (du Bois-Reymond Marcus 1955, p.34, 37) need a comment.

We refer to Pantin's comparison (1950, p. 32 ff.) of his worms with *Geodesmus bilineatus* (Mecznikow) and with *Rhynchodemus sylvaticus* (Leidy 1851). Hyman (1954a, p. 2-6), who has studied specimens of *bilineatus* received from Pantin, maintains *sylvaticus* and *bilineatus* as separate species.

Probably she is right, because 1) the dense granular secretory cells of the sole in *bilineatus* (Pantin 1950, text-fig. 3a), also developed in our material, appear absent in *sylvaticus* Hyman, *loc. cit.*, p. 6); 2) *sylvaticus* occurs outdoors «throughout the northern half of the eastern United States» (Hyman 1943, p. 7). This seems to indicate at least a physiological difference from *bilineatus* which has been found only in countries with mild winters in nature. It is true that Hyman did not verify the morphological character with certainty.

She mentions some differences between the copulatory organs of *sylvaticus* and *bilineatus*. In *sylvaticus* the male atrium is larger than the female one, contrary to *bilineatus*, and is lined by a tall, not glandular, epithelium. Two successive prostatic dilatations of the male duct, present in *bilineatus*, do not occur in *sylvaticus*. In our sectioned worm the male and female atria are of nearly equal size,

the male atrial epithelium is not glandular, and prostatic dilatations of the male duct are not developed. Examination of rich materials however, as that of *Rh. nematopsis* (Beauchamp 1930, p. 84-90) and that of *Rh. scius* du Bois-Reymond Marcus (1955, p. 31), show how much the size and the histology of the copulatory organs vary in *Rhynchodemus* according to the male or female asynchronous reproductive phases. Also Beauchamp (1952, p. 51) and Hyman (1954a, p. 2) gave examples of regressive male organs, and Percival (1925, p. 349) described histological differences in the epithelium of the female genital canal in *Microplana britannica*.

Kontikia sp.

Figs. 13-16.

Occurrence: Madeira, 19.-28. IV. 1957: 1) Ribeiro Sêco near Funchal, Loc. 111; 2) Casa das Queimadas, 880 m., Loc. 116; 3) 1 km. E of Encumeada, ca. 800 m., Loc. 122; 4) Faial, at mouth of Ribeira do Faial, Loc. 135. A total of 35 immature worms.

The biggest animal, whose hind end is wanting, is 19 mm. long, 2 mm. broad, and 1 mm. high; its mouth lies 15 mm. behind the tip. A genital aperture is not developed, and the same is true of the entire material. The longest complete worms are 28-30 mm. long and about 1.5 mm. in diameter. The body is almost cylindrical, but sometimes a little concave in the middle of the belly. The convex back passes gradually to the ventral side, without sharp lateral borders. The head is rather pointed and concave below, and bears distinct though short sensorial furrows (Fig. 13).

The worms appear black, but reveal to be striped with higher power (Fig. 14). A light median band of the back has a fine black line in its middle. Beside the median band there are two dark bands, approximately as broad as the median one. The dark bands become lighter towards the margins. A somewhat darker line runs within the light marginal zones. The belly is on the whole light (Fig. 15). But it is bordered by quite black marginal lines which conceal the series of eyes. Dark pigment also occurs in a mid-ventral band, whose breadth is sometimes a little more, sometimes a little less than half the breadth of the belly. This pigment appears as a uniform grey, or concentrated to more or less round spots, or grey in the middle and in spots on the sides. The anterior end of the worms is reddish.

The rather big eyes form a single row and are more scattered in the posterior region. There are about 80 eyes on each side.

The epidermis, though damaged in both sectioned specimens. shows the abundant cyanophilous glands (ac) of the sole as *K. orana* Froehlich (1954, p. 202), and big dorsal rhabdites (p. 203) with rounded external and attenuated internal ends.

The cutaneous muscles form a simple circular and an enormous longitudinal layer (mo), which is 70 µ thick on the ventral side. Cyanophilous glands (ac) subdivide this layer into bundles. The dorsal and ventral longitudinal cutaneous muscles together correspond to 15 % of the height of the body. Entally to these muscles lies the pigment (io) of the dorsal stripes and the mid-ventral zone. Also the ventral parenchymal longitudinal muscles (rz) are strongly developed, on the sides and on the back they are thinner. On the whole the parenchymal muscle fibres are numerous, e. g. those running between the many intestinal diverticula (i) in transverse and oblique direction.

The cylindrical pharynx is 1.7 mm. long and about 0.55 mm. thick; the mouth lies at its hind end.

The ventral nervous system (n) forms two cords. Beside these a row of small testes (t), about 60 µ in diameter is located, the hindmost testes are situated immediately behind the mouth.

DISCUSSION

C. Froehlich (1954, p. 199 ff., 245-247) was right in applying the different types of body musculature (Graff 1899, p. 83) to a natural system of *Geoplana* and his genus *Kontikia* has been accepted immediately by Beauchamp (1955, p. 312). Froehlich further characterized his genus by ventral testes, efferent ducts ventrally to the longitudinal nerve cords, and some other minor features. The absence of efferent ducts in the present immature worms does not allow for their absolutely safe generic allocation, and the absence of copulatory organs makes specific classification impossible.

Colour pattern and eyes of our material agree with Beauchamp's *Geoplana mexicana?* from Madeira (1957, p. 359). It is true that Beauchamp did not describe the black ventral stripes at the margins, but this may be negligible. By the aspect of the primordial copulatory organs, the colour pattern of the back, and the eyes Beauchamp approached his worms to *Geoplana mexicana* Hyman (1939, p. 425; 1943, p. 1), originally found on violets from Mexico and evidently established in California. *G. Mexicana* has ventral testes, but its musculature was not described. The colour of the ventral surface of *mexicana*, «uniform

medium brown» (1939) or «faint banded» (1943), differs to a certain degree from the spotted belly in Beauchamp's and our worms. This is one more reason not to use a specific name for the present material.

The occurrence of *Kontikia*, an Indo-Westpacific genus, on Madeira is probably due to passive distribution by means of banana rhizomes, as Froehlich (1954, p. 201) supposed for *K. kenneli* of Trinidad and *K. orana* of middle Southern Brazil.

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FIGURES

EXPLANATION OF LETTERING

a — atrium or superior atrium. ac — cyanophilous glands. b — bursa. c — brain. cc — cement glands. d — sphincter. e — efferent duct. ea — entrance of female genital canal into atrium. ec — pharyngeal epithelium with cilia. en — subepidermal nerve layer. f — pharynx. g — granule vesicle. h — ovovitelline duct. i — intestine. io — submuscular pigment. iw — parenchyma and glands of pharynx. j — inferior atrium. k — diverticula. l — genitobursal duct. m — mouth. ma — outer circular muscle layer. mi — inner circular muscle layer. mo — longitudinal muscle layer. n — nerve cords. o — ovary. oa — dilated part of common ovovitelline duct (shell gland chamber). p — penis. q — communication between bursa and intestine. r — pear-shaped lobes. ri — glands of the marginal adhesive zone. rz — parenchymal longitudinal muscles. s — seminal vesicle. sa — shell glands. t — testes. u — bursal canal. v — common ovovitelloduct or vitelline duct. w — genital aperture. x — bursal-intestinal duct. y — female genital canal.

Phaenocora brincki sp. n. — Fig. 1. Dorsal view. — Fig. 2. Ventral view; vitellaria in black. — Fig. 3. Reconstruction of the female organs on the right side. — Fig. 4. Reconstruction of the male organs on the left side. Fig. 5. Transverse combined section in region of genital aperture.

Procerodes dahli sp. n. — Fig. 6. Dorsal view of preserved worm. — Fig. 7. Longitudinal section of pharynx. — Fig. 8. Reconstruction of copulatory organs.

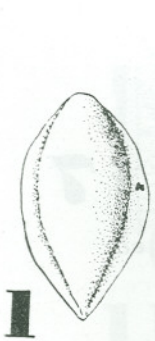
Procerodes sameha sp. n. — Fig. 9. Sagittal section. — Fig. 10. Longitudinal section of pharynx. Fig. 11. Reconstruction of male copulatory organs. Fig. 12. Reconstruction of female copulatory organs.

Kontikia sp. Fig. 13. Fore end. — Fig. 14. Dorsal colour pattern. — Fig. 15. Ventral colour pattern. — Fig. 16. Transverse section of prepharyngeal region.

Microplana terrestris (O. F. Müller) — Fig. 17. Reconstruction of copulatory organs.

Microplana hovassei (Beauchamp) — Fig. 18. Reconstruction of copulatory organs.

Microplana perereca sp. n. — Fig. 19. Reconstruction of copulatory organs.



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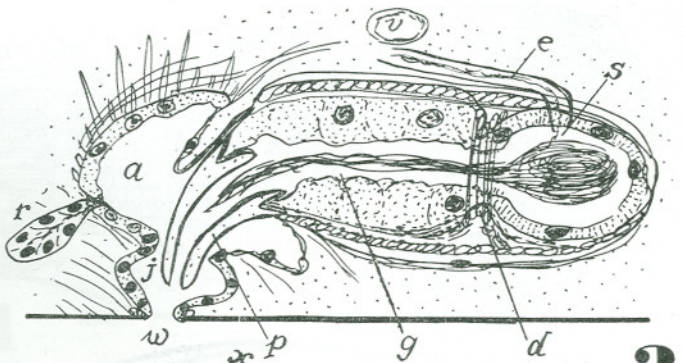

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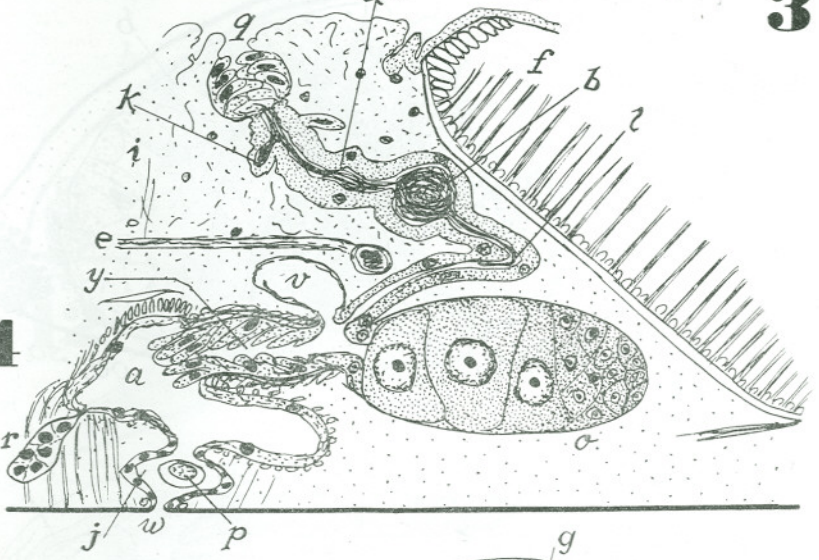

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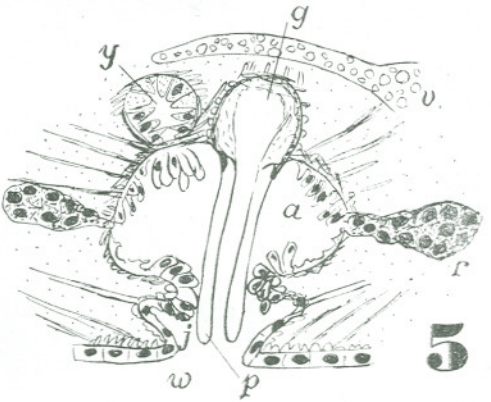

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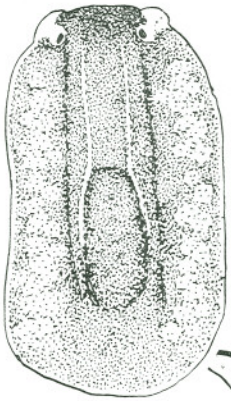

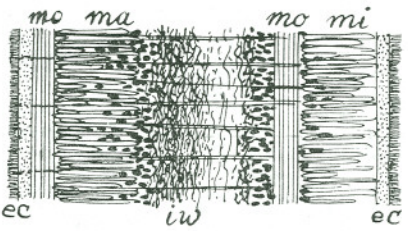
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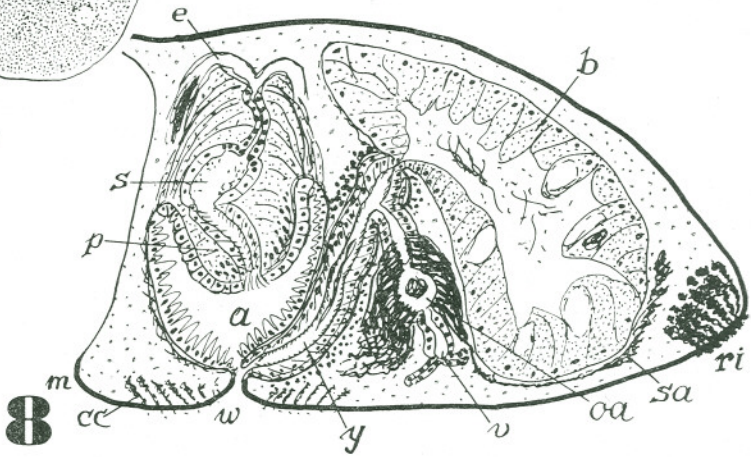
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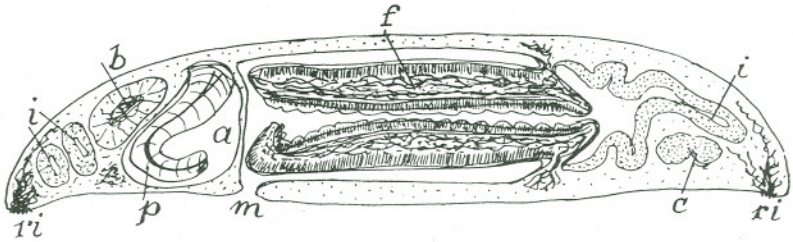
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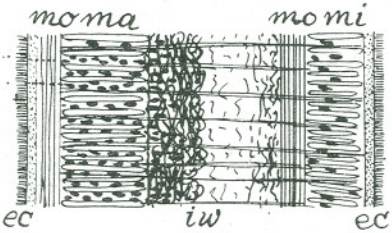
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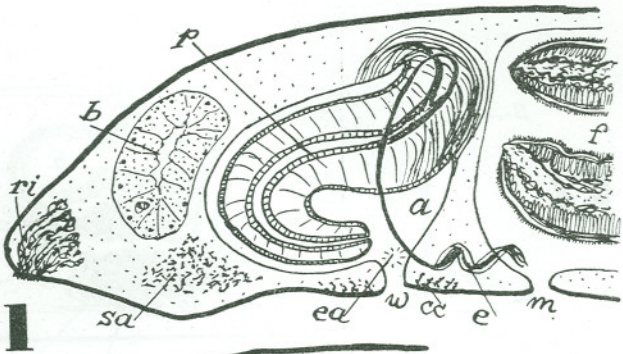

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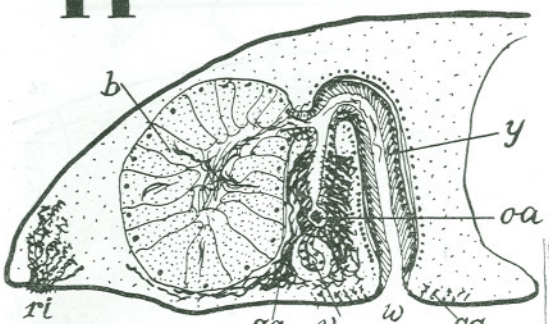

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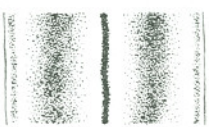

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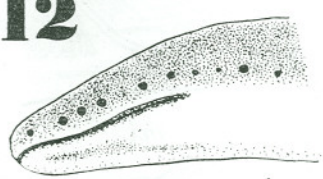

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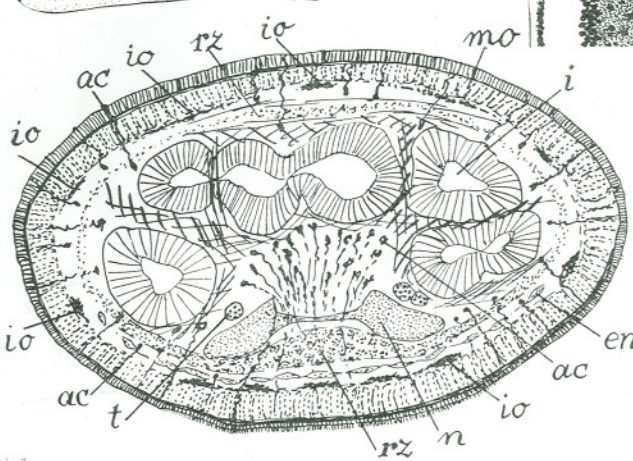

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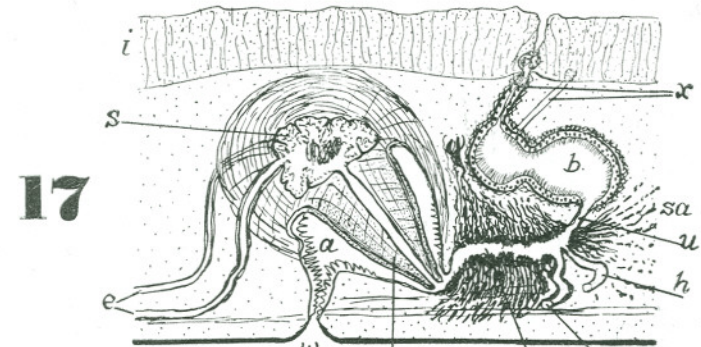
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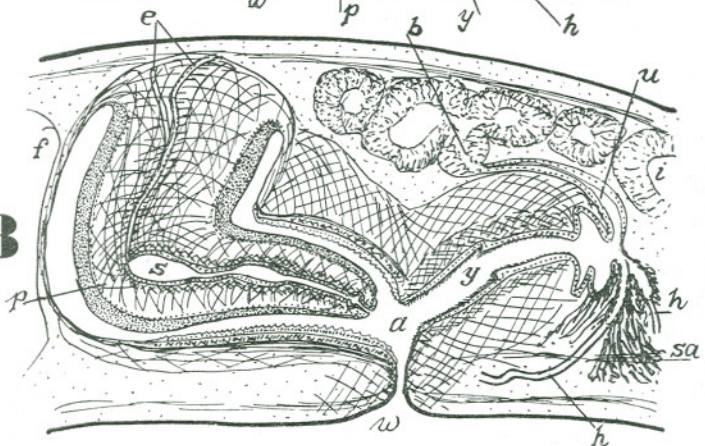
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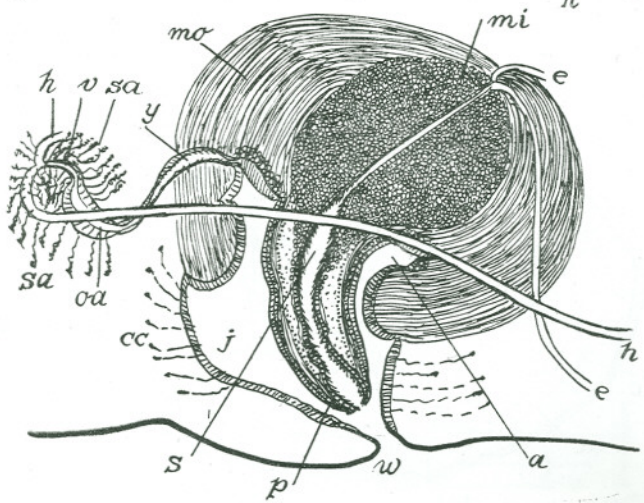
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