

# FRESHWATER NEMERTINES FROM THE AMAZON REGION AND FROM SOUTH AFRICA

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(with 2 plates)

In the rich material of amazonian worms collected by Dr. HARALD SIOLLI-Belém (Pará) 4 Nemertean of the genus *Prostoma* were verified (du Bois-Reymond Marcus 1948, p. 98). These specimens were gathered in the river Tapajós, at Fordlândia and in the mouth of the river Cupari, a right affluent of the Tapajós. I received the animals for specific classification and also 10 Nemertines, that Dr. and Mrs. D. W. EWER, Natal University College (Pietermaritzburg) had sent to our Department together with freshwater Turbellaria. Three of the south african worms are from Pietermaritzburg (Natal) and seven from Port St. Johns (Pondoland).

Three out of the four Orders of the Nemertini are to-day known from central and south american freshwater: the Heteronemertean *Siolineus turbidus* du Bois-Reymond Marcus (1948, p. 93), two species of the Hoplonemertean genus *Prostoma* A. L. Dugès, *P. rubrum* (Leidy) and *P. eilhardi* (Montgomery), and the Bdellonemertean *Malacobdella auriculæ* Blanchard (1847, p. 143). *P. rubrum*, that was originally described from North America, was verified in Mexico (Rioja 1941) and Venezuela (Cordero 1941, p. 195; 1943, p. 131). The geographic distribution of *P. eilhardi* can not yet be considered as firmly established due to taxonomic difficulties. According to Stiasny-Wijnhoff's synonymy (1938, p. 226) Berlin, Amsterdam and the Lombardy are localities of *P. eilhardi*. Its south american records refer to the brazilian States of São Paulo and Paraná (Marcus 1942; 1943). Possibly also the materials from Uruguay and Argentine belong to this species (Cordero 1943, p. 130-131).

I do not know any reports on limnic Nemertines from Africa besides that of Stuhlmann (1888) commented by Stiasny-Wijnhoff (1938, p. 227). A worm with 4 eyes was found in the mud of the river Kingani (Ruwu) 5 miles from Bagamoyo (Tanganyika Territory). As the material was obtained in the mouth-region of the river exposed to the tides, it may belong to *Prostoma* (Bürger 1895, p. 59), or to the likewise vastly distributed genus *Tetras-temma* Ehrenberg, or possibly to still another genus.

## Description of the material

1) My material shows two different types. The first (Plate I) is represented by the 7 worms from Pondoland and the four amazonian ones. Their principal characters are :

The preserved african worms have up to 6 mm. in length (living they were 10-12 mm. long), those from northern Brazil 4,5 mm. The corresponding maximum breadths are 0,4 mm. and 0,3 mm. The smallest animals are 1,5 mm. long the african, and 2,5 mm. long the amazonian worm, both 0,2 mm. in diameter, and already with incipient gonads. The colour of the living african worms was light orange. Most of the specimens have 6 eyes (Figs. 1, 2, e), and some of them show irregularities in number and distribution. The first pair of eyes that is the biggest lies before the cephalic grooves (c), into which the cerebral pores open. The second eyes are of middle size and situated close behind the grooves, and the third, smallest pair lies near the anterior border of the dorsal cerebral ganglia. The transverse groove (t) is present in the african animals, but was not recognizable in the amazonian lot.

Tactile cilia or setæ on the hind end were not found. The head gland (h) is for the most part pre-cerebral. It is true that in sections a median lobe touches the brain, but in total mounts only the concentrated masses are visible backwards to the second pair of eyes. The gland is developed chiefly on the dorsal side; ventrally it does not approach the rhynchodeum. There are no calcareous corpuscles in the parenchyma and the epidermis.

The œsophagus (Fig. 4,o) is lined with the same flat cells as the rhynchodeum (Fig. 3,r) and clearly distinct from the stomach (Fig. 5,s). The latter begins at the level of the hind end of the cerebral ganglia, and its high epithelium is ciliated and contains glands. A cæcum is not developed. The antero-lateral diverticles (Figs. 2,5,a) reach the origin of the lateral nerves from the ventral ganglia.

The rhynchocœl (Fig. 2,n) occupies two thirds of the body-length. The rhynchodeum (Fig. 3,r) has no longitudinal muscles apart from the longitudinal fibres of the head, some of which also lie near the rhynchodeum. The basis of the stylet is in some individuals slightly constricted, in others not. The constriction may be visible only on one side. In the only worm that showed the stylet clearly, it was just as long as its basis. In the other specimens this proportion could not be stated, because the stylet is rarely distinct in preserved material.

The frontal sense organ (Figs. 1,2,3,f) is developed as a simple pit surrounded by a number of high cells, that converge towards the central opening. The cells of the cephalic gland (h) unite close behind this pit, that evidently serves as their common outlet. The cephalic grooves (c) and therefore also the cerebral pores are lateral and lie between the first and second pair of eyes.

2) The 3 worms from Pietermaritzburg (Natal) (Plate II) are characterized in the following way:

The biggest worm is 5 mm. long and 0,3 mm. broad. The measurements of the smallest are 2,5 mm. and 0,4 mm. Two of the lot had the proboscis everted, and in the third it was on the point to be protruded. All three showed incipient gonads. The number and distribution of the eyes are the same as in the previously described material. The transverse groove is well visible in sections.

Tactile cilia or setæ on the hind end were not seen. The head gland (Figs. 6, 9, h) has many lobes in the pre-cerebral region. As little as in the

foregoing worms it approaches the rhynchodeum ventrally, so that this organ does not differ in the two lots. Calcareous corpuscles (Fig. 10) are abundantly distributed in the parenchyma, as Böhmig (1898, t. 14 f. 10, 11) figured them. They do not occur in the epidermis of my specimens.

The œsophagus (Fig. 7,o) is different from the rhynchodeum (r), as its lining epithelium is high and ciliated. As well the pre-cerebral position as the smaller number of gland-cells (Fig. 9) distinguish the œsophagus (o) from the following stomach (Figs. 8, 9,s). A cæcum does not exist. The antero-lateral diverticles (Fig. 8,a) of the intestine extend to the origin of the lateral nerves (l), as in the worms from Pondoland and the Amazon region.

The rhynchocoel has the same length in all three populations. The rhynchodeum (Fig. 7,r) shows a thick layer of longitudinal muscle-fibres which continue into the cutaneous muscle-mantle. The basis of the stylet (Fig. 11,b) has a slight constriction, and in one everted proboscis the measurements for stylet and basis are 0,033 mm. each in length, and the basis is 0,016 mm. in diameter.

The frontal sense organ (Figs. 6, 9,f) could be verified in sections. It is very similar to that of the lots from Pondoland and Brazil. The cephalic grooves that lie between the first and second pair of eyes are lateral, as are also the pores of the cerebral organs.

### Discussion of the Literature

In her synopsis of the genus *Prostoma* Stiasny-Wijnhoff (1938) records 16 different names applied to freshwater Nemertean and gives their bibliography that need not be repeated here. Six species are recognized as valid in that revision, viz. *P. lumbricoideum* Dug., *græcense* (Böhm.), *eilhardi* (Montg.), *grande* (Ikeda), *padanum* Pier., and *puteale* Beauch. Strangely enough, *rubrum* (Leidy) does not figure in St.-Wijnhoff's list, although Coe (1918, p. 457-458) revalidated this name for the specimens described from North America (*aquarum dulcium* Sill. and *asensoriatum* Montg.). The dutch authority considers (p. 226) the north american species and *græcense* as identical and only hesitated to introduce the corresponding changes of the name because she had not seen north american material.

As the last name, *asensoriatum*, indicates, the american species has no supra-oral or frontal sense organ, and in Montgomery's opinion (1896, p. 436) consequently the cephalic glands open individually, scattered on the frontal side. *P. græcense* however has a frontal organ towards which the ducts of the head glands converge (Böhmig 1898, p. 481, 536). Even Reisinger (1926, p. 2-3) who unites all central european species under the name of *P. græcense* (Böhm.) maintains the north american species separated, and in this respect I agree perfectly with him. As for the rest, I adopt St.-Wijnhoff's list of valid species and compare the amazonian and the african specimens with each of them.

*P. lumbricoideum* is up to 30 mm. long and frequently mottled with dark. It has 4 eyes, and a central stylet shorter than its basis.

*P. rubrum* has no supra-oral sense organ and no united ducts of the cephalic gland.

*P. grande* is up to 35 mm. long, often with greenish spots. The rhynchocoel is short, and the head gland very short.

*P. padanum* has a short rhynchocœl and a very long central stylet thrice the length of the accessory stylets.

*P. puteale* is white, without eyes, and the basis is twice as long as the central stylet.

This rapid review shows that neither the amazonian nor the south african material can belong to one of these 5 species. Therefore only *græcense* (Böhm.) and *eilhardi* (Montg.) remain for comparison. These two species were united by Reisinger (l. c.) but separated again by Stiasny-Wijnhoff (1937, p. 176-177) who confronted the following diverging characters of *eilhardi* and (*græcense*):

- 1) Without (with) tactile cilia.
- 2) Without (with) calcareous corpuscles.
- 3) Lateral (ventral) cerebral pores.
- 4) Frontal sense organ tripartite (simple).
- 5) Head gland small, pre-cerebral (ends over the brain).
- 6) Rhynchodeum without (with) longitudinal muscles.
- 7) Basis of stylet without (with) constriction.
- 8) Longitudinal muscles of stomach originate from head musculature (from septum).
- 9) Oesophagus rhynchodeal (ciliated).
- 10) Without cæcum (perhaps a short cæcum).
- 11) Intestinal diverticles end over the brain (reach the brain).
- 12) Dorsal vessel projected into the rhynchocœl with a knob (dorsal vessel normal).

The number of proboscidal nerves that Lepori (1949, p. 37) still applied as a distinctive character between *græcense* and *eilhardi*, does no longer figure in Wijnhoff's list, because it is not all constant (Reisinger 1926, p. 2).

Of Wijnhoff's differences eight are not supported by the original descriptions and therefore can not be maintained.

3) It is true that Böhmig (1898) does not indicate the lateral position of the cerebral pores, and that his figures do not permit any opposition to Wijnhoff's affirmation. Just as little does the paper mention any ventral position of the cerebral pores. The topographic figures (f. 2, 18) only show the certainly lateral cephalic grooves. As "the very short (5 micra) outer part of the cerebral canal can be distinguished from the cephalic groove only with difficulty (p. 528 f. 31, kfep — epithelium of the cephalic groove)", it can be presumed that the cephalic pores were lateral in Böhmig's material, as they are in Reisinger's (p. 8) from the same locality (Graz, Styria). Moreover the beginning of the eversion of the proboscis may dilate the rhynchocœl in such a manner that the cerebral organs of *P. puteale* come to lie rather more ventrally than laterally (Beauchamp 1932, p. 272).

4) Tripartition of the frontal organ was not described by Montgomery (1895) who only speaks (p. 103) of a roundish sac. The trilobate aspect in St.-Wijnhoff's figures (1937, f. 1, 2) may be due to a strong contraction of the anterior part of the worm.

5) The passages that refer to the volume and extension of the head gland in Montgomery's (p. 102) and Böhmig's (p. 534) papers are not opposed to each other. At most a comparison of the median section of *eilhardi* (t. 8 f. 9) and the transverse section of *græcense* (t. 15 f. 28) might reveal a stronger

ventral development of the gland in *græcense*. But as the drawing of the median section is only topographical, not histological, it can not be considered as decisive. Also Reisinger's topographical figure of *græcense* (f. 2 on p. 5) does not show the frontal gland developed ventrally in the median plane.

7) Montgomery described the basis of the central stylet as not constricted (p. 115). Böhmig said (p. 517): "a slight constriction is not rarely present." His wood-cut (on p. 515) reproduced in the "Handbuch" (Böhmig 1929, f. 25) does not show any constriction, but his figure 13 on plate 14 (1898) does. Reisinger combines (f. 5) Böhmig's wood-cut with Montgomery's drawing (1895, t. 9 f. 33) to a figure of *græcense* without constricted basis, as it is practicable after the terms of the original diagnosis of *græcense*.

8) I do not understand how St.-Wijnhoff meant to distinguish *eilhardi* and *græcense* by reason of the cephalic (*eilhardi*) and septal (*græcense*) origin of their stomachal longitudinal muscles. Both authors derive them from the body-wall. "Some cells of the cutaneous longitudinal muscles establish relations with the œsophagus and the stomach" (Montgomery, p. 101). "The œsophagus is surrounded by a layer of longitudinal muscles originated from the ventral part of the cutaneous muscle-tube. These muscles lie close to the œsophagus and run in a circular turn back to the body wall. The stomach too is provided with longitudinal muscle-fibres" (Montgomery, p. 110-111). "Along the outer face of the œsophageal epithelium run strong tracts of longitudinal muscles that also continue on to the following part of the intestine, the stomach. They are deducible from bundles that part from the longitudinal cutaneous muscles" (Böhmig, p. 499).

10) "The small unpaired cæcum" (Böhmig 1898, p. 500) does not exist in *græcense* (Reisinger 1926, p. 6).

11) The intestinal diverticles reach the brain in Montgomery's species (p. 108), and the same holds true for those of Böhmig's (p. 500). They "rise at the sides of the dorsal ganglia" in Reisinger's material (p. 6), and lie over them in St.-Wijnhoff's *eilhardi* (p. 175 f. 11). It is impossible to word distinguishing characters based upon so similar statements.

12) The dorsal vessel of *eilhardi* is only drawn in one of Montgomery's figures (t. 8 f. 17, DG), that gives the aspect of the living animal. His text does not mention the dorsal vessel, as on the whole he did not describe the blood-vascular system. Böhmig (p. 502) notes "the transitory relation" of the dorsal vessel with the rhynchocœl (t. 13 f. 2, t. 14 f. 17, dbl), but does not refer to its exact extension within the rhynchocœl. St.-Wijnhoff's (p. 176) and Marcus' (1943, p. 13) material of *eilhardi* suit to Böhmig's description; the length of the rhynchocœlic course in the worms of São Paulo is 0,015 mm. (1. c.), and in the amazonian ones (Fig. 5, u) 0,020 mm.

There remain 4 contrasts between *eilhardi* and *græcense* of which only 2 are reliable.

1) It is true that tactile cilia occur in *græcense* (Böhmig, p. 481 f. 2, sh), after Reisinger (p. 7) even some rigid, motionless setæ in the anal region, and are absent in *eilhardi* (Montgomery, p. 91). But from my own experiences with *Ototyphlonemertes* I know how difficult or even impossible it is to detect tactile cilia or setæ in preserved specimens. Therefore it is not feasible to determine every preserved material without tactile cilia as *eilhardi*.

2) The calcareous corpuscles were already used as taxonomic character in Montgomery's key (p. 95). Those of *græcense* lie in the parenchyma (Böhmg, p. 481) and the epidermis (Steinböck 1931, p. 56). They are probably temporary stored wastes (Reisinger, p. 4-5) that increase in worms kept under unfavourable circumstances (Böhmg, p. 494; Reisinger, l. c.). If conditions become better they are at least partially dissolved and re-absorbed or eliminated (Böhmg, 1929, p. 67). A physiological character can certainly serve for taxonomic purposes as well as a morphological one. But its systematic value diminishes if it varies much according to the environmental factors. Moreover it seems that the calcareous corpuscles, at least in certain cases, are somewhat doubtful structures. Although those of *græcense* are well described and figured, the concretions in the epidermis of *P. aquarum dulcium* (Silliman 1884, p. 72 t. 3 f. 21, 24 c), that are not dissolved by acids, liken the secretion of skin-glands. As is shown by the discussion about the calcareous corpuscles of the Turbellarian *Nemertoderma* (Steinböck 1931, p. 55; Westblad 1937, p. 51-52), such elements are sometimes difficult to judge and therefore precarious as systematic characters.

6) *P. eilhardi* has some longitudinal muscle-fibres surrounding the rhynchodeum (Montgomery, p. 129) that are head-muscles (p. 101). *P. græcense* shows a thick coat of longitudinal fibres in the wall of the rhynchodeum (Böhmg, t. 15 f. 28). Although the description of *græcense* (Böhmg, p. 523) only mentions longitudinal rhynchodeal muscles that lie outwards from the annular ones, the cited figure contrasts with Montgomery's indication (p. 129) for *eilhardi*: "The musculature of the rhynchodeum is very little developed". Therefore I accept the disjunctive character of the rhynchodeal longitudinal muscles, that was introduced by St.-Wijnhoff to separate *eilhardi* and *græcense*.

9) The epithelium of the œsophagus of *eilhardi* likens that of the rhynchodeum (Montgomery, p. 105). That of *græcense* evidently differs from that of the rhynchodeum, but the descriptions of Böhmg (p. 198-199) and Reisinger (p. 5), both referring to worms from Graz (Styria), are not conform with each other. Böhmg described this epithelium as provided with a thin cuticula composed of very small thick rodlets, a brush border of the present terminology. Reisinger called the œsophagus "strongly ciliated". With the reservation imposed by these different statements the rhynchodeal and the not rhynchodeal œsophagus of the two species must be admitted as a separating character.

### Conclusions

As the worms from the amazonian region and from St. Johns (Pondoland) (Plate I) have a rhynchodeal œsophagus (Fig. 4, o) and a rhynchodeum without a true layer of longitudinal muscle fibres (Fig. 3, r), they must be classified as *Prostoma eilhardi* (Montgomery 1895). Moreover they have no calcareous corpuscles.

As the worms from Pietermaritzburg (Natal) (Plate II) have an œsophagus with ciliated epithelium (Fig. 7, o) and the rhynchodeum with a true layer of thick longitudinal muscles (Fig. 7, r), they must be determined as *Prostoma græcense* (Böhmg 1892). Besides they have parenchymatic calcareous corpuscles (Fig. 10, x); and although it is not recommendable to con-

sider this character as decisive, it may serve as a valuable supplementary sign.

Although the general aspect of *P. græcense* and *P. eilhardi* is very similar, they are distinctly separate species. At first sight I noted a certain difference between the lots from Pietermaritzburg and Pondoland, and the sections confirmed this impression. I hope that now, after the comparison of worms that belong to the two species, these have become better defined for future students. Morphological characters have to prevail over zoogeographic considerations. Among freshwater worms also the genera *Stenostomum* and *Aeolosoma* comprise each morphologically and ecologically similar species, many of which are vastly distributed.

### Resumo

Stiasny-Wijnhoff (1938) reconhece 6 espécies válidas do gênero *Prostoma*, a saber : *P. lumbricoideum* Dug., *græcense* (Böhm.), *eilhardi* (Montg.), *grande* (Ikeda), *padanum* Pier., e *puteale* Beauchamp. *P. rubrum* (Leidy) revalidado por Coe (1918), para as espécies norte-americanas *aquarium dulcium* Sill. e *asensoriatum* Montg., considera Stiasny-Wijnhoff provavelmente idêntico a *P. græcense*. Mas, se *rubrum* for entendido na base da diagnose de *asensoriatum*, não possui órgão sensorial frontal (presente em *græcense*) e as glândulas cefálicas não desembocam concentradamente (em *græcense*, sim). Os caracteres mencionados de *rubrum* (ou *asensoriatum*) foram reencontrados em material do México (Rioja 1941) e da Venezuela (Cordero 1943). Por isso, esta espécie até agora conhecida só do novo mundo, sem órgão frontal e com desembocadura difusa das glândulas cefálicas, deve ser acrescentada à lista de Stiasny-Wijnhoff.

Comparando o meu material com esta lista, assim completada, consegui imediatamente excluir 5 espécies. Restaram-me apenas duas para comparação pormenorizada : *eilhardi* e *græcense*.

Reisinger (1926) opinou pela identidade destas 2 espécies, mas Stiasny-Wijnhoff (1937) indica 12 caracteres disjuntivos entre elas. Dêstes apenas 4 são aproveitáveis : dois pouco incisivos e dois realmente seguros.

O primeiro refere-se a cerdas e cílios tácteis, ausentes em *eilhardi*, presentes em *græcense*. Acontece, porém, que material conservado frequentemente não se presta para a verificação dêstes finos apêndices, e de fato não os consegui vêr nos vermes aqui em mãos, dos quais um lote pertence a *græcense*.

O segundo sinal, corpúsculos calcáreos no parênquima, privativos de *græcense*, ocorrem no grupo de vermes que classifiquei como *græcense* (Fig. 10,x). Mas os corpúsculos aumentam, segundo a literatura, em condições desfavoráveis e tendem a diminuir na volta de condições normais. Tais fenômenos fisiológicos, embora perfeitamente admissíveis nas diagnoses, são sistematicamente um tanto precários.

Os dois caracteres restantes, a meu vêr, seguros, destacam-se no meu material : 1) um grupo de vermes continha espessa camada de musculatura longitudinal na parede do rincodeo (Fig. 7, r) e 2) epitélio esofágico ciliado (Fig. 7, o). No outro grupo 1) a musculatura longitudinal rincodeal era ausente (Fig. 3, r) e 2) o epitélio esofágico destituído de cílios assemelhava-se ao epitélio rincodeal (Fig. 4, o).

Tive em mãos vermes do rio Cupari, afluente direito do rio Tapajós no Estado do Pará (Brasil) e da África do Sul. Os vermes amazônicos pertencem a *P. eilhardi* (Montgm.), espécie já conhecida dos Estados de São Paulo e Paraná (Marcus, 1942-1943). O material sul-africano perfaz 2 lotes, um de Port St. Johns (Pondoland) e o outro de Pietermaritzburg (Natal). O primeiro classifiquei também como *P. eilhardi*; o segundo como *P. gracense* (Böhm.).

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## **Estampas**

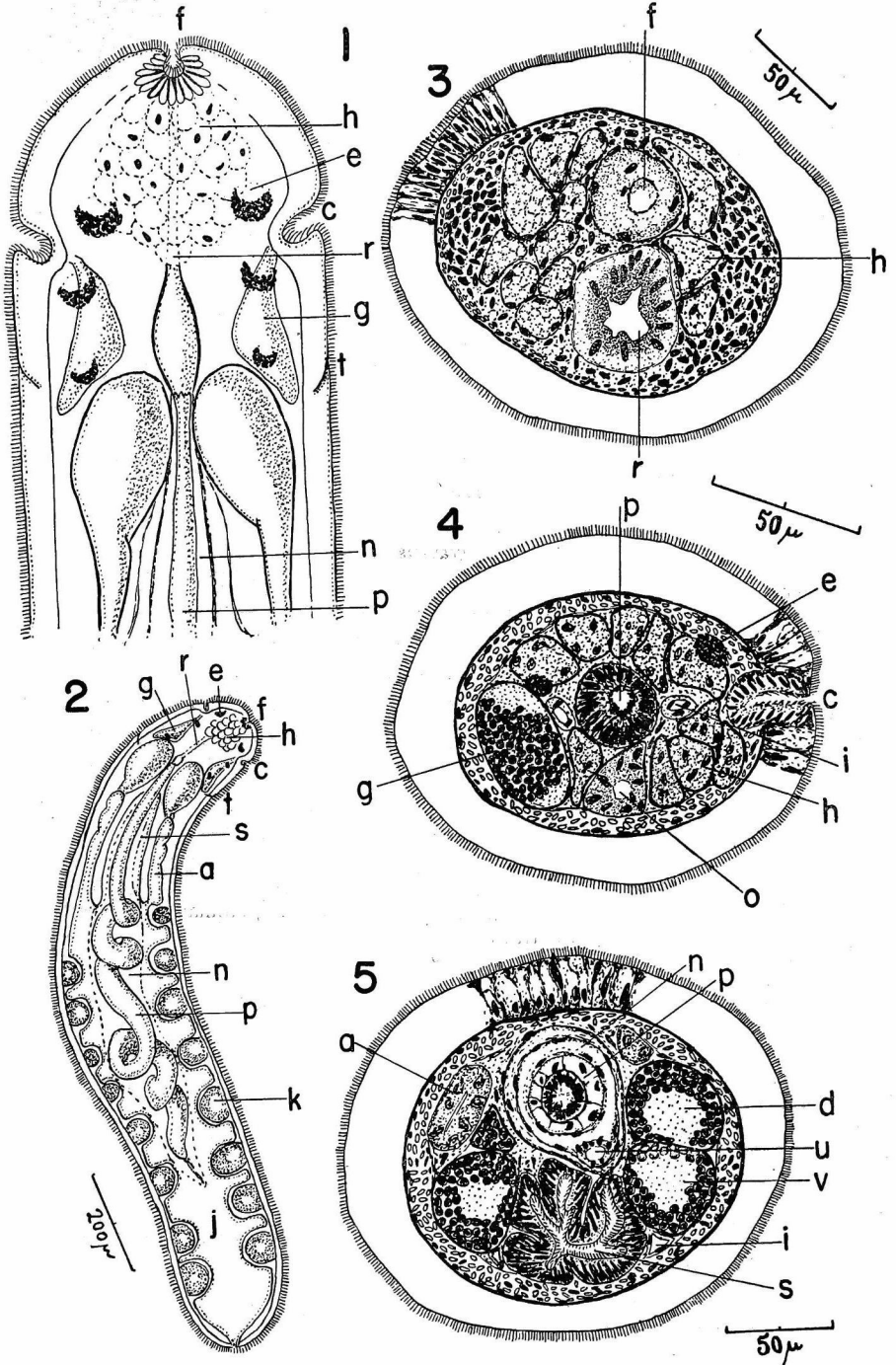
## PLATE I

*Prostoma eilhardi* (Montg.)

- Fig. 1 — View of the anterior part.  
Fig. 2 — Total view.  
Fig. 3 — Transverse section at the level of the rhynchodeum.  
Fig. 4 — Transverse section at the level of the œsophagus.  
Fig. 5 — Transverse section at the level of the stomach.

## Significance of the lettering :

a, antero-lateral diverticles. c, cephalic grooves. d, dorsal cerebral ganglion. e, eyes. f, frontal sense organ. g, cerebral organ. h, cephalic glands. i, lateral vessels. j, intestine. k, gonads. n, rhynchocœl. o, œsophagus. p, proboscis. r, rhynchodeum. s, stomach. t, transverse grooves. u, dorsal vessel. v, ventral cerebral ganglion.



## PLATE II

*Prostoma græcense* (Böhm.)

- Fig. 6 — Combined section of the tip of the head.  
 Fig. 7 — Transverse section at the level of the œsophagus.  
 Fig. 8 — Transverse section at the level of the stomach.  
 Fig. 9 — Sagittal combined section of the tip of the head with everted proboscis.  
 Fig. 10 — Calcareous corpuscles in parenchyma cells.  
 Fig. 11 — Central stylet and basis.

## Significance of the lettering :

a, antero-lateral diverticles. b, basis of stylet. e, eyes. f, frontal sense organ. g, cerebra, organ. h, cephalic glands. i, lateral vessels. l, lateral nerves. m, retractor muscle. n, rhynchocœl. o, œsophagus. p, proboscis. r, rhynchodeum. s, stomach. u, dorsal vessel  
 x, calcareous corpuscles. y, central stylet.

