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Two New rhabdocoel Turbellarians parasitic in Tasmanian Holothurians

By

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(WITH 13 TEXT FIGURES AND 3 PLATES)

ABSTRACT

A list of the valid species of rhabdocoel Turbellarians recorded as endoparasites of Holothurians is given. Two new species are described. One of these occurs in the intestine of *Mensamaria thomsoni* (Hutton) and belongs to a new genus. It is named *Notothrix inquilina* gen. et sp. nov. The second species is found in the intestine of *Stichopus mollis* (Hutton) and belongs to the genus *Ozametra* Marcus. It is named *Ozametra striata* sp. nov.

INTRODUCTION

The rhabdocoel Turbellarians recorded as endoparasites of Holothurians all belong to the family Umagillidae (Wahl, 1910). In a recent revision of the family Stunkard and Corliss (1951, p. 324) record 13 valid and 5 doubtful species from sea-cucumbers. Westblad (1953, p. 269) has re-established one of the doubtful species, namely, *Anoplodium graffi* Monticelli, and described three new forms. Of these one, *Anoplodiopsis gracilis*, is recorded as doubtfully synonymous with *Anoplodium gracile* Wahl. whilst another, *Ozametra elegans*, is stated to be the species, which Bock (in Westblad, 1926, p. 212) assigned to the genus *Umagilla* but did not describe.

It would seem, therefore, that 16 valid species of rhabdocoel Turbellarians parasitic within Holothurians are now recognized. These are listed in the following table.

Turbellarian	Holothurian host	Site in host	Locality
Anoplodiera voluta Westblad, 1930	*Stichopus tremulus* (Gunnerus)	Intestine	West Coast of Norway
Anoplodiopsis gracilis Westblad, 1953	*Holothuria forskali* Delle Chiaje	Body cavity	Naples, Italy
Anoplodium evelinae Marcus, 1949	Holothurians	Body cavity	Bay of Santos, Brazil
Anoplodium graffi Monticelli, 1892	*Holothuria impatiens* Forskal	Body cavity	Naples, Italy
Anoplodium mediale Ozaki, 1932	*Stichopus japonicus* Selenka	Body cavity	Hiroshima, Japan
Anoplodium parasita Schneider, 1858	*Holothuria tubulosa* Gmelin	Body cavity	Naples, Italy
Anoplodium stichopi Bock, 1926	*Stichopus tremulus* (Gunnerus)	Body cavity	West Coast of Norway
Anoplodium tubiferum Westblad, 1953	*Holothuria forskali* Delle Chiaje	?	Plymouth, England
Cleistogamia holothuriana Faust, 1924	*Actinopyga mauritiana* (Quoy and Gaimard)	Intestine	Andaman Seas
Cleistogamia loutfia (Khalil and Azim), 1937	Holothurians	Intestine	Hourghada, Red Sea

Turbellarian	Holothurian host	Site in host	Locality
Macrogynium ovalis Meserve, 1934	*Stichopus* sp.	Intestine	Bermuda
Monticellina longituba Westblad, 1953	*Holothuria impatiens* Forskal and *Holothuria polii* Delle Chiaje	Body cavity	Naples, Italy, and Rovinj, Yugoslavia
Ozametra arbora (Ozaki), 1932	*Stichopus japonicus* Selenka	Intestine	Hiroshima, Japan
Ozametra elegans Westblad, 1953	*Stichopus tremulus* (Gunnerus)	Intestine	West Coast of Norway
Umagilla forskalensis Wahl, 1906	*Holothuria forskali* Delle Chiaje	Fore-gut	Naples, Italy
Wahlia macrostylifera Westblad, 1930	*Stichopus tremulus* (Gunnerus)	Intestine	West Coast of Norway

Westblad (1953, p. 276) gives a diagnosis of the genus *Anoplodium* and states that the species are "Parasites in the intestine of sea-cucumbers". This seems to be an error since of the six species mentioned in the above table five are recorded as occurring in the body cavity of the host. The precise location in its host of the remaining species, *Anoplodium tubiferum*, Westblad, is not mentioned in the original description.

In the present paper two new parasitic rhabdocoels found in Tasmanian Holothurians are described. One, *Notothrix inquilina* gen. et sp. nov., is from the intestine of the small bluish sea-cucumber, *Mensamaria thomsoni* (Hutton), collected under stones at low tide near Fossil Island, Eaglehawk Neck. The other, *Ozametra striata* sp. nov. is from the intestine of the large sea-cucumber, *Stichopus mollis* (Hutton), taken in D'Entrecasteaux Channel.

With the exception of *Anoplodium evelinae* Marcus from Holothurians in the Bay of Santos, Brazil, the two Tasmanian species appear to be the only parasitic rhabdocoels so far recorded from Holothurians in the Southern Hemisphere.

DESCRIPTIONS

Order: **NEOOPHORA**

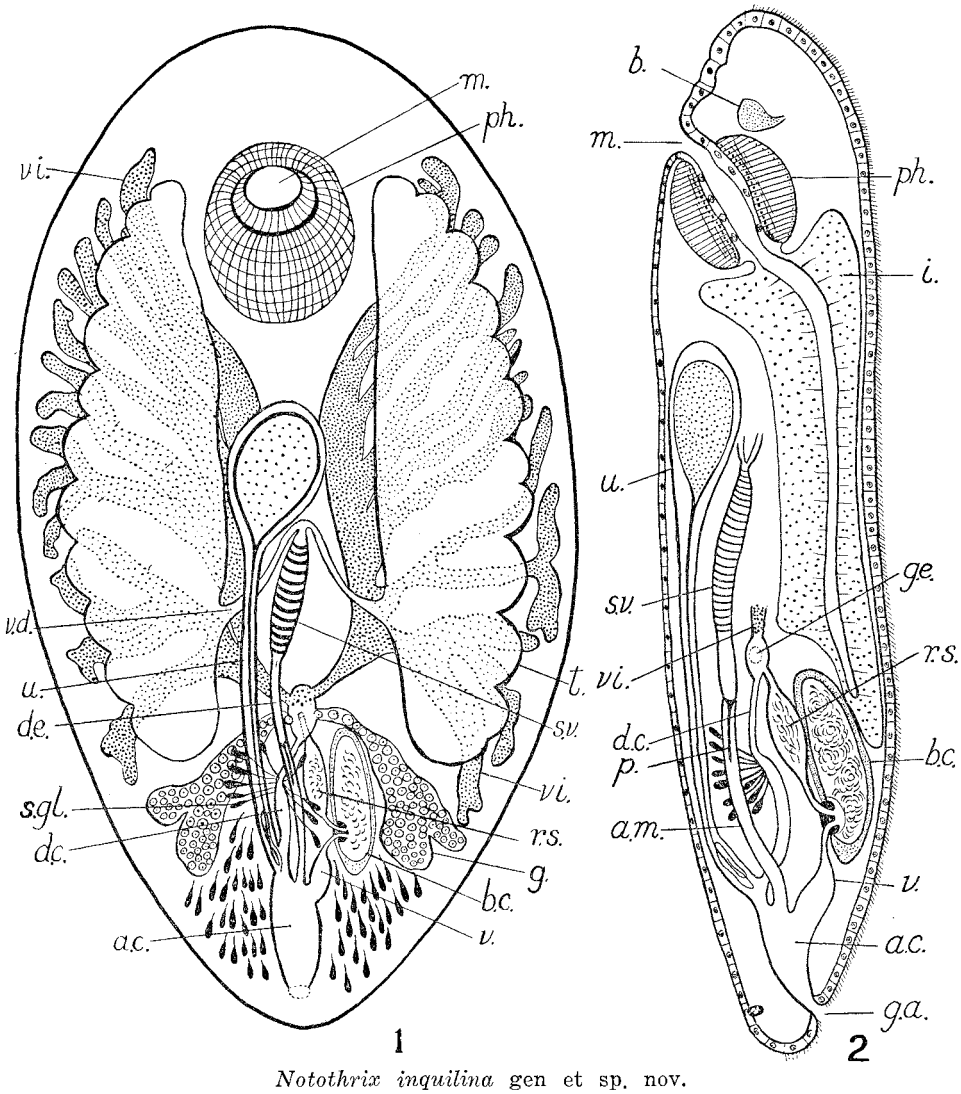
Sub-order: **Neorhabdocoela**

Family: **Umagillidae** Wahl, 1910

Genus: *Notothrix* nov.

Definition of genus: Umagillidae with dorsal surface of body ciliated, ventral surface non-ciliated. Large pharynx doliiformis at anterior end of intestine. Germaria paired and lobed. Testes paired, lateral, long and lobed. Vitellaria paired, separate and dendritic. Penis in the form of a stylet lying in a tubular non-ciliated antrum masculinum. Vagina leading into a glandular bursa copulatrix. Genital aperture dorsal and near posterior end.

Type of genus: *Notothrix inquilina* sp. nov.



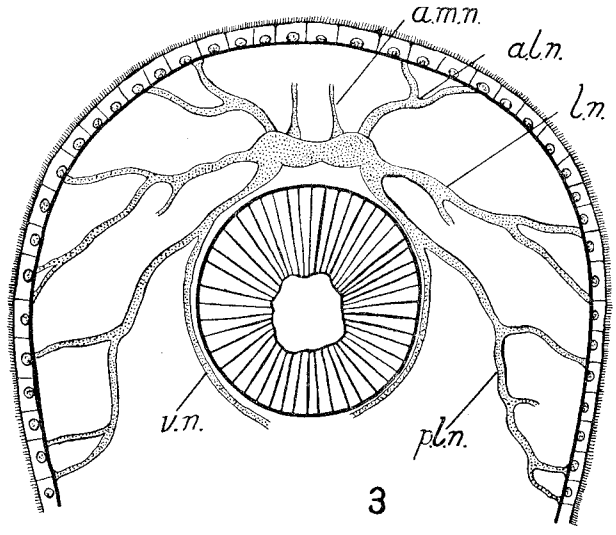
Notothrix inquilina gen et sp. nov.

FIG. 1.—Ventral view of general organization.
FIG. 2.—Sagittal section.

Notothrix inquilina sp. nov.

(TEXT FIGURES 1-6. PLATES I AND III)

External features: Living specimens are somewhat leaf-shaped, wide and rounded in front and becoming narrower posteriorly. The length of mature individuals after fixation 1·0-1·6 mm.; the width 0·45-0·67 mm. The dorsal surface is convex and clothed with cilia. The ventral surface is usually concave in life but somewhat convex in preserved specimens. The body is white and translucent, the yellowish vitellaria and egg-capsule being clearly visible. The mouth is in a median position on the ventral surface about 1/7 of the length of the animal from the anterior end. The genital aperture is near the posterior end and on the dorsal



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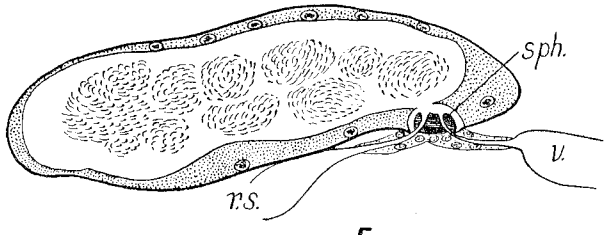

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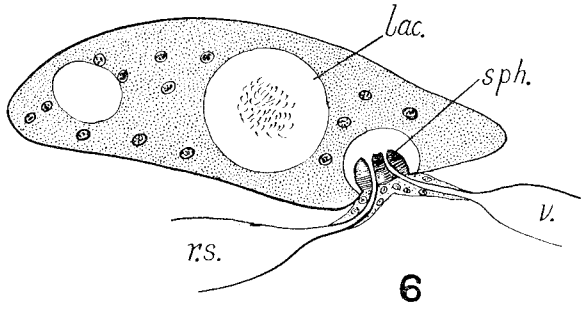

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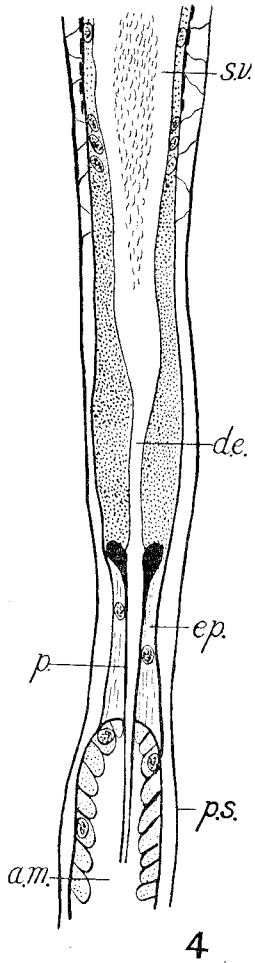

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Notothrix inquilina gen. et sp. nov.

FIG. 3.—Dorsal view of brain and main nerves.
FIG. 4.—Penis (stylet) in sheath.
FIL. 5.—Bursa copulatrix filled with many spermatozoa.
FIG. 6.—Bursa copulatrix with few spermatozoa.

surface. When removed from the intestine of its host and placed in sea water the Turbellarian creeps about with the wide rounded end directed forwards. It also swims freely with the body somewhat twisted or with the concave ventral side uppermost. If several individuals are placed together in a dish they will often become attached to one another by means of the strong suctorial pharynx and are then difficult to separate without damage.

In order to examine the internal features specimens were fixed in either Bouin's fluid or in sublimate-acetic. Sections were cut at 5-10 μ and stained in haematoxylin and eosin.

Body epithelium: The cells of the dorsal surface are ciliated. In horizontal sections they appear polygonal, usually six-sided. In longitudinal sections they appear rectangular and usually columnar. They vary in height from 7-12 μ and in width from 7-27 μ according to the degree of contraction or extension of the animal. The nuclei of the cells are about 6 μ in diameter and the cilia 4 μ in length.

The cells of the ventral surface are non-ciliated and form an epithelium which is thinner than that of the dorsal surface. In height the cells vary from 6-7 μ and in width from 10-14 μ. Their nuclei are slightly smaller than those of the dorsal cells. Both dorsal and ventral epithelia are devoid of gland cells, rhabdites and pigment.

Body musculature: The muscular sheath lying below the body epithelium consists of an outer layer of transverse fibres and an inner layer of longitudinal fibres. Between the two layers are a few diagonal muscles. The transverse muscles are more numerous dorsally than they are ventrally, there being in a length of about 26 μ in the middle region of the body about 10 dorsal fibres and only 4 or 5 ventral fibres. The longitudinal muscles, on the other hand, are stronger and more numerous ventrally than dorsally. Some of the diagonal fibres arise from the sides of the longitudinal muscles. Dorso-ventral muscles are numerous. They are strongly developed lateral to the testes, where they pass upward between the testicular lobes.

Digestive system: The mouth is circular and in a median position on the ventral side of the body. In a specimen 1·11 mm. long it is 0·15 mm. from the front margin. It is opened by a series of radial fibres in the dermal muscular sheath and is closed by a sphincter. Immediately inside the mouth is a small pharyngeal pouch which leads into a large pharynx doliiformis, 0·135 mm. long and 0·129 mm. in diameter (fig. 2). The pharynx projects forwards and downwards from the front of the intestine. The usual pharyngeal muscles are present, namely, inner and outer circular, inner and outer longitudinal and radial. The inner circular muscles are stouter than the others and form about 29 rings. The epithelium lining the lumen of the pharynx consists of a layer of cells with distinct nuclei and is not merely composed of the extended ends of the cells surrounding the opening of the pharynx into the intestine. In the resting condition the cells measure 8 μ in height and their nuclei about 5 μ in diameter. They are non-ciliated and resemble the cells of the ventral surface of the body. Pharyngeal glands are absent. Arising from the antero-dorsal surface of the pharynx and passing upward to be inserted in the dorsal muscular sheath of the body are two pairs of strong retractor muscles. The first pair lie between the

pharynx and the brain. The second pair are a short distance behind the first pair and more widely separated. All four muscles have brush-like ends. Arising from the postero-ventral surface of the pharynx and passing backward close to the ventral body-wall are a number of stout longitudinal or slightly oblique fibres, which are inserted in the ventral dermal muscular sheath and which also act as retractors of the pharynx. Several protractor muscles arise on the front of the pharynx and pass forward and downward to be inserted in the ventral muscular sheath a short distance in front of the mouth.

The passage leading from the pharynx to the intestine is very short, measuring about 13 μ in length and 10 μ in width. Its wall is furnished with strong circular and longitudinal muscles, the latter being continued for some distance into the wall of the intestine. The circular muscles act as a strong sphincter closing the opening of the pharynx into the gut. The epithelium lining the passage consists of large pyriform cells some of which project into the lumen of the pharynx. A distinct oesophagus or " crop ", such as occurs in certain other species, is absent in the Turbellarian under consideration.

The intestine is an elongated more or less cylindrical sac extending backwards from the pharynx as far as the bursa copulatrix. The posterior end of the intestine usually overlies the anterior end of the bursa. The length of the intestine is about half that of the animal and varies from 0·589-0·786 mm. The width varies from 0·131-0·197 mm. There are no lateral diverticula. The cells lining the lumen of the gut are long and club-shaped. They contain numerous vacuoles, many of which enclose food particles. The vacuoles vary in diameter from about 10-21 μ. The cell nuclei are generally basal in position. The wall of the intestine is provided with a few weak longitudinal muscles but no circular muscles were observed. The sides of the gut are slightly indented by muscles which pass upward through the parenchyma from the ventral to the dorsal body-wall.

Excretory system: No special excretory organs were observed in either the living or the preserved specimens. It seems probable that excretion occurs at the general surface of the body.

Nervous system: The brain (fig. 3) is immediately in front of the pharynx and about 78 μ from the dorsal surface. It measures 70-86 μ in width. The main nerves arising from the brain are shown in fig. 3. Two pairs of short nerves are given off anteriorly and supply the front of the body. Behind these a large pair of nerves extend laterally giving branches to each side of the body in front of the pharynx. Posteriorly the brain gives rise to a pair of stout trunks, each of which soon divides to form a branch which extends in a postero-lateral direction to the sides of the body and a branch which runs round the pharynx to the ventral surface. The postero-lateral nerve gives off branches to the vitellaria, the testes and the dorsal surface.

Reproductive system: The atrium genitale commune is a somewhat narrow chamber lined with rounded or club-shaped non-ciliated cells. It curves upward to open at the genital aperture, the opening being closed by a sphincter. The atrium is provided with strong protractor

and retractor muscles and its outer wall is furnished with weak circular fibres and more strongly developed longitudinal fibres. Dorsally the atrium leads into the vagina. Below the vagina it communicates with the antrum masculinum and below the latter with the antrum femininum. Owing to the ductus communis joining the uterus near the atrium genitale, the antrum femininum is relatively short. Strong dorso-ventral muscles pass through the parenchyma on each side of the atrium.

The testes, which measure 550-655 μ in length and 118-131 μ in greatest width, are large, paired and slightly lobed. They lie one on each side below the vitellaria and extend from the pharynx almost to the posterior end of the ovaries.

The vasa deferentia measure about 131 μ long and 23 μ wide. Each arises from the inner side of the posterior half of the testis. In the resting condition the vasa deferentia converge below the intestine and above the bulbous part of the uterus (figs. 1 and 2). They unite and immediately join the anterior end of the seminal vesicle. When filled with spermatozoa they are very wide and thin walled.

The seminal vesicle is about 120-200 μ in length and 27-30 μ in diameter. Its wall is provided with strong circular and longitudinal muscles. The circular muscles form bands which are 1-6 μ in width. The seminal vesicle is lined with an epithelium of flat cells and is closed by a strong sphincter at its junction with the vasa deferentia. Posteriorly it narrows to form the ductus ejaculatorius. The latter measures 60-100 μ in length and about 13-15 μ in diameter. Its wall is provided with strong longitudinal and weak circular muscles. The lining of its lumen is thick and appears to consist of a protoplasmic syncytium.

At its posterior end the ductus ejaculatorius passes into the penis, which is a slender chitinous stylet, 47-54 μ in length, projecting into the antrum masculinum (fig. 4). When completely retracted the stylet is usually near the region of the shell-glands. However, it may protrude through the genital aperture, extend into the atrium, or occupy other positions in the posterior part of the male canal. The stylet rises from a strong circular base, which is about 8 μ in diameter and gives attachment to the longitudinal muscles of the ductus ejaculatorius. In transverse sections the ends of these muscles appear as 12 fibres arranged radially round the base of the stylet.

The germaria are elongate and paired. They lie one on each side of the body in the posterior third. Each is about 330-350 μ in length and is lobed posteriorly. The number of lobes varies from two to three and sometimes differs in the left and right germaria of the same specimen. Anteriorly the germaria curve inwards and open laterally into the ductus communis immediately behind the openings of the vitellaria.

The vitellaria (fig. 1) occupy the middle two-thirds of the body. They are paired and dendritic, with four to ten main branches on each side (Plate I, figs. 1 and 2). The branches extend laterally above the testes and often divide dichotomously. The two median stems, however, lie below or at the sides of the intestine. The ends of the most anterior branches are level with the front of the pharynx, whilst the ends of the posterior branches lie lateral to and almost level with the posterior ends of the germaria. The left and right vitellaria are often asymmetrical,

there being more branches on one side than on the other. They converge in front of the germaria and open directly into the anterior end of the ductus communis.

The ductus communis is 250-390 μ in length. It lies immediately below the receptaculum seminis and, for the greater part of its length, above the male canal. It extends from the convergence of the vitellaria almost to the atrium genitale. Before reaching the latter, however, it curves downwards on the right side of the antrum masculinum to open into the neck of the uterus (uterine duct). From its junction with the germaria to a position below the middle of the receptaculum seminis the ductus communis is a narrow tube having a diameter of about 6 μ. It then suddenly increases in diameter to about 24 μ. Into the anterior end of this wider part open the so-called shell-glands. These glands form two large groups of elongate pyriform cells situated behind and between the germaria. They extend forwards surrounding the male canal and open into the ductus communis ventrally and laterally (Plate I, fig. 3). The outer wall of the ductus communis is provided with weak circular and stronger longitudinal muscles. The wide part of the duct is lined with rounded or club-shaped cells, the narrow part with flat cells. At its opening into the uterine duct the ductus communis is surrounded by a sphincter.

The uterus lies in a median ventral position and extends from the atrium commune almost to the pharynx. The anterior part is ovoid, somewhat dorso-ventrally compressed and measures 219 μ in length, 87-92 μ in height and 132-137 μ in width. Posteriorly the ovoid part merges into a long neck or uterine duct, 342 μ long, 13 μ high and 50-76 μ wide, which extends backwards to the atrium. Before entering the latter, however, it curves upward and is joined by the ductus communis. The uterus is lined by an epithelium of flattened cells and its outer wall is provided with circular and longitudinal muscles.

Only a single egg-capsule is present in the uterus at one time. It is yellowish in colour, ovoid in shape and with one end drawn out into a long slender much coiled filament, which rests in the posterior elongated neck of the uterus (Plate II, fig. 7). The ovoid part of the capsule measures 189-210 μ long and 97-137 μ in diameter. Its wall is of a horny or chitinous nature and measures 5 μ in thickness.

The vagina is about 81 μ in length. It leads directly from the dorsal part of the atrium to the bursa copulatrix (fig. 2). On leaving the atrium it has the form of a wide tube about 45 μ long and 21 μ in diameter. This tube is lined with club-shaped cells and its outer wall is provided with circular and longitudinal muscles. Anteriorly the vagina becomes reduced to a narrow duct about 36 μ long and only 3 μ in diameter. The lining of this narrow part of the vagina appears to be cuticularized. The duct enters the bursa copulatrix ventrally a short distance in front of the posterior end of the latter. At the point of entry it passes through a hemispherical structure, 21 μ in diameter, which projects into a lacunar space in the bursa (figs. 5 and 6).

The bursa copulatrix has the form of a long ovoid or spindle-shaped sac measuring about 165-186 μ in length and 60-75 μ in width. It lies between the germaria and near the dorsal surface. Its anterior end,

however, underlies the posterior end of the intestine. The wall of the bursa is glandular and has the appearance of a protoplasmic syncytium with irregularly disposed nuclei. Spermatozoa contained within the bursa form rounded masses. When these are numerous the wall of the bursa is relatively thin and the lumen large (fig. 5), but when the masses of spermatozoa are small and few, the wall becomes so thick that the lumen is reduced to lacunar spaces in a syncytial mass (fig. 6 and Plate II, fig. 6). The outer wall of the bursa copulatrix is furnished with very fine circular and longitudinal fibres.

Immediately in front of the entrance of the vagina into the bursa and passing through the same dome-like structure is a narrow duct directed downwards and forwards. The duct soon expands to form an ovoid or spindle shaped sac, the receptaculum seminis, which lies close below the bursa (fig. 2) and extends forwards and downwards to open into the ductus communis above the junction of the latter with the germaria. The length of the receptaculum is about 200 μ. Its diameter depends on the extent to which it is filled with spermatozoa and may vary from 36-72 μ. The epithelium lining the receptaculum is composed of flat cells. Circular and longitudinal muscle fibres are present in the outer wall.

Habitat: Notothrix inquilina occurs in the intestine of *Mensamaria thomsoni* (Hutton) and is usually found in the pigmented first part of the intestine. During the three months, January, February and March, 1954, one hundred and twenty-one specimens of the Holothurian were collected. Of these 51 were found to be infected with the parasite. Usually only one or two specimens of the Turbellarian were present in an infected host. In one case, however, 22 were found in the one Holothurian.

Locality: Fossil Island, Eaglehawk Neck, Tasmania.

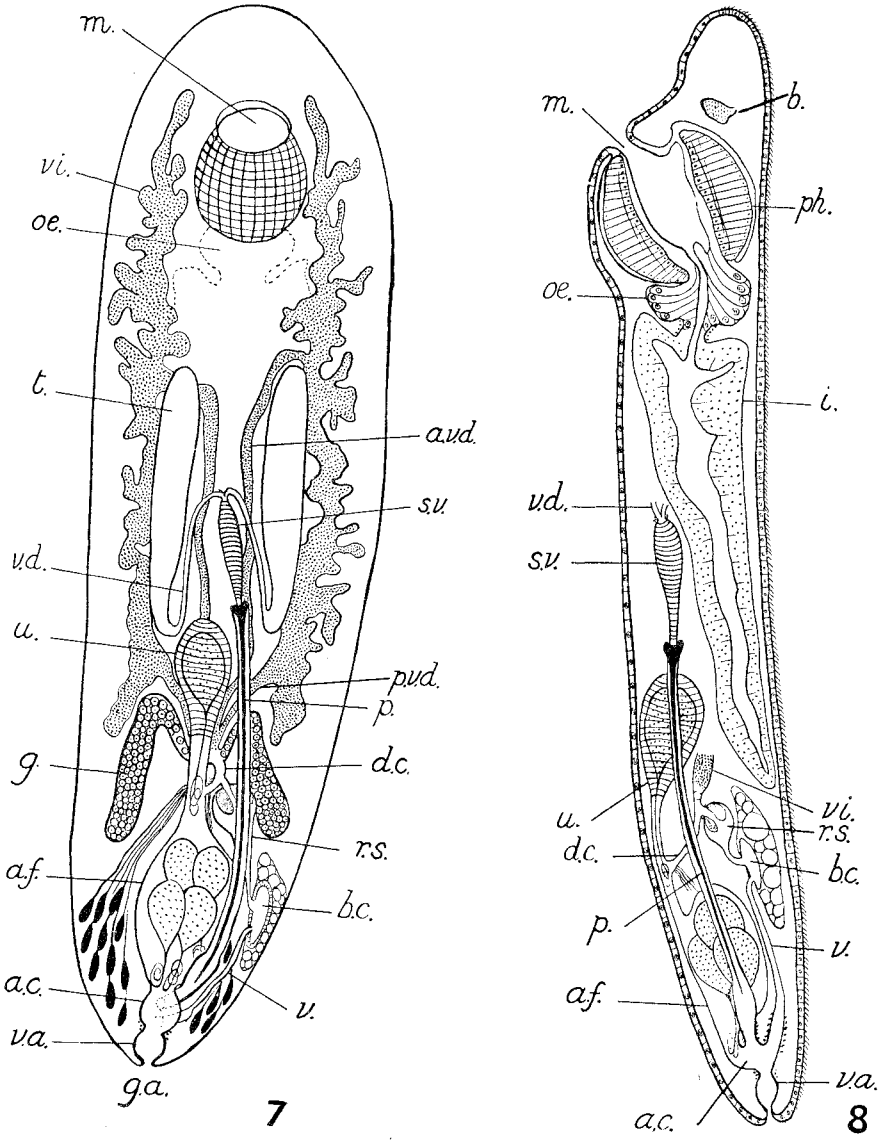
Affinities: Notothrix inquilina resembles *Wahlia macrostylifera* Westblad (1930), *Anoplodiera voluta* Westblad (1930) and *Monticellina longituba* Westblad (1953) and differs from all other recorded members of the family Umagillidae in having a non-ciliated ventral surface. It differs from *Wahlia macrostylifera* in possessing much larger testes and a glandular bursa copulatrix, from *Anoplodiera voluta* in having paired germaria and from *Monticellina longituba* in possessing much larger testes, a non-ciliated antrum masculinum and a not unusually long seminal vesicle.

Genus: *Ozametra* Marcus, 1949

(Syn. *Xenometra* Ozaki, 1932)

Definition of genus: Umagillidae with the uterus composed of two parts: an anterior ovoid primary uterus connected by a narrow neck to a posterior sac-like secondary uterus (antrum femininum) containing several mature egg-capsules. Germaria paired, elongate, not lobed, situated in posterior third of body and directed backwards. Testes paired, lateral and in middle third of body.

Type of genus: *Xenometra arbora* Ozaki, 1932



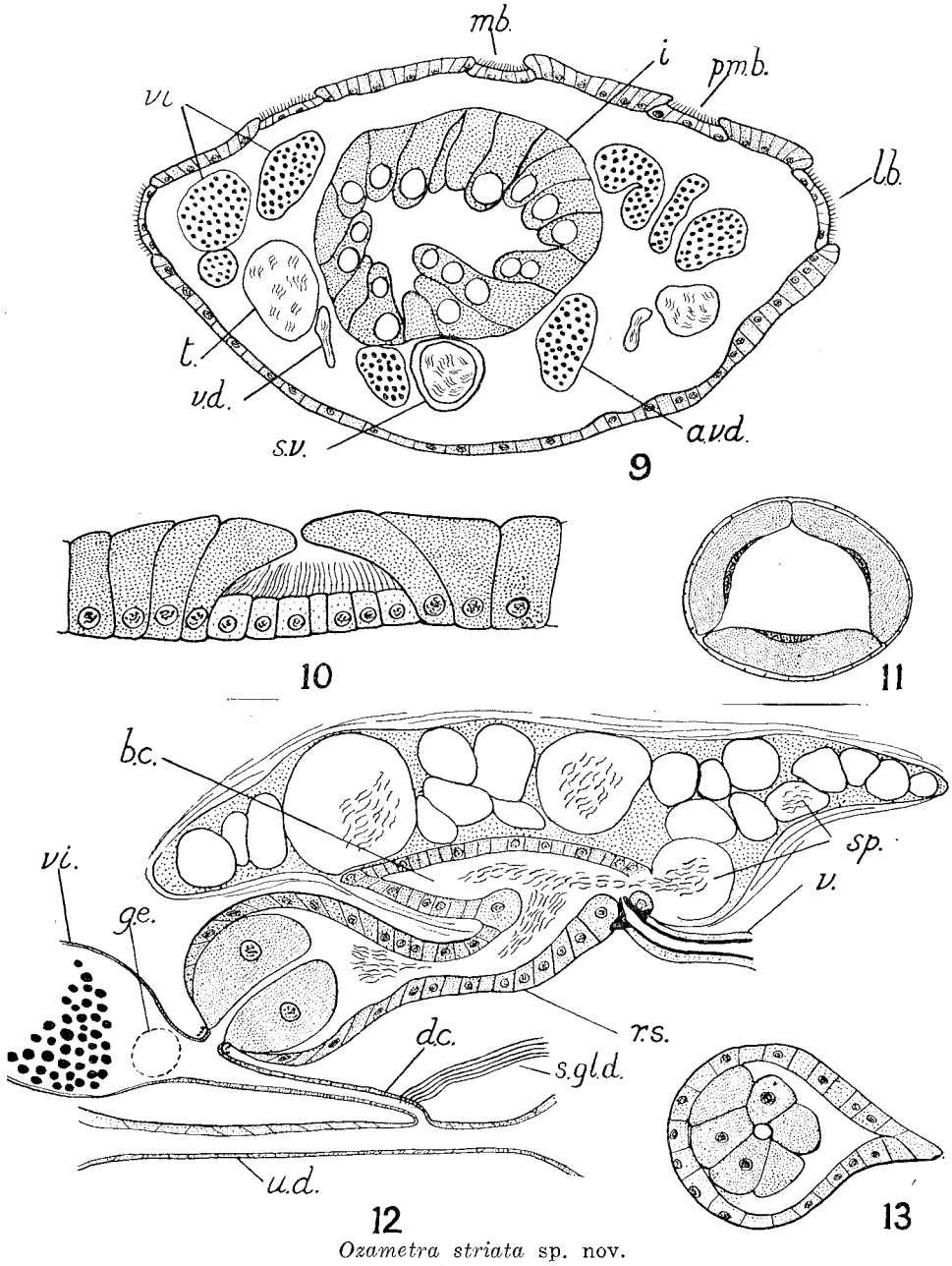
Ozametra striata sp. nov.

FIG. 7.—Ventral view of general organization.
FIG. 8.—Sagittal section.

Ozametra striata sp. nov.

(TEXT FIGURES 7-13. PLATE III)

External features: The body is leaf-shaped, rounded and wide in front, somewhat narrow posteriorly, convex above and flat or slightly convex below. It measures 1·48-1·96 mm. in length and 0·50-0·60 mm. in width. The mouth is in a median position on the ventral surface and about 1/9 of the animal's length from the anterior end. The genital aperture is at the posterior end (figs. 7 and 8).



Ozametra striata sp. nov.

FIG. 9.—Transverse section through body immediately in front of the uterus.

FIG. 10.—Transverse section through dorsomedian ciliated groove and adjacent epithelium showing the groove almost closed over.

FIG. 11.—Transverse section through anterior bulbous part of uterus.

FIG. 12.—Sagittal section through bursa copulatrix and receptaculum seminis.

FIG. 13.—Horizontal section through anterior wide part of receptaculum seminis.

The surface of the body is provided with five longitudinal ciliated bands, two of which extend along the lateral margins, one is mediodorsal, and one on each side is paramedian, being situated about midway between the mediodorsal and marginal bands (fig. 9). The width of the bands varies with the degree of extension or contraction of the animal. In a moderately extended specimen they are widest in the anterior quarter of the body. In this region the widths of the mediodorsal, paramedian and marginal bands are 90 μ, 51 μ and 39 μ respectively. The bands extend from the anterior to the posterior end of the body. The cells of the ciliated bands are about 5 μ whilst those of the adjacent epithelium are 10-13 μ in height. Hence, the bands appear to be in shallow grooves. In some cases the margins of a groove may be brought together so that the ciliated band is completely covered (fig. 10). The cilia are 5 μ in height and are confined to the cells forming the bands. All other epithelial cells of both dorsal and ventral surfaces are non-ciliated. The epithelium of the ventral surface is thinner than that of the dorsal surface. Rhabdites and pigment are absent.

The colour of the animal is whitish and translucent, the vitellaria and egg-capsules yellow.

Body musculature: Below the epithelial cells is a layer of transverse muscles and a layer of longitudinal muscles. Between the two are a few strong diagonal fibres (Plate III, fig. 8). The diameter of the diagonal fibres measures about 3 μ, that of the longitudinal fibres about 2 μ and that of the transverse fibres about 1 μ. On each side of the body is a series of dorsoventral muscles, there being about 19 such muscles on either side of the intestine.

Digestive system: The mouth leads into a large and strong pharynx doliiformis, which is situated at the anterior end of the alimentary canal and directed forwards and downwards. The pharynx measures about 189 μ in length and 199 μ in diameter. The usual muscles are present, the inner circular muscles being very strong and forming about 25 rings. The lumen of the pharynx is lined by extensions of the long club-shaped cells which form the lining of the oesophagus. The latter structure is situated between the pharynx and the intestine (fig. 8). In the contracted condition it measures 137 μ in diameter and 69 μ in length. Its outer wall is furnished with weak circular and strong longitudinal muscles. The opening of the oesophagus into the intestine is surrounded by a strong sphincter.

The intestine is an elongate sac about 655 μ in length and 158 μ in diameter. It lies in a median position close below the dorsal surface and extends from the oesophagus to the bursa copulatrix. The lumen of the intestine is lined by long club-shaped cells containing numerous vacuoles. The outer wall is provided with a few longitudinal muscles but no circular fibres can be seen.

Excretory system: As in the preceding species a specialized excretory system appears to be absent.

Nervous system: The brain lies immediately in front of the pharynx and about 44 μ from the dorsal surface. It measures 84 μ in width. As in the preceding species the main nerves given off from the brain consist

of three pairs of lateral nerves which run out to the sides of the body, and a pair of ventral nerves which pass round the sides of the pharynx.

Reproductive system: The atrium genitale commune (fig. 8 and Plate III, fig. 9) is large and constricted in the middle so that it forms two compartments, one in front of the other. The constriction between the two is surrounded by a sphincter. The posterior compartment is comparable to the vestibulum atrii, which occurs in certain other rhabdocoels. It is ovoid in shape, 53 μ long and 39 μ in diameter. It opens to the exterior by the genital aperture. The front compartment of the atrium leads anteriorly into the vagina above, the antrum masculinum in the middle and the antrum femininum below. All three apertures are surrounded by strong sphincters.

The epithelium lining both compartments of the atrium consists of club-shaped or pyriform cells. The outer wall is provided with circular and longitudinal muscles. Strong dilator muscles as well as protractor and retractor fibres arise from the sides of the atrium and extend outwards to the body wall.

The testes are paired. They lie one on each side of the intestine and below the vitellaria in the middle third of the body. Each measures about 406 μ in length and 52 μ in width, the length being slightly more than 1/4 that of the body. In shape the testes are somewhat cylindrical and without lobes. From the posterior end of each a thin-walled narrow vas deferens is given off. The two vasa deferentia turn inwards and forwards below the intestine. They converge at the anterior end of the seminal vesicle, into which they separately open.

In the retracted state the seminal vesicle lies in a median position below the intestine and immediately in front of the uterus (figs. 7 and 8). It is about 202 μ long and fusiform in shape, being 32 μ wide near its anterior end and tapering to 21 μ wide near its posterior end. Its outer wall is provided with strong wide circular muscles and weaker longitudinal fibres. Retractor muscles are attached to its front end. The lumen of the vesicle is lined by an epithelium of very flat cells. The posterior end of the organ opens into the base of the penis stylet.

In the largest specimens the stylet measures 720 μ long and is about 2/5 the length of the extended animal. It lies in a sheath, the wall of which is thin and furnished with fine longitudinal fibres. The stylet, which has a hard chitinous appearance, passes above or to the left of the anterior bulbous part of the uterus and extends almost to the atrium. Its base is expanded into a strong ring-like structure which has an external diameter of 16 μ and surrounds the posterior end of the seminal vesicle. The internal diameter of the stylet at the base is 5 μ but throughout the greater part of the length of the structure it is only 3 μ. The distal end of the stylet projects into the antrum masculinum. This region of the male canal is about 144 μ long and 16 μ in diameter. Its outer wall is provided with strong circular and longitudinal muscles and it is lined with slender club-shaped cells similar to those lining the atrium.

The germaria are paired and lie one on each side in the posterior third of the body. Each is about 500 μ long, more or less cylindrical and

not lobed. Anteriorly the germaria bend inwards and open into the ductus communis immediately behind the entrance of the vitelline ducts.

The vitellaria occur in the anterior two-thirds of the body. They form two irregular stems one on each side of the intestine. The stems give off short branches and extend from in front of the pharynx to the germaria. At about 3/7 of their length from the anterior end they give off on the inner side a pair of anterior vitelline ducts. These extend posteriorly below the intestine and unite with a pair of posterior vitelline ducts, which are given off a short distance in front of the posterior ends of the vitellaria. The two ducts thus formed converge in the mid-line and enter the anterior end of the ductus communis (fig. 7 and Plate III, fig. 10).

The ductus communis is very short varying from about 60 μ to 100 μ in length. It is wide anteriorly but decreases to about 18 μ near the middle of its length. Immediately behind the entrance of the vitelline ducts it is joined by the germaria, which open into it laterally. Slightly posterior to the junction with the germaria, but on the dorsal side, it is joined by the receptaculum seminis. From here it passes backward and downward to open dorsally into the neck of the uterus slightly in front of the antrum femininum. Near its junction with the neck of the uterus it receives the ducts from the shell-glands. These glands form two large groups of pyriform cells, one group on each side of the antrum femininum. The glands give rise to extremely fine ducts, which pass forward in two compact bundles to open into the ductus communis.

The uterus lies in a median position close to the ventral surface and extends from slightly in front of the convergence of the vitelline ducts to the atrium genitale. In an extended animal its length is about 1/3 that of the body. The anterior part is in the form of an ovoid or bulbous sac about 184 μ long and 53 μ in diameter. The cells lining the lumen of this part of the uterus are arranged in a series of rings, about 21 in number. Each ring consists of 3 curved cells placed end to end (fig. 11). The nucleus of each cell is closely applied to the inner wall of the cell. When the uterus is distended by the presence of an egg-capsule, the nuclei of the cells become so stretched that they are scarcely recognisable. Posteriorly the bulbous part of the uterus leads into a long somewhat depressed neck region or uterine duct, which is continued towards the atrium. Before reaching the atrium, however, the uterine duct expands into a large sac-like antrum femininum or secondary uterus, in which the egg-capsules are lodged prior to being discharged. The number of egg-capsules contained in the antrum femininum at one time varies from one to twelve. When filled with capsules the antrum may be so enlarged as to extend forwards almost to the convergence of the vitelline ducts, the adjacent organs being deformed and pushed out of position. The outer wall of the whole of the uterus is provided with circular and longitudinal muscles.

The egg-capsules (Plate III, fig. 11) are pyriform in shape, yellow in colour and chitinous in appearance. Each is produced into a long polar filament at one end. The bulbous part of the capsule is about 105 μ long and 78 μ wide and its wall is nearly 3 μ in thickness. When

the capsule is in the uterus the polar filament is closely coiled but after the capsule is discharged, the filament becomes uncoiled and straight. It then measures about 760 μ long and tapers to a very fine point. Numerous capsules massed together are often found in the cloaca and posterior part of the intestine of the host, *Stichopus mollis*. Sometimes they are drawn into the respiratory trees by the inhalent current and are lodged in the branches. A capsule contains two eggs. When the young are hatched they escape from the capsule at the wider end, where an operculum, 44 μ in diameter, is pushed off.

The receptaculum seminis (figs. 12 and 13) is pyriform in shape measuring 126 μ long and 60 μ in the diameter of its widest part. It leaves the bursa copulatrix ventrally a short distance in front of the entrance of the vagina. The lumen of the receptaculum is lined by columnar or cubical cells. In the narrow posterior part of the organ the cells are about 5 μ in height and their nuclei about 3 μ in diameter. However, the antero-ventral aperture of the receptaculum leading into the ductus communis is surrounded by six very large cells, which measure 39 μ in height and have nuclei 8 μ in diameter. These large cells project backward into the lumen of the receptaculum. Their cytoplasm is finely granular and they appear to be glandular in function. The outer wall of the receptaculum is provided with weak circular and longitudinal fibres. A sphincter surrounds the aperture leading to the ductus communis.

The bursa copulatrix (fig. 12) is a more or less spindle shaped sac, which measures 92μ long and 37 μ in diameter. Its lumen is lined with columnar cells rich in cytoplasm. Associated with the bursa and covering it dorsally and laterally are numerous large vacuoles or lacunae. Some of these contain spermatozoa and some also communicate with the cavity of the bursa. The parenchyma surrounding the bursa and vacuoles is fibrous in appearance. In its normal position the bursa lies immediately behind the intestine.

The vagina passes upwards and forwards from the dorsal wall of the atrium genitale. The posterior two-fifths of the vagina has a diameter of about 15 μ and is lined with club-shaped cells. Its outer wall is provided with circular and longitudinal muscles. The circular muscles become very large and strong towards the entrance of the vagina into the atrium. Anteriorly the vagina becomes a very narrow tube, which is only about 4 μ in diameter. The inner lining of this tube is cuticularized. It enters the bursa copulatrix ventrally a short distance in front of the posterior end of the latter. The entrance into the bursa passes through a papilla-like structure which stains very darkly with haematoxylin.

Habitat: Ozametra striata occurs in the first part of the intestine of its host, *Stichopus mollis* (Hutton).

Locality: D'Entrecasteaux Channel, Tasmania.

Affinities: Only two other species belonging to the genus *Ozametra* are known. These are *Ozametra arbora* (Ozaki) and *Ozametra elegans* Westblad. The new Tasmanian species, *Ozametra striata*, differs from *Ozametra arbora* in the position of the mouth, the relative size of the pharynx, the extent of the intestine, the form of the testes and penis and

in the nature of the bursa. It differs from *Ozametra elegans* in the form of the vitellaria, the relative size of the receptaculum seminis and in the sperm ducts arising from the posterior ends of the testes. It differs from both the species in possessing a vestibulum atrii and probably also in the peculiar ciliation of the body. However, it is not possible to make a definite comparison in respect to the latter feature, since the ciliation of the body in *Ozametra arbora* and in *Ozametra elegans* has not been described.

ACKNOWLEDGMENTS

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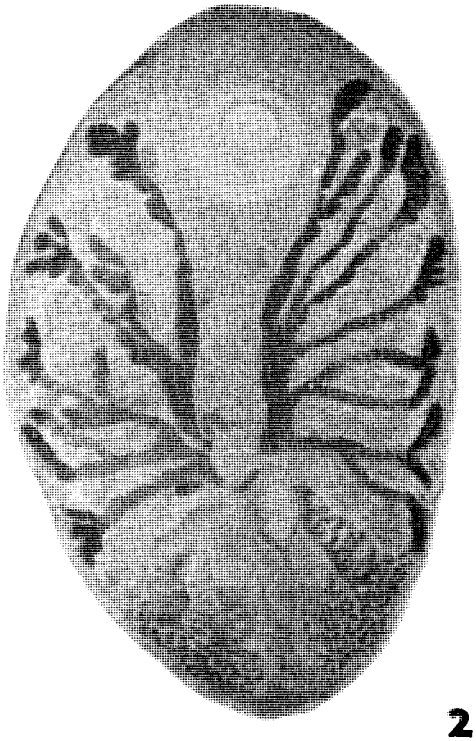
REFERENCES TO TEXT FIGURES AND PLATES

a.c.—Atrium genitale commune
a.f.—Antrum femininum
a.l.n.—Anterior lateral nerve
a.m.—Antrum masculinum
a.m.n.—Anterior median nerve
a.v.d.—Anterior vitelline duct
b.—Brain
b.c.—Bursa copulatrix
d.c.—Ductus communis
d.e.—Ductus ejaculatorius
e.p.—Epithelium of penis
g.—Germarium
g.a.—Genital aperture
g.e.—Entrance of germarium into ductus communis
i.—Intestine
lac.—Lacuna
l.b.—Lateral ciliated band
l.n.—Lateral nerve
m.—Mouth
m.b.—Median ciliated band
o.e.—Oesophagus
p.—Penis (stylet)
ph.—Pharynx
p.l.n.—Posterior lateral nerve
pm.b.—Paramedian ciliated band
p.s.—Penis sheath
p.v.d.—Posterior vitelline duct
r.s.—Receptaculum seminis
s.gl.—Shell glands
s.gl.d.—Shell gland ducts
sp.—Spermatozoa
sph.—Sphincter
s.v.—Seminal vesicle
t.—Testis
u.—Uterus
u.d.—Uterine duct (neck of uterus)
v.—Vagina
v.a.—Vestibulum atrii
v.d.—Vas deferens
vi.—Vitellaria
v.n.—Ventral nerve

Plate I

1



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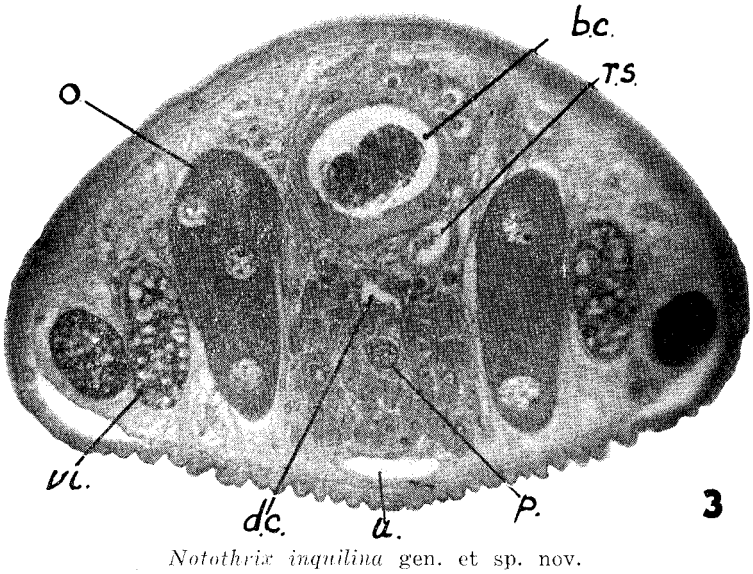


3

Notothrix inquilina gen. et sp. nov.

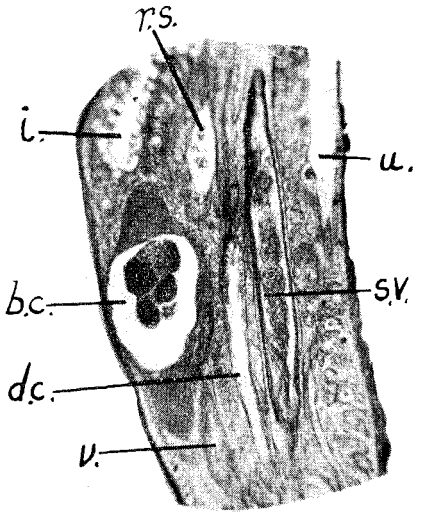
FIG. 1.—Whole mount, slightly compressed, stained in haematoxylin to show vitellaria. Egg-capsule has moved towards the posterior.

FIG. 2.—Whole mount, slightly compressed, stained in haematoxylin to show variation and asymmetry in the number of branches of the vitellaria. The egg-capsule has moved further towards the genital atrium than in the specimen shown in Fig. 1.

FIG. 3.—Transverse section through the body and passing through the middle of the bursa copulatrix.

Plate II

4



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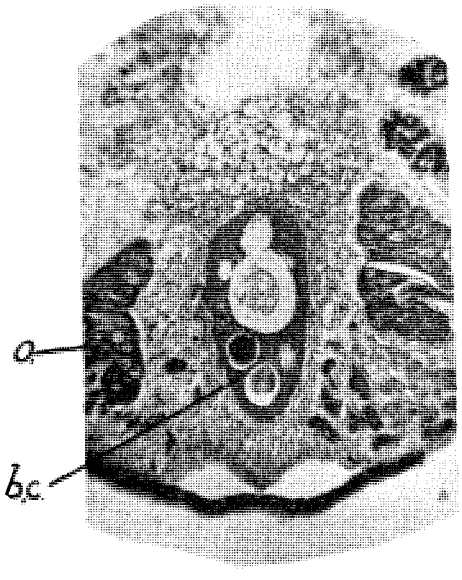

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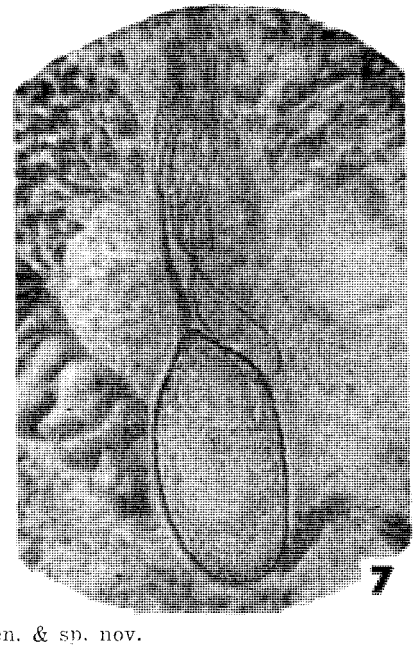


7

Notothrix inquilina gen. & sp. nov.

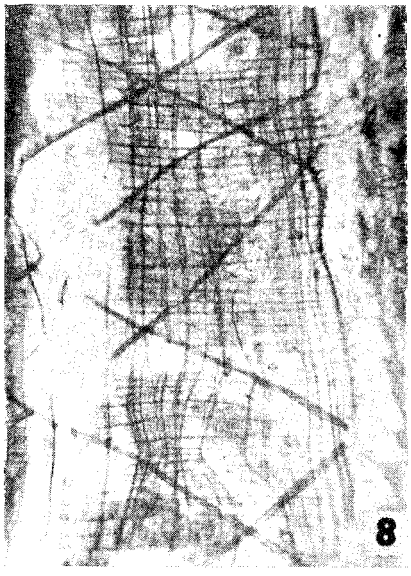
FIG. 4.—Transverse section through side of body showing the ciliated dorsal epithelium and the non-ciliated ventral epithelium.

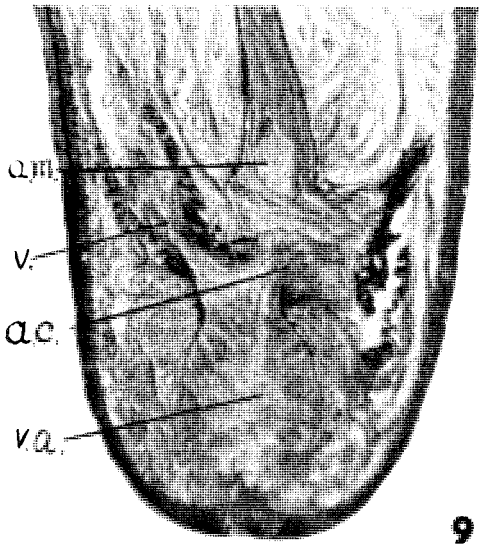
FIG. 5.—Part of a sagittal section through body in the region of the bursa copulatrix.

FIG. 6.—Horizontal section through bursa and adjacent structures, showing lacunae in the bursal syncytium.

FIG. 7.—Egg-capsule with its long coiled polar filament lying in the neck of the uterus.

Plate III





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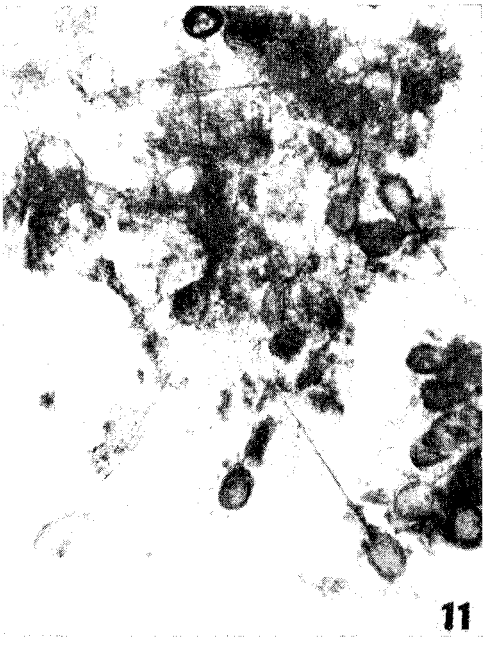

11

Ozametra striata sp. nov.

FIG. 8.—Horizontal section through the sub-epidermal musculature showing the strong diagonal fibres.

FIG. 9.—Sagittal section through the posterior end of body showing the strong circular muscles round the end of the vagina.

FIG. 10.—Whole mount stained with alum carmine and showing the arrangement of the vitellaria.

FIG. 11.—Masses of egg-capsules of the Turbellarian mingled with material from the intestine of the host.