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Two New Trematodes of the Family Gyrodactylidæ.

By

Seitaro GOTO,
Professor in the Science College, Imp. Univ., Tokyo,
and
Hajime KIKUCHI,
Teacher in the Kawagoe Middle School, Saitama Ken.

With two plates.

1. Dactylogyrus inversus, n. sp.

This new species of *Dactylogyrus* is quite common on the gills of one of our most widely distributed food fishes, *Lateolabrax japonicus* (CUV. & VAL.), and may be collected all the year round. Two or three worms are usually found attached close together to the same gill. Their movements are quick and active and consist of alternate contractions and elongations of the body, at the same time feeling about in various directions with their anterior ends; but they mostly keep themselves attached to one spot by their caudal disk, although they are able to execute leech-like locomotion. Full grown worms are 2.5 mm. long and 0.6–0.7 mm. wide. As a rule smaller worms are found on smaller hosts. The worms die rather soon when detached from the host; we have been able to keep them alive in physiological salt solution only for a single day; it was in autumn.

The body is colourless except for the vitellarium, which is faintly yellow and shows through very well; it is spatulate in form, being broadest at the middle and well rounded both in front and behind when contracted moderately, but is comparatively

thick, especially in its hinder one-third, where it is nearly cylindrical in form. We may distinguish three portions of it, the anterior, the middle and the posterior, or caudal. The middle portion contains the vitellarium, while the anterior and posterior portions are free of it and are exceedingly contractile in life. The anterior end of the body is more or less 4-lobed, and these lobes can be protruded in the from of as many papillæ or tentacle-like processes, at the top of which open the dermal glands to be described later. The hind end of the body is simply rounded off and the caudal disk is not well defined from the surrounding parts; in fact we have seen it well delimited only once in the fairly numerous cases that have come under our observations, when it was somewhat reniform with the hilus turned backward. The caudal disk bears a pair of more or less centrally placed hooks with a connective, and seven marginal pairs, which are larger than the former, a condition which appears to obtain in none of the species of *Dactylogyrus* described so far. The central hooks are represented in fig. 3, a; each consists of a comparatively stout, bifid body and a curved, sharply pointed claw, the one passing into the other without any sharp demarcation; the hoop is situated at the boundary of the two portions and is crescentic in shape. The transverse connective is just perceptibly curved and thickened at both ends. A strong retractor muscle is attached to each bifid end of the central hooks and a number of much smaller muscles to the connective, as shown in the figure. The marginal hooks, all of the same size and form, are lightly curved and consists each of a comparatively thick, club-shaped body and a small claw distinctly set off from the former (fig. 3, b); the body is hollow and is filled by a substance which stains well with haematoxylin. To each marginal hook are attached some protractor and retractor muscles. The marginal hooks are arranged on the caudal disk in such a way that one of the pairs occupy nearly the centre of the disk, a second closely in front of the former, while the rest are almost uniformly distributed along the margin, so far as it is not occupied by the central hooks and the two pairs of marginal hooks mentioned first. The length of the central hooks is 24–31μ,

that of the connective 23μ, that of the marginal hooks 42–72μ, irrespective of the size difference of the individual worms. WEGENER'S ventral unpaired piece is absent in this species. The normal position of the central hooks appears to be such that their sharp points are directed dorsally, as is stated also to be the case in the species studied by WEGENER [p. 221].

Of the dermal glands, two pairs open at the front end of the body and two on the caudal disk. Of the two pairs of the anterior or *cephalic glands*, the *inner* consist each of two or more very large cells near the median line of the body, more on the dorsal side; the comparatively long ducts open at the top of the inner pair of the papilliform processes already mentioned, close to the median line and on the ventral side. The ducts of these unicellular glands are sometimes empty, but at other times they contain a finely granular secretion similar to but usually less well stained than that of the outer glands to be directly described. These inner pair of glands lie as a whole in front of the pharynx, and the cells lie so close together in the median line of the body that the ducts alone are separated to form a pair (fig. 1). The cells of the *outer cephalic glands* are situated in two groups on the ventral side, embeded in the parenchyma close to the dermal muscular system on either side of the posterior part of the pharynx, wedged in between the front end of the vitellarium and the pharynx and salivary glands. The cells are naturally of various sizes according to the stages of their secretory activity, but they are very large, measuring in cross sections of the body 19μ or more in diameter when the cytoplasm is completely filled with a finely granular secretion, and they are then more or less pyriform; but the smaller cells are more or less polygonal owing to mutual pressure. In double staining with haematoxylin and orange, the secretion takes up only the latter, and therefore the larger cells are all stained yellow, while the smaller ones are more or less blue stained according to the stage of their secretory activity. The number of the gland cells in each group is about one dozen. Their nuclei are vesicular and have but little affinity for haematoxylin; sometimes the chromatin forms a single conspicuous

mass at the centre. These gland cells give rise on each side of the body to about five ducts, which are very large and conspicuous, so that they can be easily observed both in life and total preparations. Of the five ducts, four usually enter the outer papilliform process already mentioned and one the inner, and open at the apices of the respective processes on the ventral side.

The posterior dermal glands again consist of two groups, an anterior and a posterior, the latter confined to the caudal portion of the body, the former between it and the testis. For the sake of description we shall call the posterior group *caudal glands* and the anterior *post-testicular*. That these two groups are different in character is certain from the difference in their staining reactions, the post-testicular glands staining well with borax carmin for example, while the caudal glands remain entirely unstained. The cells of the latter are besides much larger than those of the former which have attained their full size.

The *post-testicular* gland cells are quite numerous and lie mostly in three groups, one directly behind the testis, in the triangular space enclosed between it and the intestinal loop, the other two on the outside of the intestinal loop and between the lobes of the vitellarium, the two groups however mingling with each other across the median line. The cells are of various sizes according to the amount of secretion contained in them, and of various forms owing to mutual pressure and that of the surrounding organs; smaller ones may measure 17μ or less in diameter, larger ones 41μ or more. In the smallest ones which can be unmistakably recognized as gland cells, measuring some 7μ in diameter, the cytoplasm is very compact and finely granular and stains so deeply with both haematoxylin and borax carmin that the nucleus can hardly be distinguished as a relatively large vesicle containing more or less chromatin granules. As the cells grow larger, i. e. as the secretory activity progresses, the contents of the cells become coarsely granulated and vacuolated, and in the largest cells the contents present the appearance of a well stained, spongy mass (fig. 1, 4); the nucleus is large, oval and vesicular and contains a relatively large chromatin nucleolus. The

approximate number of these gland cells appears to be about thirty. The wide ducts begin one on either side of the body directly behind the intestinal loop, and proceeding backward first on the ventral side of the caudal glands and more posteriorly side by side with and on the outer side of the ducts of the latter, open on the caudal disk; they are of nearly uniform width throughout their course and much smaller than the ducts of the caudal glands.

The *caudal gland* cells form a large mass in the anterior half of the caudal portion and are very conspicuous under the microscope even in life and total preparations (fig. 1). The cells are of gigantic size when at the height of their secretory activity and do not show so much inequality in size as the post-testicular glands; one of them measured in cross section 96μ in diameter and four of them occupied nearly the entire breadth of the body at this part. The contents of these glands are coarsely granular and have no or almost no affinity for haematoxylin or carmin, but take up orange well, and this peculiarity puts them in sharp contrast to the post-testicular glands (fig. 5). The nuclei are small (12μ) relatively to the large size of the cells, vesicular and contain each a comparatively large, spherical chromatin mass. The approximate number of these gland cells may be given as thirty. The ducts, which may be two or three times as wide as those of the post-testicular glands, arise one on either side of the median line and open on the caudal disk by means of numerous canalicules traversing the cuticle. In the intervals of their activities these gland cells are much smaller, 24μ, and the coarsely granular and vacuolated cytoplasm stains well with haematoxylin.

The *cuticle* is quite thick in comparison to the small size of the body. Generally speaking, it is thicker in the hinder than in the front part of the body and on the dorsal than on the ventral side. On the dorsal side just behind the pharynx, it is only 5μ thick or less, while near the caudal disk it is nearly three times as thick or thicker. The cuticle shows numerous fine transverse striations which are especially conspicuous in the caudal region.

The *dermal musculature* is well developed and consists of the typical three layers of the circular, diagonal and longitudinal

fibres. According to WEGENER the diagonal fibres are absent in all of the sixteen species of *Dactylogyrus* studied by him; the present species seems to be an exception to the rule. The *circular fibres* are exceedingly fine and are seen in longitudinal sections of the worm as small dots lying in close contact with the basement membrane of the cuticle. They appear to be better developed in the middle part of the body in the region of the post-testicular glands, where the fibres are thicker and more numerous. Around the mouth the circular fibres are especially well developed and form a sphincter. The *diagonal fibres* lie closely internal to the circular and are thicker. The *longitudinal fibres* are best developed in the caudal portion and are individually the thickest ones. They lie internally to the diagonal fibres and are mostly separated from them by intervening connective tissue. They are better developed on the ventral than on the dorsal side, and in the greater part of the body run either singly or in bundles of a few fibres each. In the caudal region the fibres are especially thick. In some parts the longitudinal fibres are arranged in two layers, an outer of isolated fibres and an inner consisting of bundles of a few fibres each. *Dorsoventral* muscle fibres are fairly numerous in some regions.

As forming part of the system of longitudinal muscle fibres must be regarded the retractor muscles of the pharynx and the caudal disk. On the ventral side of the caudal region two or three pairs of strong muscular bundles are very conspicuous in cross-sections of the body, lying more internally and separately from the superficial fibres which form a practically continuous layer. Shortly before the caudal disk these bundles subdivide and are inserted to the hooks and cuticle. There are similar bundles also on the dorsal side, but they are not so strong as those of the ventral. A pair of fairly strong bundles of longitudinal fibres run on either side of the median line in the middle part of the body; posteriorly they become merged with the bundles of the caudal region above mentioned, and anteriorly are attached to the pharynx.

The *mouth* is a small subcircular aperture on the ventral side-

at some distance from the front end of the body and leads into a rather spacious mouth cavity into which the pharynx protrudes, and which consists of two portions, a short tubular portion continued inwards from the mouth and lined by a cuticle similar to that of the body surface and a posterior expanded portion lined by a very thin structureless membrane. The mouth cavity extends further backwards on the ventral side of the pharynx than on the dorsal. As above mentioned the mouth is provided with a sphincter and in life is seen to close and open rapidly. The *pharynx* is an ellipsoidal muscular organ with a thick wall and a narrow lumen lined by a refringent structureless membrane of some thickness, and triradiate in cross section. There are on the front margin of the pharynx six papillæ, on which the pharyngeal glands open. These are large cells occupying the interspaces of the muscular fibres of the pharyngeal wall, with coarsely granular contents, which stain deeply with haematoxylin, floating in a hyaline medium; the nuclei are vesicular and usually contain a conspicuous chromatin mass. The musculature of the pharynx is very well developed and consists almostly entirely of radial fibres. The circular fibres appear to be very weakly developed immediately inside the outer limiting membrane of the pharynx as well as around the anterior part of the lumen. Fine isolated meridional fibres are also present here and there. In sagittal sections of the worm the ventral wall of the pharynx is much thicker than the dorsal. The interspaces left by the tissues above mentioned are filled by very delicate reticulated connective tissue.

The pharynx is followed by a very short *œsophagus* lined by an epithelium exactly similar to that of the intestine; into it open the unicellular salivary glands, which are situated in two groups, one on either side of the body about midway between the dorsal and ventral sides and dorsally to the outer pair of cephalic glands mentioned before. The cells are large and contain a coarsely granular substance staining well with haematexylin but not with orange and therefore conspicuously different from the cephalic glands in sections; the nuclei are vesicular and mostly contain a chromatin mass. The ducts are comparatively long but distinctly

observable only when they are filled with secretion. The cells are more or less pyriform and may measure 24μ by 12μ, or more. The two *intestinal cœca* proceed on either side of the body further backwards than the testis and then unite, and from this point a very short median cœcum projects backwards. In the region of the vagina the right cœcum is often reduced to a small tube in sharp contrast to that of the other side. The intestinal cœca are uniformly lined with cells which are all of one sort and cubical or cylindrical, with distinct membrane around each but with a naked free surface; the small vesicular nuclei are mostly situated near the base of the cells and contain each a well stained dot-like chromatin mass; the cytoplasm is more or less granular and vacuolated and has but little affinity for haematoxylin.

The nervous system presents nothing peculiar. The *brain* lies just in front of the pharynx on the dorsal side of the body and gives out nerves both anteriorly and posteriorly. Two pairs of nerves are distributed to the anterior end of the body, one just outside the inner pair of cephalic glands and the other more laterally. Two pairs are also given out posteriorly, the large ventral nerves arising from the posterolateral corner of the brain and proceeding backwards on the ventral side just inside the dermal musculature, along the inner border of the vitellarium, and the smaller ventrolateral nerves arising from the brain together with the former and running along the ventrolateral region of the body. In the brain are embedded two pairs of *eyes*, arranged in the four corners of a regular trapezoid, of which the posterior side is the longest; the anterior pair is notably smaller, and each eye consists of a pigment cup and a lenticular body contained in it.

The main vessels of the *excretory system* present an arrangement that is generally characteristic of the Heterecotylea. The excretory openings lie in a pair on either side on the dorsolateral border of the body, about midway between the pharynx and the paired yolk ducts. The terminal vessel is comparatively large and proceeds inwards and slightly backwards to the inner side of the intestinal cœca, where it divides into

two smaller vessels, one proceeding forwards, the other backwards. The posterior vessel winds along the internal border of the intestinal cœcum on to the caudal portion of the body into the region of the caudal glands, where it turns forwards and closely follows its former course. The anterior vessel proceeds to the region of the brain, where it is resolved into finer vessels. Branches are given out from various parts of the main vessel, and the main vessels of the two sides of the body are connected by a short commissure at their posterior ends, where they turn upon their former course. In cross sections of the body the main vessels are seen to run for the most part on the dorsal side of the ventral nerves.

The single *testis* is a large, dorsoventrally flattened, irregularly globular organ situated between the intestinal cœca at the middle of the body, and consisting of sperm mother cells and spermatozoa in all stages of development, surrounded by a dense layer of connective tissue. From its anterior end starts in the median line a single *vas deferens*, which proceeds forwards and obliquely to the left and in close contact with the ovary; at about the anterior end of the latter it comes to lie between the vitellarium and the left intestinal cœcum, which it embraces on the outer side and then comes to lie on its ventral side between it and the vitellarium, still continuing its forward course; then it again turns towards the dorsal side and slightly backwards and after forming an expanded *ejaculatory duct* richly provided with circular muscle fibres, suddenly turns forwards again and opens at the base of the *chitinous penis* (fig. 1, 2, 6). The latter is a hollow tube with a lightly sigmoidal curvature and with a funnel-shaped expansion at the base and an acorn-shaped one at the distal end, the whole enclosed in a deep invagination of the genital atrium, from which it can be protruded by the protractor muscles, which are apparently specialisations of the dorsoventral fibres of the body and consist of two bundles arising from the ventral cuticle and attached to the expanded base of the penis. A rather strong retractor muscle arises from the dorsal cuticle and is attached to near the base of the penis opposite to the protractor muscles.

The penis is accompanied by a solid sigmoidal supporting chitinous rod of about the same length, lying roughly parallel to it. In three of the five specimens measured for the purpose, the length of the penis was 96μ, while in the other two it was respectively 103μ and 84μ, the curvature not taken into account; that of the supporting rod is only slightly less. The basal end of the penis is set on a globular mass of compact connective tissue, surrounded on all sides by very loose fibrous tissue.

Together with the vas deferens open at the base of the penis two accessory (*prostate*) glands, which may be distinguished as the anterior and posterior. The *anterior prostate glands* are unicellular and very extensive; the cells occupy the dorsal side of the body immediately under the dermal musculature and lie between the salivary glands and the genital opening or may extend a little further backwards; they are more or less pyriform and may measure 25μ by 31μ, or less according to the stages of their secretory activity (fig. 1, 6, 8). The cell contents are coarsely granular and stain fairly well with haematoxylin and orange; the nuclei are small and vesicular and mostly contain each a single chromatin mass. Each of these gland cells sends out a duct, which unites shortly before the genital opening with those of the other cells into a small duct with a thick wall; this duct runs backwards side by side with the vas deferens, and undergoing a swelling on the way, again becomes a fine tube and opens at the base of the penis (fig. 6). The *posterior prostate gland* is an irregularly lobulated organ lying mostly on the left side of the median line, between it and the intestinal cœca, immediately behind the anterior glands and partly overlapped by them; it is a mass of large cells with coasely granular contents like those of the anterior glands but staining on the whole less well with haematoxylin; the nuclei are mostly comparatively small and vesicular and usually contain each a well defined chromatin mass (fig. 1, 6, 7). The duct of this gland is fine and less distinct than the terminal duct of the anterior glands, but is still perfectly definite, and after a short forward course opens at the base of the

penis. The transition between the duct and the glandular mass is sudden.

The *ovary* is a somewhat pyrifrom organ with a light constriction near its middle, situated directly in front of the testis, to which its posterior border is closely apposed (fig. 1, 2, 6). It is a mass of egg cells in all stages of development and is enclosed by a distinct membrane of connective tissue; the youngest ova are found in the hindmost part and the most mature ones at the front end, whence the oviduct takes its rise. The ovary and the oviduct communicate with each other by an exceedingly small opening which never appears in more than one section (5μ or less). The *oviduct* is a comparatively short and spacious canal lined with a layer of finely granular protoplasm, which varies in thickness according to the degree of distention, but becomes thicker near the ootype and contains a few vesicular nuclei; it is provided with very fine circular muscle fibres. The oviduct is separated by a light constriction from the fusiform *ootype* which follows it and which has a wall similar to that of the oviduct, in which a few flattened nuclei are present. The ootype receives the ducts of the numerous unicellular *glands of* MEHLIS (fig. 1, 6, 10), which are unusually well developed and occupy nearly the whole of the space between the intestinal cœca of both sides, from the posterior prostate gland to the anterior end of the ovary or further backwards. The cells are pyriform and very large, 53μ or more when at the height of their activity, when the contents are coarsely granular and vacuolated and stain but faintly with haematoxylin; the nuclei are large but have faint contour just perceptible under the microscope (Zeiss objective E), and enclose each a well defined chromatin mass. The ducts are especially conspicuous in sections when the discharge is actively going on and can be seen converging to the ootype, into which the secretion appears to ooze through its wall. In the smaller ones of these gland cells the cytoplasm stains fairly well with haematoxylin and the nuclear contour is better defined. The ootype leads in front into a short *uterus* opening into the genital atrium from behind, close to the ventral surface of the

body (fig. 1, 2, 6). The wall of the uterus presents a peculiar structure, inasmuch as it consists of large pyramidal cells with distinct membrane, vacuolated cytoplasm and vesicular nuclei, sitting on the basement membrane with their bases and projecting into the uterine lumen, reducing it to a narrow space. The number of these cells is four or five in one cross section, and they remind one in some respects of the tentacular endodermal cells of hydroids; they probably function as valves to retain the egg in the ootype while in process of formation (fig. 9, b).

The *vitellaria* of the two sides may be separated or continuous both in front and behind according to the degree of their development, and accompany the intestinal cœca from their front to their hind end, or may even extend a little further backwards, enclosing them on the dorsal and ventral sides as well as laterally. The lobed structure is very apparent and the lobes are comparatively large for the size of the animal. The paired ducts originate shortly in front of the ovary and are relatively large, and proceeding straight towards the median line there unite to form on the ventral side of the oviduct an inconspicuous yolk reservoir, from which a very short unpaired duct leads into the oviduct, into which it opens from the right side. The paired yolk ducts form a transverse bridge across the body.

Close behind the opening of the yolk duct, the oviduct receives on its ventral side another canal, the *vaginal*, which proceeds from thence obliquely towards the right and the dorsal side, passing close behind the transverse yolk duct and between the intestinal cœcum and the vitellarium and opens on the dorsal surface of the body at some distance from the lateral margin. The vaginal canal very gradually enlarges as it proceeds dorsalwards and is expanded like a funnel at its external opening; it is lined by a structureless membrance, which is directly continued onto the cuticle of the body and is quite thick in the terminal portion of the canal; it is richly provided with circular muscle fibres for nearly half its course from the external opening, which is very conspicuous both in living specimens and total mounts as well as in sections. In the neighbourhood of the vaginal canal

the dorsoventral muscle fibres take a course parallel to that of the canal and undoubtedly function as retractors.

The egg shell is provided with a filament at one extremity and measures 0.07 mm. by 0.04 mm.

II. Tetrancistrum sigani, n. g., n. sp.

This worm is common on the gills of *Siganus fuscescens* Houttuyn, a marine food fish distributed from Tokyo southwards to the Philippines. The body is flattened dorsoventrally, broad at the middle and narrowed towards the ends. The front end is lightly 4-lobed when moderately retracted, but can be produced into as many tentacle-like processes, as in *Dactylogyrus*, although the inner pair is not so conspicuous as in that genus. From this front end the body narrows slightly for a short distance and forms what may be called the neck portion, which is free of the vitellarium extending through the greater part of the length of the body. The caudal portion which is also free of the vitellarium is nearly as long as the neck portion and its posterior end is expanded into a caudal disk, which is clearly set off from the adjacent parts, transversely oval in shape and carries near the centre two pairs of large hooks but lacks the marginal hooks entirely, a peculiarity which distinguishes it from the closely allied *Ancyrocephalus*. In the brain are found irregularly scattered pigment granules, some of which may be so located as to simulate the four eye spots often found in allied genera. The animal is colourless except for the yellowish vitellarium, which shows through the transparent tissues. Specimens may be obtained at all seasons of the year and the size is 1.2–2 mm. by about 0.5 mm. in the preserved state. Egg laying appears to take place all the year round.

The materials of this species that we have been able to obtain so far are in an unsatisfactory state of preservation histologically, hence we will limit ourselves to a general account of the anatomy of the animal.

The *cuticle* is of nearly uniform thickness in all parts of the

body, being about 2.5μ, and almost homogeneous in appearance. The dermal glands are present at both ends of the body but less well developed than in *Dactylogyrus*. The *cephalic glands* of either side open by three groups of ducts on the top of the tentacle-like processes already mentioned, two for the inner and one for the outer (fig. 11). The cells are situated in two groups on either side of the body, an anterior group of fairly numerous cells directly on the outer side of the mouth cavity and a posterior group of fewer cells on the outer side of the posterior half of the pharynx or further backwards. The ducts of the posterior group are naturally longer and the outer tentacle-like process receives ducts from both groups. Besides secreting mucus these gland cells give rise to small rod-like bodies with well defined outlines (rhabdites). Similar bodies have been observed by MACLAREN in *Diplectanum* and by WACKE in *Temnocephala*. The secretion of the cephalic glands stains well with eosin or borax carmin but not with haematoxylin. The cells of the anterior group may be as large as 10μ by 19μ, those of the posterior group 24–29μ by 17μ. The *caudal glands* are situated in the caudal portion posterior to the intestinal cœca; the cells are pyriform and provided with efferent ducts which unite into a large duct on either side of the body and open on the caudal disk, nearer to the ventral side close to the hooks. The cytoplasm of these cells are either deeply or faintly stained according to the stages of their secretory activity; the nuclei are vesicular and contain a chromatin mass; the size of the cells may be 19μ by 12μ.

The transversely oval caudal disk measures 0.12 mm. by 0.09 mm. and bears near its centre two pairs of hooks, whose apices are directed one pair ventrally the other dorsally, although their positions can be altered in various ways by the action of the muscles attached to them (fig. 12). They are nearly alike in form, but the dorsal pair appear to be always slightly larger than the other and to be situated on the outer side. Each hook is flattened and consists of an asymmetrically V-shaped body with longitudinal surface striations and a sharp bent claw projecting from the apex of the V like the beak of a falcon and provided with

a hoop (fig. 13); the length of a hook is 96μ for the larger one and 84–89μ for the smaller. The transverse connecting piece for the ventral hooks is curved and short dumb-bell shaped and 19μ long; that for the dorsal hooks is more slender and longer, being 26μ long. Under certain conditions these connecting pieces stain very well. The hooks are provided with retractors and protractors.

The dermal musculature consists of the usual three layers, the circular, diagonal and longitudinal. Dorsoventral fibres are also present.

The *mouth* opens on the ventral side at a short distance from the front end of the body; its cavity extends backwards on the ventral side of the pharynx to the hind end of the latter, while on the dorsal side it extends less backwards; this condition is however subject to alteration by the action of the retractor muscles of the *pharynx*. The latter is wellnigh cylindrical in form and when viewed dorsoventrally sends out two lateral horns backwards; it is surrounded on all sides by a distinct membrane of connective tissue and its main mass is formed by the radial muscle fibres, in the large interstices of which lie the pharyngeal glands. The circular and meridional fibres appear to be very weakly developed. As viewed under the pressure of a cover glass, the pharynx is 132μ long and 96μ wide. It leads into a very short *œsophagus*, into which open numerous unicellular salivary glands, the cells of which are located in the lateral parts of the body, outside the initial portion of the intestinal cœca. The cells are pyriform and provided each with a long duct, which opens into the œsophageal cavity; they may measure as much as 12μ by 17μ, and the cytoplasm has hardly any affinity for borax carmin but stains well with haematoxylin. The two *intestinal cœca* run backwards on either side of the body and unite directly behind the testis but again separate a little further backwards and terminate blindly shortly afterwards. Each intestinal cœcum is provided on its outer side with short, secondary cœca, some 15–20 in number, terminating near the body margin. Both the primary and secondary cœca are lined with a tolerably thick epithelium,

the cell boundaries of which are fairly distinct in sections, and the nuclei of which are relatively large, round and vesicular in appearance. This species has the power of sucking out the blood of the host and the contents of the intestine consist of blood corpuscles and mucous cells of the host in all stages of digestion.

The general arrangement of the *excretory vessels* is similar to that of *Dactylogyrus*. The openings lie on either side of the body close to the lateral margin, at the level of the hind end of the pharynx. Each one leads backwards into a terminal vessel, which enlarges into a club-shaped vesicle lying on the ventral side of the intestinal cœcum. From the hind end of this terminal vesicle starts the principal posterior vessel, which proceeds backwards on the ventral side of the intestinal cœcum, at whose hind end it suddenly bends towards the median line and is connected with the corresponding vessel of the other side by a short commissure; it then turns back and retraces its former course and becomes very fine at about the level of the genital opening. Close to and just in front of the origin of the posterior vessel, the terminal excretory vesicle gives rise to a vessel which immediately divides into two and are distributed to the anterior parts of the body, where one of them is directly continued into the corresponding vessel of the other side in the region of the brain. From the main vessels above mentioned are given off numerous branches which terminate in the way generally known for flatworms.

Among more recent writers MACLAREN [p. 509] divides the *Gyrodactylidæ* into two groups, in the first of which the vagina is present and the excretory canals open behind, while in the second the vagina is absent and the excretory canals open in front, and he assigns *Tetraonchus*, *Dactylogyrus*, *Amphibdella* and *Diplectanum* to the first, and *Gyrodactylus* and *Calceostoma* to the second. But in view of our observations on *Dactylogyrus* and *Tetrancistrum*, a near ally of *Ancyrocephalus* (=*Tetraonchus*), the above division, so far as it refers to the opening of the excretory system, is no longer tenable.

The *nervous system* is in its main arrangement similar to that of *Dactylogyrus.*

The *testis* is a dorsoventrally flattened globular organ directly in front of the posterior intestinal loop and similar in its general structure to that of *Dactylogyrus.* At its front end in the median line it gives rise to a single sperm duct, which proceeds forwards on the dorsal side of the ovary obliquely towards the left side and from the anterior end of the ovary onwards runs for some distance parallel to the intestinal cœcum close on its inner side; here the duct is expanded into an elongated *vesicula seminalis* (fig. 11, 14). It then narrows and again expands into a second smaller vesicle, and at a short distance behind the anterior intestinal loop it turns suddenly backwards and obliquely to the right and forms an *ejaculatory duct* provided with muscle fibres, and finally opens at the base of the *chitinous penis.* The latter is a hollow tube curved in the form of a fishing hook, the expanded base corresponding to the barb, and lies in a tubular extension of the male genital pore, which lies a short distance behind the anterior intestinal loop. It is of nearly uniform calibre and its base is continued forwards in the form of a tongue, while its distal end has somewhat the shape of the point of a Turkish sword. The *supporting rod* is of the same general form but more curved and has numerous, small, irregular cavities in its axis; its terminal end is closely apposed to that of the penis, while its base is continued backwards into a tongue-shaped chitinous piece united with the penis base and fixed together with the latter onto an elongated fusiform mass of peculiar chitinous-looking fibrous tissue (fig. 14, 15). To the front end of this mass of peculiar tissue and of the base of the penis is attached a muscular bundle, which runs obliquely forwards and merges with the longitudinal dermal muscles; another smaller bundle is attached to the base of the penis and runs forwards nearly parallel to the first; a third bundle is attached to the basal process of the supporting rod behind the penis and also runs forwards; no doubt they are the protractors of the penis. The retractor consists of two bundles inserted one to the hind end of the basal mass, the other to that of the basal

process of the supporting rod; these two soon unite and proceed backwards to merge into the longitudinal dermal muscles. The penis and the supporting rod are subequal in length, 108μ; the basal mass is 72μ long.

Side by side with the sperm duct open into the penis base two accessory glands, the *anterior* and the *posterior prostate*. In the *posterior* one, the fine duct that opens into the penis leads into a fusiform sac situated on the left side of the median line and containing a granular, yellowish secretion especially conspicuous in life; where it crosses the sperm duct it lies more dorsally. This fusiform sac is continued backwards into a larger sac of irregular form, whose contour becomes fainter backwards. Into this reservoir open by long necks numerous unicellular glands, which lie between the ovary and the genital apertures, both in the area bounded on either side by the intestinal cœca and outside the latter close to the lateral margin of the body. The cytoplasm of these cells is finely granular and stains well with haematoxylin and carmin; they may be 24μ by 36μ. The *anterior prostate*, which opens side by side with the posterior, has also a very fine duct which almost immediately enlarges into a somewhat reniform sac with distinct muscular wall lying oftener on the right side of the penis and containing a transparent colourless secretion, in life contrasting sharply with the surrounding organs. The sac narrows at its front end into a duct of small calibre, which curves backwards and to the right and then expands again into a large sac of irregular contour, into which open numerous gland cells. These are situated almost entirely between the intestinal cœca of both sides and the posterior prostate; their cytoplasm stains but very slightly with haematoxylin and carmin and can therefore be distinguished from the cells of the posterior prostate without difficulty; the cells are also distinctly smaller, being 12μ by 24μ, and the nuclei are vesicular and contain each a very distinct chromatin spherule.

The *ovary* is a cordiform organ situated directly in front of the testis, sometimes overlapping the latter with its emarginate hind end, where the youngest ova are situated. From its front

end starts the *oviduct*, which proceeds straight forwards along the median line of the body and is continued into the *ootype* a short distance in front of the ovary. There is a light constriction at the boundary between the oviduct and the ootype, where the *glands of* MEHLIS open; these are aggregated into a comparatively narrow space between the intestinal cœca on either side, the ovary behind and the posterior prostate in front. The gland cells stain about as well as or slightly better than those of the anterior prostate. The ootype is continued without any sharp demarcation into the *uterus*, which runs forwards and opens to the exterior directly behind the male pore. The uterus is provided with longitudinal and circular muscle fibres.

Immediately behind the ootype, the oviduct communicates with a small chamber on its dorsal side, which bears a tongue-shaped sac, the *receptaculum seminis*; lying on the dorsal and left side of the oviduct and extending for a short distance forwards from its connection with the latter (fig. 14). A curious fact in connection with it is that a slender canal proceeds backwards from its hind end and becoming gradually finer, terminates blindly near the front end of the ovary—probably a homologue of the genito-intestinal canal found in many other Heterocotylea. The short neck of the seminal receptacle is provided with sphincter fibres and the sac usually contains spermatozoa. According to WEGENER [p. 210] a similar receptacle is present in *Ancyrocephalus paradoxus*, but the tail-like prolongation appears to be lacking.

The *vitellarium* appears to be less well developed than in *Dactylogyrus* and surrounds the intestinal cœca on all sides except the inner; behind the posterior intestinal loop it is also found between the cœca of either side. The paired yolk ducts, which are formed each by the union of two ducts arising from the vitellarium at about the level of the anterior end of the ovary, proceed inwards and uniting in the median line on the ventral side of the oviduct immediately open into the latter. Into the small chamber above mentioned on the dorsal side of the oviduct opens the *vaginal canal* obliquely from the right and dorsal side, whence the canal proceeds obliquely forwards and towards the

right and passing on the ventral side of the vitellarium opens into an elongated botryoidal cavity at about the level of the hind end of the penis (fig. 14). The wall of the canal is comparatively thick and is provided with longitudinal and circular muscle fibres. The botryoidal cavity, which may be called *bursa vaginalis*, lies with its long axis oblique to that of the body and opens on the ventral side close to the lateral margin, receiving the vaginal canal not at its bottom but a short way aside towards the right margin of the body. The bursa vaginalis is ciliated on its inner surface and surrounded by inner longitudinal, middle circular and outer oblique muscle fibres, which are modifications of the dermal musculature of the body. Besides these fibres there are numerous unicellular glands opening into its cavity; their staining capacity is intermediate between those of the two prostate glands.

This new genus may be characterized as follows: Gyrodactylidæ without eyes; with a caudal disk bearing two pairs of hooks, each pair connected by a transverse piece; without marginal hooks; with a lateral vagina. Paired intestinal cœca united behind and with lateral secondary cœca.

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Abbreviations used in the Explanation of Plates.

apg . . . . . Anterior prostate glands.
br . . . . . Brain.
cg . . . . . Caudal glands.
dg . . . . . Cephalic glands and their ducts.
ej . . . . . Ejaculatory duct.
eo . . . . . Excretory aperture.
ex . . . . . Excretory vessel.
exv . . . . . Excretory vesicle.
go . . . . . Genital opening.
int . . . . . Intestinal cœca.
lm . . . . . Longitudinal muscle of the caudal portion.
m . . . . . Mouth.
me . . . . . Glands of MEHLIS.
oe . . . . . Œsophagus.
oot . . . . . Ootype.
ov . . . . . Ovary.
ph . . . . . Pharynx.
ppg . . . . . Posterior prostate glands.
ptg . . . . . Post-testicular glands.
rs . . . . . Receptaculum seminis.
sg . . . . . Salivary glands.
t . . . . . Testis.
vag . . . . . Vaginal opening.
vd . . . . . Vas deferens.
vt . . . . . Vitellarium.

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TWO NEW TREMATODES OF THE FAMILY GYRODACTYLIDÆ.

PLATE I.

Plate I.

Dactylogyrus inversus.

1. Semidiagrammatic representation of an entire worm killed under the pressure of a cover slip ; dorsal view.
2. Sagittal section through the body, showing the relative positions of the different organs.
3. a. Central hooks and connective, with attached muscles. b. Two marginal hooks. ×290.
4. A post-testicular gland cell. ×600.
5. A caudal gland cell. ×600.
6. Reproductive organs in dorsal view. ×200.
7. Posterior prostate gland cells. ×600.
8. Anterior prostate gland cells. ×600.
9. a. Ootype in cross section. b. Uterus in cross section. ×290.
10. Glands of Mehlis. ×600.

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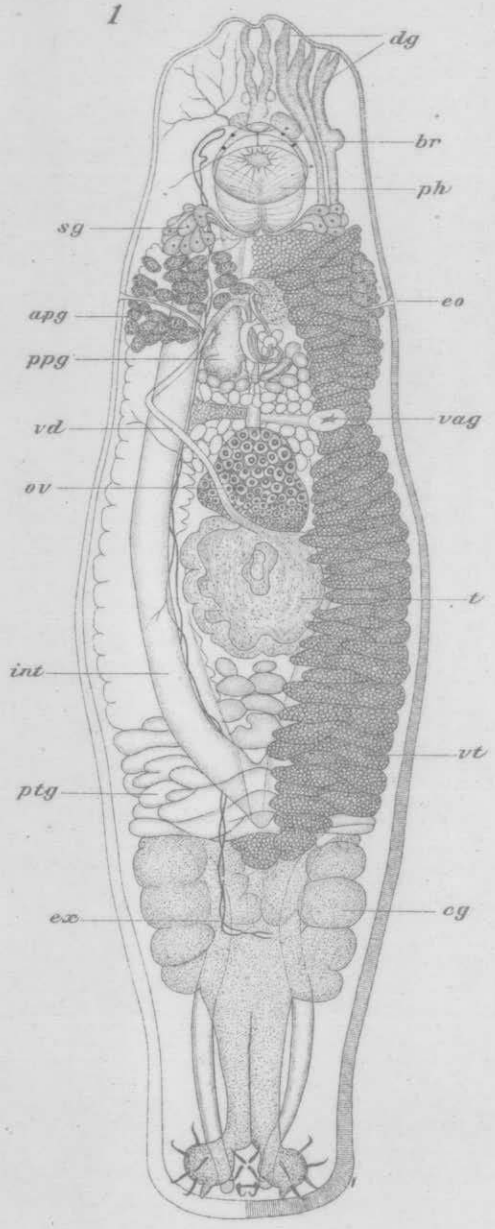

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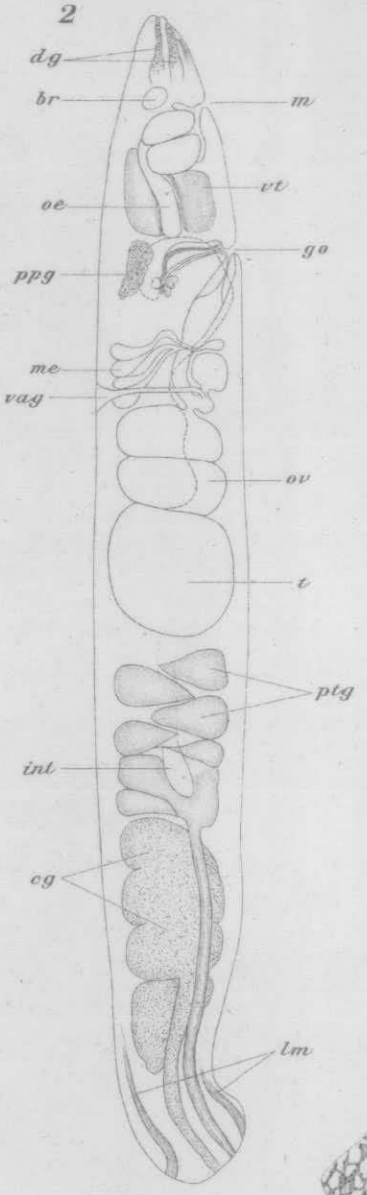

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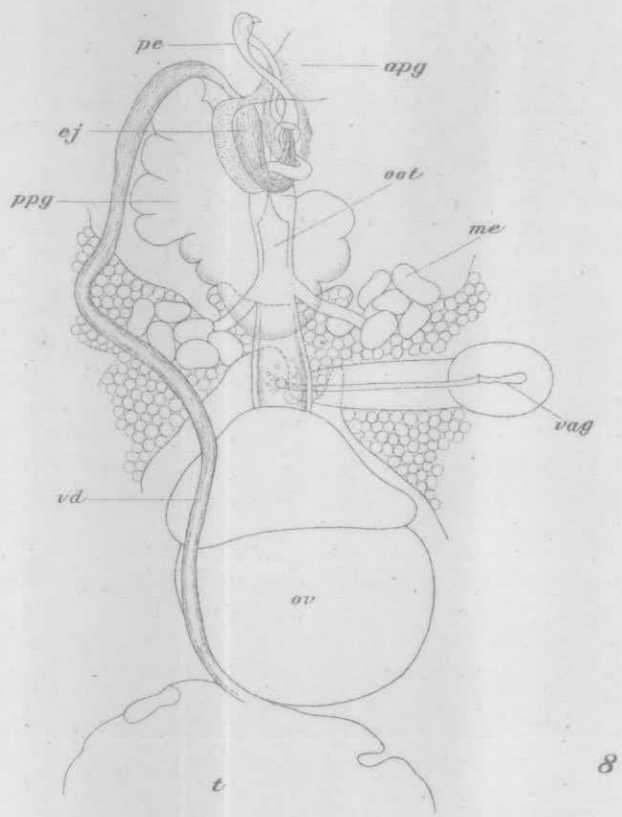

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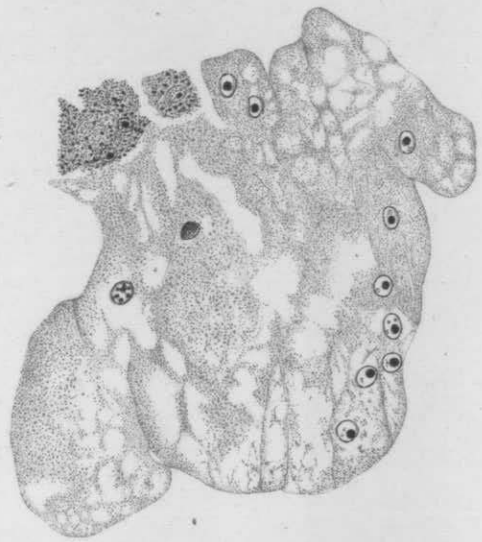

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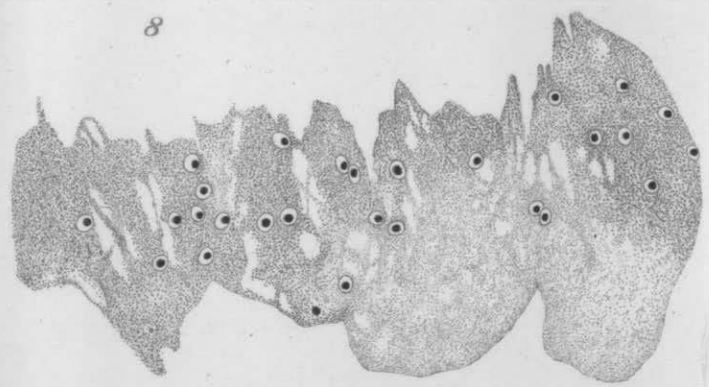

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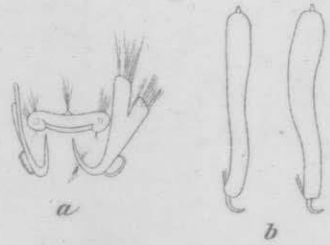

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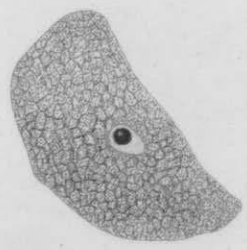

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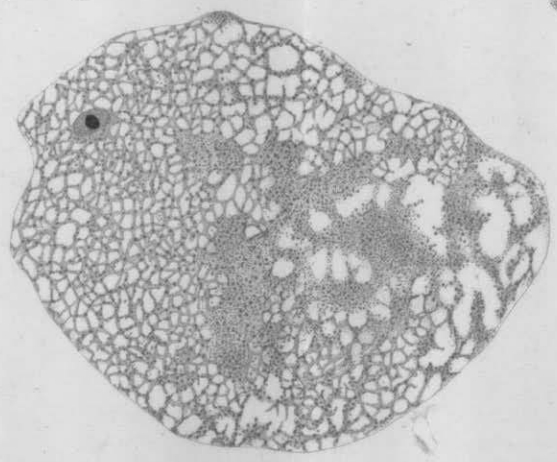

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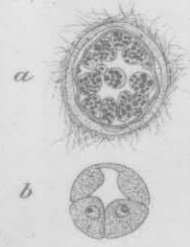

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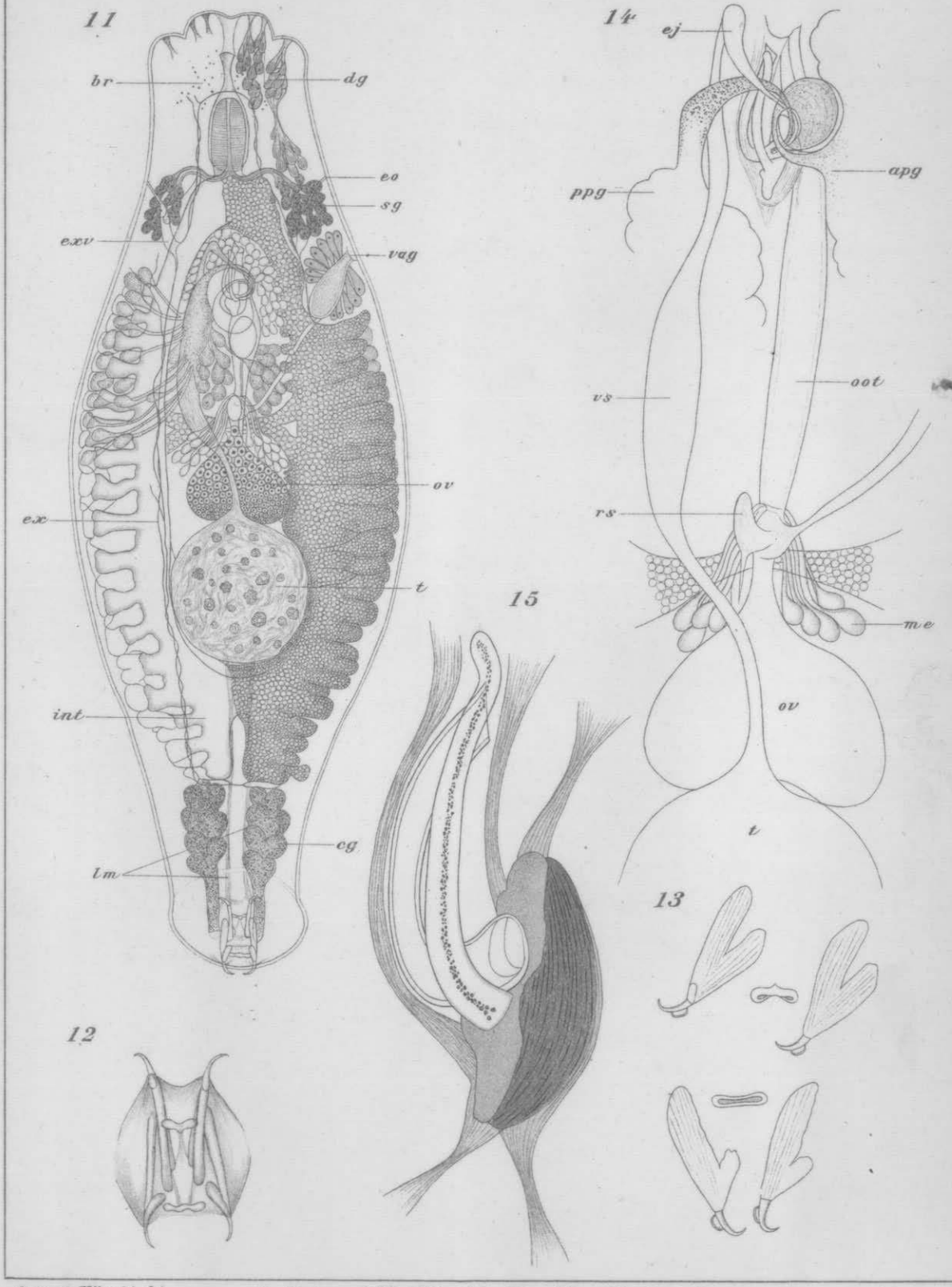
PLATE II.

Plate II.

Tetrancistrum sigani.

11. Semidiagrammatic representation of an entire worm killed under the pressure of a cover slip ; dorsal view.
12. Caudal hooks in natural position. ×290.
13. Caudal hooks as spread out. ×290.
14. Reproductive organs in dorsal view. ×200.
15. Chitinous penis and accessory parts. ×600.



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