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The Classification and Reproductive Organs of New Zealand Land Planarians.

PART III.

ARTIOPOSTHIA MARIAE (Dendy), *A. AUSTRALIS* (Dendy), *GEOPLANA IRIS* Dendy, and *A. GARVEYI* (Dendy).

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Artioposthia mariae (Dendy). Plate 47, Fig. 1.

1895. *Geoplana mariae* Dendy, *Trans. N.Z. Inst.*, vol. 27, p. 184.

Material. Selected specimens from Dendy's collection in the British Museum.

Locality. West Coast of New Zealand.

Type. The following series of longitudinal sagittal sections are designated as a lectotype:—(1) Eight slides of the anterior end. (2) Five slides of the posterior end. These slides will be deposited in the British Museum.

External Characters. According to Dendy (1895) the length when crawling is 97 mm., with breadth 5 mm. Dendy describes the colouring as follows: "Ground colour of the dorsal surface very pale brownish-yellow, thickly marbled with dark-brown speckles. In the mid-dorsal line a rather narrow, paler band, with less of the dark brown marbling, but edged on each side by an ill-defined darker band, where the brown marbling is unusually strongly developed. Anterior tip pink. Ventral surface very pale yellow sprinkled with brown in smaller specks than on the dorsal surface, and with a lighter median band where the brown specks are smaller still. Margins speckled as elsewhere."

The eyes are arranged as usual in a horseshoe round the anterior tip. Dendy states that they are "unusually small and few." In sections they were of a normal size and number, but were deeply embedded in the skin so that from the surface they would be only partly visible if seen at all.

The mouth is two-thirds of the length from the anterior end and the genital pore is very near the posterior end, being much nearer it than the mouth.

Reproductive Organs. The genital pore leads into a common genital atrium (at.) into which the male duct opens anteriorly and the female posteriorly. Projecting from the atrial wall are several adenodactyli (aden.). Of the two specimens examined, one had seven and the other nine adenodactyli. How constant this number is can only be decided after examining many specimens, and this is not possible with the small amount of material allowed for sectioning. Although both the specimens examined had well-developed reproductive organs, some of the adenodactyli were much larger than other which may have developed more recently, so that the exact number of adenodactyli present may not be constant and may depend on the state of maturity of the worm.

Each adenodactylus is of the *triangulata* type, short and fat with usually only a small portion projecting into the atrial cavity. The main feature of the adenodactylus in this species is the large reservoir (res.), which is quite inconspicuous in *subquadrangulata*, and not present at all in *howesii*. In *mariae* the reservoir is large and oval and is surrounded by a wide band of closely-set muscles. It is lined with long glandular cells, the secretion of which sometimes fills the cavity. A short, narrow, glandular duct (d.) connects the reservoir with an irregular wide vesicle (v.) which opens into the genital atrium. It is to be noted that in those species such as *exulans* with a small reservoir, the duct is long and is surrounded by its own layer of circular muscles, whereas in this species the special musculature surrounds the reservoir which communicates by a short duct with the vesicle, which has no special muscle layer.

The paired ovaries are in the usual ventral position and are situated halfway between the mouth and the anterior end. The two oviducts (od.) join behind the genital atrium to form a single glandular canal (g.c.) which opens into the atrium dorsally between the two adenodactyli.

The testes are ventral and extend from almost the anterior end to behind the pharynx. The two vasa deferentia widen into false seminal vesicles (v.s.f.) which join to form a narrow median seminal duct (d.s.). This enters a seminal vesicle (v.s.) which has its own musculature and opens into the atrium through an ejaculatory duct (d.ej.

There is no penis, but there are two adenodactyli, one on each side of the ejaculatory duct, and these no doubt fulfil the functions of a penis.

Remarks. This is a comparatively large worm with several adenodactyli of a characteristic type. It resembles *triangulata* in its size, in the absence of definite stripes on the dorsal surface and in the type of adenodactylus. These, however, are much more numerous in *mariae*, and the shape and position of the ovary is quite different in the two species. In *mariae* the ovary is of the normal type (small, spherical, and anterior in position), whereas in *triangulata* it is long and narrow and situated at the side of the seminal vesicle. The position of the genital pore, which is much nearer the posterior end than the mouth, is very unusual.

Artioposthia australis (Dendy). Plate 48, Fig. 3.

1895. *Geoplana triangulata* var. *australis* Dendy, *Trans. N.Z. Inst.*, vol. 27, p. 190.

Material. Selected specimens from Dendy's collection in the British Museum. Specimens 374 and 466 in the writer's collection.

Locality. Dendy's specimens were collected at Dunedin and various parts of Canterbury. 374 was collected at Dunedin and 466 at the Homer Saddle, West Coast, Otago.

Type. As there is no type specimen, I have selected from Dendy's collection of syntypes a specimen from Peel Forest which has been dissected and shown to have the internal anatomy characteristic of the species. This I designate as lectotype.

External Characters. The length of a fully grown worm is 210 mm., which is one of the largest recorded. The corresponding breadth is about 20 mm. The dorsal surface has a wide median band of uniform purplish-brown colouring with narrow marginal bands of a pale colour. The ventral surface is pale. There are no speckles (or only a very few) on the marginal bands and the ventral surface.

Reproductive Organs. The type and arrangement of the genital organs and ducts are the same as in *triangulata* except for the adenodactyli (aden.). *Triangulata* has three large rounded adenodactyli on each side of the atrium, while *australis* has numerous small conical ones which project from the sides and from two muscular flaps (fl.) hanging from the dorsal wall of the atrium (at.).

Remarks. This worm resembles *triangulata* in being very large and in its uniform dorsal colouring without stripes, but it lacks speckles on the marginal bands and the ventral surface, which parts are abundantly speckled in *triangulata.* On account of this difference in marking, Dendy created the var. *australis* for those forms without speckles.

In the description of *A. triangulata* (1937) the writer suggested that the absence of speckles in the var. *australis* might be due to the effect of preservatives which tend to dissolve pigment, as had been seen in some specimens of *triangulata* examined. Since then the writer has seen living worms which externally resembled *triangulata* except for the absence of speckles, but which internally had numerous adenodactyli arranged as above. This internal difference in the number and arrangement of adenodactyli combined with the external difference in speckling is sufficient to warrant the elevation of the variety *australis* to specific rank.

JUVENILE FORMS OF **Artioposthia australis.**

1896. *Geoplana latissima* (Dendy), *Trans. N.Z. Inst.*, vol. 28, p. 211.
1897. *Geoplana flavimarginata* (Dendy), *Trans. N.Z. Inst.*, vol. 29, p. 259.
1897. *Geoplana cucullata* (Dendy), *Trans. N.Z. Inst.*, vol. 29, p. 259.

Material. Selected specimens of the above worms were loaned from Dendy's collection in the British Museum. Specimens 377, 467, and 468 are from the writer's collection. One specimen from Dendy's collection which he identified as the Australian *G. sanguinea* Moseley (1897, p. 258), proved on sectioning to be a juvenile *A. australis* with no resemblance to the reproductive organs of the Australian species. Whether the remainder of Dendy's *G. sanguinea* are wrongly identified cannot be decided until further material from the British Museum collection is made available for sectioning.

Locality. The specimens came from Wellington, Dunedin, and the West Coast of the South Island, N.Z. They were all collected either in the summer or winter months.

External Characters. These planarians resemble *A. australis* in having a uniformly coloured dorsal surface with narrow paler marginal bands which, like the pale ventral surface, are unspeckled or only slightly speckled. They are all more brightly coloured than the adult type and the dorsal surface, which in the adult is purplish-brown with pale yellow margins, is in these juveniles bright brown, deep crimson (*flavimarginata*) or orange (*latissima*), with marginal bands of mustard, orange, or bright yellow. They are naturally smaller in size than the average adult, the length varying from 20 mm. to 80 mm.

Reproductive Organs. The reproductive organs are in various stages of development, the order of development being: atrium, seminal vesicle, testes, adenodactyli, ovaries. All have atrium and seminal vesicle, nearly all have adenodactyli, though some worms are without a genital pore. Nearly all have testes, though these are not always ripe, and about half have ovary and oviduct. All the organs present are of the *australis* type, the degree of maturity being more or less proportional to the length of the worm. For instance, 466 and 467 were collected in the same place at the same time: 466 in spirit measured 70 mm. and had the regular *australis* reproductive organs, but 467, which was 20 mm. long, had atrium, seminal vesicle, and adenodactyli, but no ovary or oviduct, and the genital pore was not completely open.

Remarks. The bright colour of these immature worms as compared with the more sombre adult colour is a juvenile character, as was pointed out for *A. howesii* (1944). Dendy says of *flavimarginata* (1896): "This species appears to be intermediate between *G. sanguinea* and *G. triangulata* var. *australis.* It is distinguished . . . from the latter by the much narrower body and the bright red colour. From average specimens of both it is distinguished by its smaller size." The brighter colour and smaller size are only juvenile characters.

Of *latissima*, Dendy (1896) remarks: "At first sight this species resembles *G. triangulata* var. *australis*, but in life the orange colour is really very characteristic, while in spirit the shape is more so." The orange colour again is a juvenile character. *G. cucullata* Dendy describes as being very like *latissima* except for its peculiar hooded shape in spirit. Both this and the broadness of *latissima* are post-mortem characters and as such can be disregarded.

In all these worms Dendy admits a similarity to *australis*, the only difference being in the size and brightness of colour, which are juvenile characters, and which are seen also in those of the above specimens in the writer's collection. The peculiar shapes assumed by *latissima* and *cucullata* when preserved are post-mortem changes and are not diagnostic.

Cardale (1941) states that the eggs of *A. civis* are laid in the spring and autumn as is the case with certain fresh-water planarians. This would mean that the young appear in November and May, and one would expect to find many juvenile forms in May, June, July, and in November, December, and January. These summer and winter months were the ones in which all these immature forms were collected, which further emphasises the fact that they are juveniles.

Artioposthia subquadrangulata (Dendy).

1897. *Geoplana suteri* Dendy, *Trans. N.Z. Inst.*, vol. 29, p. 263–4.

Material. The type specimen and one co-type from Dendy's collection in the British Museum. Longitudinal sagittal sections were cut and examined in series.

Remarks. The internal structure and arrangement of the reproductive organs is the same as for *subquadrangulata*. Dendy created a new species for *suteri* on account of the dorsal surface having six very narrow dark-brown stripes arranged in pairs, the median pair being closer together. *Subquadrangulata* has three dark-brown stripes, a narrow median one, and two broader lateral ones. The edges of stripes are often darkened with more intense speckles so that the six darker edges of the three stripes in *subquadrangulata* might easily be interpreted as six very dark stripes arranged in pairs, the median pair being closer together. This would give the description of *suteri*. The only other external difference is that *suteri* is larger than the average *subquadrangulata*, but the difference is not large enough to be significant.

The genital pore in *suteri* is much nearer the mouth than the posterior end, which is unusual and characteristic of *subquadrangulata*.

The three specimens on which the species *suteri* was created were collected by Suter along with *subquadrangulata*, those which were larger and more intensely marked being called *suteri*.

Artioposthia garveyi (Dendy). Plate 48, Fig. 4.

1901. *Geoplana garveyi* Dendy, *Trans. N.Z. Inst.*, vol. 33, p. 234.

Material. One specimen from Dendy's collection in the British Museum. Longitudinal sagittal serial sections were cut and stained in picro-indigo-carmine.

Locality. The head of Lake Te Anau, Otago.

Type. As there is no type specimen, I designate as lectotype the specimen which I have cut in serial sections. These will be deposited in the British Museum and consist of nine slides of the posterior end and five slides of the anterior end of the worm.

External Characters. Dendy (1901) gives the length of the living worm as about 50 mm. He describes the colour as follows: "The colour in life was almost uniform bluish-grey, rather paler in the mid-dorsal line and at the margins. The ventral surface paler grey, except for a pair of ill-defined longitudinal stripes. . . . The anterior tip was pinkish brown."

The eyes are numerous and extend almost to the posterior end. The mouth is about one-third of the length from the anterior end with the genital pore nearer the mouth than the posterior end.

Reproductive Organs. The characteristic feature of this worm is the large number of adenodactyli (aden.) opening into the genital atrium (at.). They are arranged on muscular flaps (fl.) which hang from the dorsal and side walls of the atrium. The paired spherical ovaries are in the usual ventral position towards the anterior end. The oviducts pass back and join to form a glandular canal (g.c.) opening into the atrium near the ventral surface.

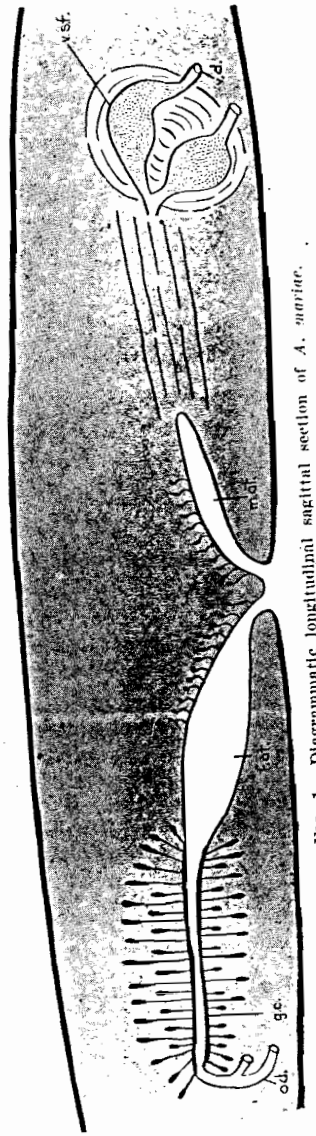

FIG. 1.—Diagrammatic longitudinal sagittal section of *A. auriae*.

FIG. 2.—Diagrammatic longitudinal sagittal section of *G. iris*.

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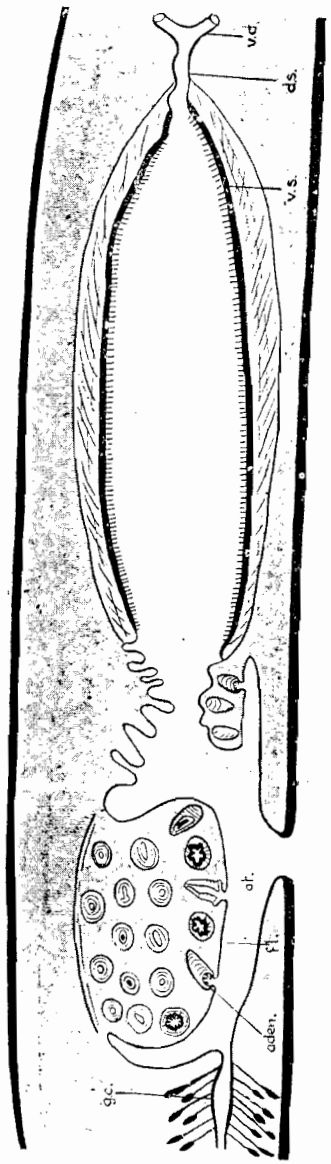

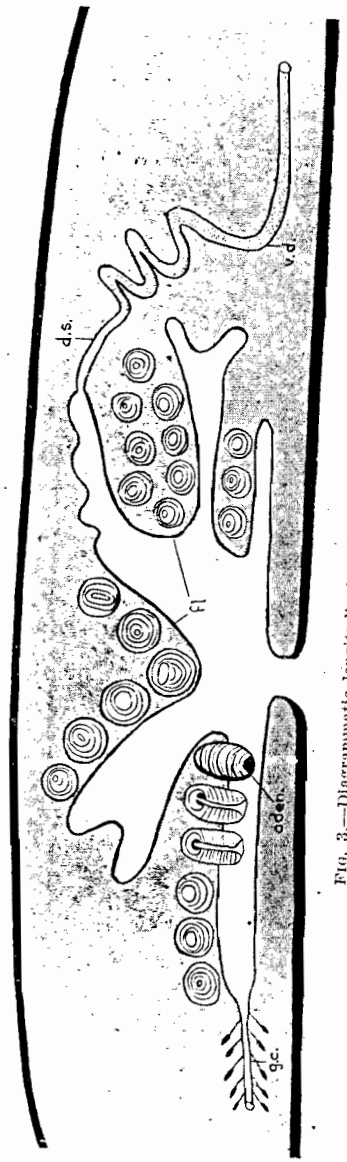

FIG. 3.—Diagrammatic longitudinal sagittal section of *A. australis*.
FIG. 4.—Diagrammatic longitudinal sagittal section of *A. parvipi*.

The testes extend from in front of the genital pore to near the posterior end. There is no seminal vesicle, sperm are stored in the vas deferens and enter the atrium direct through a narrow seminal duct.

Remarks. This worm is characterised by the absence of speckles and definite stripes on the dorsal and ventral surfaces, and by the anterior position of the mouth. In its general colouring and the very large number of adenodactyli it resembles *A. australis*, but it differs from this worm in size, in the absence of seminal vesicle, in the shape and position of the ovary and in the position of the mouth.

Geoplana iris Dendy. Plate 47, Fig. 2.

1897. *Geoplana graffii* var. *otiraensis* Dendy, *Trans. N.Z. Inst.*, vol. 29, p. 261.
1901. *Geoplana graffii* var. *nigrescens* Dendy, *Trans. N.Z. Inst.*, vol. 33, p. 230.

Material. Specimens of *G. graffii* var. *otiraensis* and of *G. graffii* var. *nigrescens* were obtained from Dendy's collection in the British Museum. Of three specimens of *G. iris* forwarded from the British Museum, one from Peel Forest is identical with *G. graffii;* the other two from Springburn are distinct from *graffii* and similar to the varieties *otiraensis* and *nigrescens*. In describing the specimens from Peel Forest, Dendy (1901) says: "This species makes a very near approach to *G. graffii* and its allies in N.Z.," which is true for the Peel Forest specimen. Specimen 375 in the writer's collection.

Locality. Most of Dendy's material was collected under logs near Otira. Specimen 375 was found on the bark of a tree at Morrison's Creek, Dunedin.

Type. As there is no type specimen, I designate as lectotype a complete specimen which has been examined in oil of wintergreen and found to have the structure characteristic of this species. This specimen will be deposited in the British Museum.

External Characters. The average length of the extended worm is 80–100 mm., which is longer than *G. graffii*. The worm is also correspondingly broader. The dorsal surface is dark-brown or black finely speckled with green, and flecked with white. There is a narrow median dorsal stripe varying in colour from pale brown to nearly black. The marginal bands are pale brown. The ventral surface is brown with darker brown speckles.

The mouth is slightly behind the middle of the body and the genital pore halfway between the mouth and the posterior end. The eyes are numerous and arranged as usual.

Reproductive Organs. The reproductive organs are of the simplest type, which according to von Graff (1899, p. 166) is characteristic of primitive forms. There is no penis papilla or penis bulb and no adenodactyli to serve the function of these. The atrium is separated into male (m.at.) and female (f.at.) portions by a narrow muscular fold reaching nearly to the genital pore. Atrial glands open into both portions.

The ovaries are as usual in a ventral anterior position and the two oviducts (od.) join behind the atrium to form a long narrow

glandular canal (g.c.) opening into the female atrium. In one specimen a ripe egg surrounded by a mass of secretion filled up the whole of the glandular canal, showing that this simple type of worm is mature and not an immature stage of a more elaborate worm.

The testes lie in a ventro-lateral band extending from the ovaries to the atrium. The two vasa deferentia (v.d.) converge as they near the atrium and swell to form either one single or two separate false seminal vesicles (v.s.f.), there being no true seminal vesicle. The connection between the false seminal vesicles and the atrium has not been observed, though many specimens have been examined both in transverse and in sagittal sections. There is a slight musculature surrounding the false seminal vesicles and extending as a band from there to the atrium. This suggests that a seminal duct would normally run through the muscular band from the seminal vesicles to the atrium. In transverse sections the muscle fibres and parenchyma in this band appear as an open mesh from which a small duct with thin walls would be undistinguishable. On the other hand, in such a simple type as this worm there may be no permanent connection between the seminal vesicles and the atrium, although the fact that in some series the seminal vesicles do join on the atrial side (as in the figure) suggests the beginning of a seminal duct.

Remarks. This planarian is characterised externally by its fairly large size and its very dark colouring. Compared with *graffii*, it is longer and broader, the dorsal surface is darker, being nearly black in some specimens, and the dark median line is not so distinct as in *graffii*. Internally, the reproductive organs are of the simplest type and are very different from those of the land planarians so far described for New Zealand—a difference which is in no way apparent externally either in the size or the markings of the worm.

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Lettering in Plates.

at., genital atrium
aden., adenodactylus
d., duct of adenodactylus
d.ej., ejaculatory duct
d.s., seminal duct
f.at., female atrium
fl., muscular flap
g.c., glandular canal
m.at., male atrium
od., oviduct
re., reservoir
v., vesicle of adenodactylus
v.s., seminal vesicle
v.s.f., false seminal vesicle
v.d., vas deferens