

**OCCASIONAL PAPERS**  
OF  
**BERNICE P. BISHOP MUSEUM**  
HONOLULU, HAWAII

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Volume XXI

October 7, 1952

Number 4

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**Land Planarians from Oceania**

By P. DE BEAUCHAMP

LABORATOIRE D'ÉVOLUTION DES ÊTRES ORGANISÉS, PARIS

INTRODUCTION

The collection of planarians on which this paper is based was loaned to me for study by Bernice P. Bishop Museum. The specimens, principally from the Fiji Archipelago, were collected by E. C. Zimmerman, entomologist on the Mangarevan and Henry G. Lapham Expeditions of 1934 and 1938, respectively. The only data on Fijian land planarians are found in Von Graff's great monograph (4)<sup>1</sup> and even fewer data are available for the rest of Oceania. Concerning the "Viti-Inseln" planarians (only one specimen is specified as coming from Viti Levu), Von Graff describes three *Platydemus* which had been collected at a much earlier date by E. Graeffe and deposited in the Museums of Breslau and Berlin by Grube (5), who had given them one specific name. Two of these are found again in the material under consideration, together with a new form.<sup>2</sup> Discussed here also are a few other rhynchodemids which, unfortunately, cannot be perfectly defined, and a cosmopolitan bipaliid.

The specimens, on the whole, were in a mediocre state of preservation, the more so because some vials were partially emptied in transit. The state of the tissues left much to be desired, and the nuclei did not take the nuclear stain well. However, the hematin eosin orange G stain allowed a satisfactory analysis of the copulatory apparatus.

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<sup>1</sup> Numbers in parentheses refer to Literature Cited, page 62.

<sup>2</sup> There must be added to this one indeterminate specimen from Viti Levu studied anatomically by Lang (10), to which Von Graff alludes (4, pp. 206 and 530).

FAMILY BIPALIIDAE

Genus **Bipalium** Stimpson

**Bipalium kewense** Moseley, Ann. Mag. Nat. Hist. V, 1:237, 1878.

*Placocephalus kewensis*, Graff, Monogr. Turb. II. Tricl. Terric., 462, figs. 3-8a, pl. 13, 1899.

Austral Islands: Raivavae, near Unurau, Kairua, Aug. 3, 1934. "Beneath a stone," E. C. Zimmerman. One rolled up specimen, about  $10 \times 3$  mm.

Fiji: Ovalau, Thawathi, July 16, 1938, E. C. Zimmerman, 600 to 800 ft. One specimen  $15 \times 25$  mm., thick body, small head, white, doubtless in regeneration, two lateral bands alone are visible under the opaque epidermis. Viti Levu, Nandarivatu, Oct. 11, 1938. One specimen, very much rolled up, about  $100 \times 5$  mm., appears non-sexual. Brownish coloring, typical ornamentation.

The first and the last already carried a determination that I can only confirm, their appearance conforming with the well-known character of the species (see recent description by Hyman, 7). A species of an essentially oriental kind and probably of Indo-Chinese origin (de Beauchamp, 3, see description of copulatory apparatus) was raised by man within the tropics, as well as in hothouses.

FAMILY RHYNCHODEMIDAE

Genus **Rhynchodemus** Leidy (Desmorhynchus Heinzel)

All the specimens in this material appear to refer to this type in the sense of Hyman (9), who, adopting the groups of species made by Heinzel, rectified their names by the identification of the Leidy type. They could belong to the group of *R. nematoides* Loman, *R. vejodvskyi* and *R. ochroleucus* Graff, and *R. nematopsis* Beauchamp. For lack of sufficient data about them all (de Beauchamp, 1, 2), it is difficult to distinguish them even by the copulatory apparatus. The present paper will not clear up the question, as only two of the specimens are sexual, and they are incomplete. Therefore I shall describe them without specific name.

NON-SEXUAL SPECIMENS

Rapa: Maitua, 400-700 ft., E. C. Zimmerman, July 10, 1934. Two specimens, about  $10 \times 1.5$  mm.

Fiji: Ovalau, Thawathi, 600 to 700 ft., E. C. Zimmerman, July 16, 1938. Two specimens, the one very tapered, about  $15 \times 1$  mm. without visible ornamentation, has been sectioned and found too damaged to be used, even if it were sexed. The second, a little more flattened,  $8 \times 1$  mm., is of the same type as the others.

Fiji: Moala, Vunuhu [Vunuku], 100 ft., E. C. Zimmerman, Aug. 23, 1938. One specimen, broken,  $10 \times 1$  mm.

All the specimens have practically the same ornamentation, which is, with slight variation, that of the species cited (see de Beauchamp, 2, fig. 7) which shows two dark submedian stripes blunted on the inner side and tending to merge, separated by two light bands from two thick, lateral bands. On the other hand, the width of the sole on the ventral surface is somewhat variable and could perhaps provide a specific characteristic if one could place it in relation to the particulars of the genital apparatus. The eyes are small.

#### SEXUAL SPECIMENS

##### **Rhynchodemus** sp. 1. (fig. 1).

The specimen described here was sectioned transversally, its curvature not lending itself to sagittal sections. The beginning of the male system was found just at the point of rupture of the fragment and a few of the sections have not been mounted, with the result that the series presents small gaps. These do not, however, impede the reconstruction of the topography. This male system appears in retrogression, a dichogamy appearing to exist in this type according to my observation on *R. nematopsis* (2). This specimen indeed resembles most nearly the two specimens which I described in 1930 (2) and which were also imperfect, but in this case the female part has developed an enormous length, three times that of the male part. In the 1930 specimens, the proportion was almost inverse, and in the *R. ochroleucus belli*, according to Heinzl (6), the proportions are almost equal. This relationship, on the contrary, exists appreciably in the *R. americanus* of Hyman, wherein the structures appear more simple.

The male system begins, then, by a small bulb plainly retrogressing. Here, starting from a dorsally placed seminal vesicle, radiate runners which are in part at least pink glands, emerging ventrally to the neck, whereas the two deferent canals join from the rostral side and bend toward the sole. The whole recalls *R. nematopsis*, but it is possible that at maturity there exist segments receiving different glands, as in *R. ochroleucus belli*. Following this, some sections are lacking, but it is scarcely probable that a small penis might exist at their level. The male atrium expands in the sagittal plane. It presents a low epithelium followed by one longitudinal muscular layer, one circular, one longitudinal, and again one circular, which recalls the *R. nematopsis* of Tjibodas. Surrounding it is a layer of radiate tractus with nuclei which are certainly myoblasts, with some scattered longitudinal fibers. At the genital pore emerges a fairly long common atrium with a thick wrinkled epithelium surrounded by a circular layer

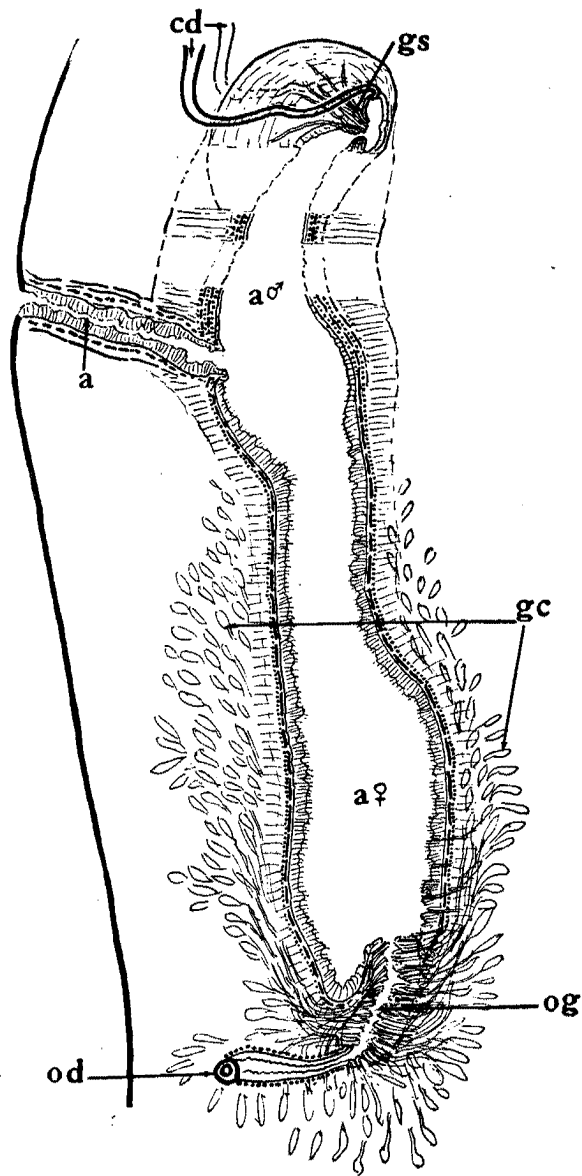


FIGURE 1.—*Rhynchodemus* sp. 1: Diagrammatic sagittal section of copulatory apparatus reconstructed according to transverse sections ( $a$ , common atrium;  $a\sigma$ , male atrium;  $a\varphi$ , female atrium;  $cd$ , deferent canals;  $gc$ , shell-glands;  $gs$ , glands of seminal vesicle;  $od$ , paired oviducts;  $og$ , ootype). Gaps are filled in with broken lines.

and some longitudinal layers, which link the former at the point where it continues with the female atrium.

This duct, or vagina, is 1.3 mm. long and very wide in the dorso-ventral direction, but compressed laterally. It is uniformly covered by an epithelium of blunt papillae, fairly tall and ciliated, which are lined by one longitudinal muscular layer and one circular layer, then a thinner radiate layer. Throughout the parenchyme appear extremely developed pink shell-glands, but contrary to first interpretation, they do not belong to this segment, the epithelium of which is not crossed by ducts, except a few at the end on the median dorsal line. They all converge on the small ootype, which is a tube with an epithelium—in this case completely infiltrated by red rodlike tractus—which protrudes a little dorsally in the end of the vagina. It appears to possess only a few circular fibers at the beginning. At its other extremity, the common oviduct emerges, deprived of glands but with a clear circular, which proceeds toward the ventral surface and receives the two paired oviducts. The shell-glands extend still farther toward the tail.

Except for the copulatory apparatus the transverse sections have little resemblance to that which I have published for *R. nematopsis*, the muscles of the parenchyme being much less developed (a few ventral transversals). On the other hand, the vitellogenes fill the entire parenchyme. However, this is obviously dependent upon the degree of maturity.

Fiji: Viti Levu, Tholo-i-Suva, E. C. Zimmerman, Aug. 27, 1938.

This material was important but in bad condition. It contained the *Platydemus*; two incomplete specimens, the genera of which are not certain; two damaged specimens, one of which,  $20 \times 1.5$  mm., was sexed and has been sectioned, the other only 16 mm.; and one-third of 12 mm., lacking a head, which will be described hereinafter. The last two showed the bands fairly distinctly. The sole was about one-third the size of the body.

#### **Rhynchodemus** sp. 2 (fig. 2).

As it lacks a head one cannot affirm that this specimen did not have multiple eyes, which would make it rank in the genus *Pelmatoplana*. But the copulatory apparatus suggests a form remotely related to the preceding species. The coloring is very dark with two well-defined lateral bands,  $12 \times 2$  mm., the genital pore at 3 mm. from the point, the mouth nearly 4 mm. from it.

From the male side a long muscular bulb encloses an ejaculatory canal, undulating rather more in a frontal plane than in the sagittal where I had to figure it. It begins with a curved horn-shaped vesicle of which the dorsal part receives the two deferent canals which flank the bulb; the following part has its epithelium infiltrated with pink secretion. This raised epithelium becomes very flat in the ejaculatory canal, which has a characteristic musculature composed of a thin circular layer and of longitudinal fibers rather widely spaced. Running around are the looser fibers of the bulb, longitudinal on the whole and curving toward the canal; some circulars exist at the periphery, especially dorsally. The extremity of the canal, slightly dilated and enclosing a ball of pink secretion, is surrounded by a circular musculature thicker in the interior of the conic papilla which fills almost all the common atrium and encloses also the end of the longi-

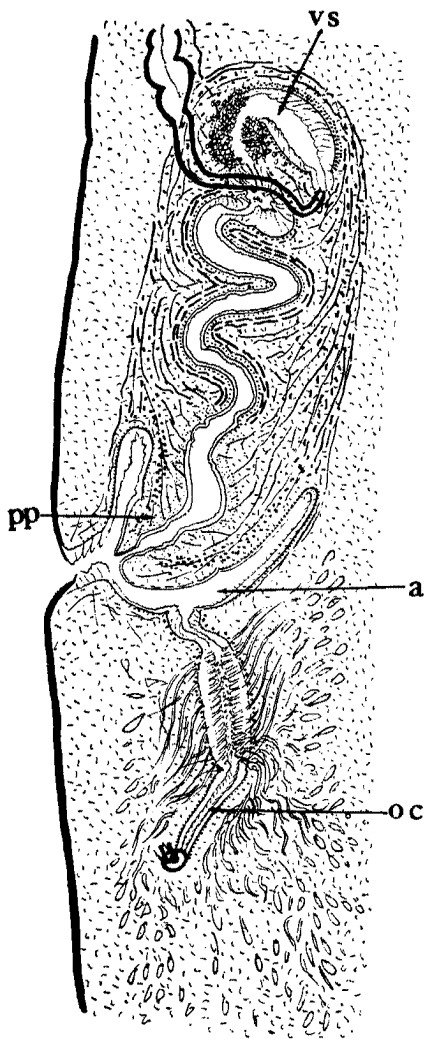


FIGURE 2.—*Rhynchodemus* sp. 2: Semi-diagrammatic sagittal section of the copulatory apparatus (*a*, common atrium; *oc*, common oviduct; *pp*, false penis; *vs*, seminal vesicle).

tudinal fibers and other irregular ones. It is probable that this papilla is only a "false penis," as it is in other species, preceded by a male atrium and not by an ejaculatory canal, and that the true one, homologous to that of the *Geodesmus*, would be at the junction of the vesicle and of this atrium, if it were not degenerating as in the *Platydemus* described below.

The common atrium has a fairly raised epithelium, becoming papillary at the orifice, surrounded as usual by one circular and one longitudinal muscular layer. At half of its length opens the female canal, which goes in the caudal direction and shows a raised epithelium regularly infiltrated, except for a short neck, by the red tractus of the highly developed shell-glands, which converge on it from the back and from the tail. To this ootype follows a common oviduct of the same length, with epithelium lower down, lacking the confluence of glands although the latter surround it at some distance. It receives the two paired oviducts at its extremity.

Fiji: Viti Levu, Tholo-i-Suva, E. C. Zimmerman, Aug. 27, 1938.

With the interpretation given above, the affinities of this form are with *R. ochroleucus belli*, according to Heinzl, in which the topography is analogous, but the glands are more differentiated in the seminal vesicle and the false penis is scarcely defined.

#### Genus *Platydemus* Graff

*Platydemus bistriatus* (Grube), Graff, Monogr. Turbell. II. Tricl. Terric., 527, pl. 16, figs. 20-22, 1899. (See figure 3.)

*Rhynchodemus bistriatus* Grube, Jahresb. Schlesische Gesell., no. 45: 46, 1868.

*Platydemus lineolatus* Graff, Monogr. Turbell. II. Tricl. Terric., 526, pl. 16, figs. 37-41, 1899.

The first of two specimens is in two fragments, measures  $18 \times 4$  mm., the mouth at 10 mm. from the upper end, the genital pore at 4 from it. Brownish coloring, two black lateral bands, each one formed of three lines spreading and anastomosing. Sole lighter in color, four-fifths of the width of body. The second specimen is in four fragments  $20 \times 5$  mm., mouth at 10 mm., genital pore at 6 mm. On the pointed head can be distinguished a third median band and the two eyes with choroid and slightly bulging cornea. The appearance is indeed that of the two specimen types of Grube revised by Von Graff, labeled Viti Levu in the Museums of Hamburg and Breslau, whereas Grube's original text (5) erroneously indicates Samoa. It appears probable that the *P. lineolatus* of Von Graff, founded on a specimen from the same source (Viti-Inseln, the name had been given in manuscript by Grube) is the same species. It differs only in having the bands closer together accompanied by small, sparse, longitudinal fibers similar to those which composed them (deposits of pigment between the longitudinal muscles), and condensations in spots of the brown epidermic pigment.

I am able to give the description of the copulatory apparatus, heretofore unknown, which appears in its entirety after clearing as a spot more than 3 mm. in diameter. Some small details differ between one specimen and another. The male system is better preserved in the first specimen, the female better developed in the second. The sagittal sections show first the two deferent ventral canals,

dilated and undulating, which proceed dorsally to end in the two sides of a flattened external seminal vesicle which has, as they have, a thin, flat epithelium. A narrow canal of the same structure ascends to open into an internal vesicle much more spacious and anfractuouse, diminishing in a short ejaculatory canal which emerges a little dorsally on a protuberance scarcely meriting the name of penis. The whole is lined with an epithelium at first flat, then raised and infiltrated by pink glands which flow from the exterior of the bulb, reaching a density such that their coagulated mass breaks up irregularly (especially in the second specimen in which, moreover, a dorsal rupture existed). They are a little more basophilic above. There is no musculature other than the fibers of the bulb which are dome-like in arrangement and are scattered and irregular.

From there up to the pore extends, at a length double that of the preceding region, a male atrium which is spacious on the median section, but contracted at the beginning by a lateral constriction and secondary folds, on the lower part by longitudinal folds indicated in dots on the illustration (fig. 3). Up to the lower quarter, the epithelium is thin and without appreciable structure, uniformly colored pink by the eosin. It receives, in fact, some small pink glands; but below the neck where it thickens, are some well-developed blue glands (shown by dots in figure 3). On the last quarter, the epithelium is raised and formed of narrow cells, again with glands of two sorts, the blue ones especially at the orifice. Along the entire length is a circular muscular layer, thin at first then increasing rapidly in thickness. It has been possible to represent it only very diagrammatically. Surrounding all this is a loose network of fibers prolonging those of the bulb, with some radiating fibers ending in the epithelium, and some sparse circular fibers.

The female system contains a somewhat dilated receptacle, which opens in the far end of the atrium at the level of the pore and has a continuous raised and papillous epithelium. In the first specimen, the receptacle is dilated but is very badly preserved with a dorsal rupture and no oviduct. In the other specimen, it is a little wrinkled but extends dorsally and caudally by a large common oviduct, the epithelium of which is low and ciliated in the usual way and surrounded by a clear connective layer, and which folds back toward the ventral surface to receive the paired oviducts. Some pink shell-glands surround the receptacle and emerge near its orifice in the ootype, the remainder of which receives the little blue glands.

Fiji: Viti Levu, Tholo-i-Suva, E. C. Zimmerman, July 27, 1938.  
Two specimens.

This animal differs little from the structures described by Von Graff (4, pp. 204-205) with *P. grandis* and *P. fasciatus* of Lord Howe Island, which are very distinctive because of their ornamentation and have the male atrium even shorter in proportion to the female part, especially the second one; the plane is exactly the same, without the excessive glandular development of the specimen here described. The two species from New Guinea which I have described (1) have a greater muscular development and different details, the one has a "uterus" separated from the oviduct. *P. bivittatus* of New Guinea and *P. victoriae* of Australia approach nearer to our species (Heinzel,



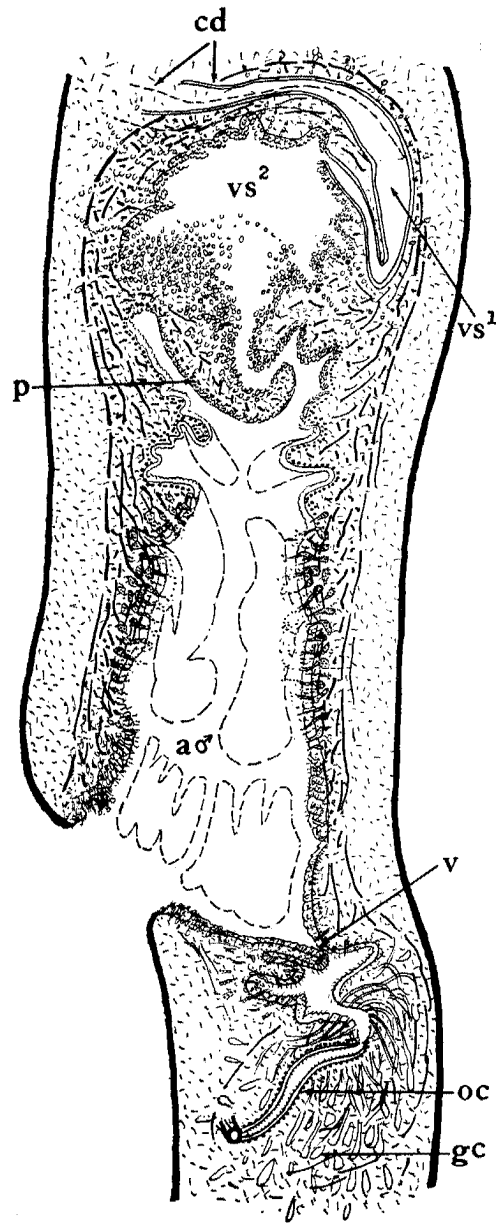


FIGURE 3.—*Platydemus bistratus*: Semi-diagrammatic sagittal section of copulatory apparatus (a♂, male atrium; cd, deferent canals; gc, shell-glands; oc, common oviduct; p, penis; v, vagina; vs, seminal vesicle).

6) by the length of the male atrium, by the epithelium wrinkled and without blue glands, and by the ootype, which is scarcely separated. *P. lividus* of Palau, according to Hyman (8), alone has a place apart because of a sinuous muscular bulb, a well-developed penis which is separated from the atrium by a diaphragm, and a long muscular vagina.

**Platydemus kraepelini** Graff, Monogr. Turb. II. Tricl. Terric., 519, pl. 14, figs. 15-19, 1899.

Tapered and flattened,  $17 \times 2.5$  mm., head a little truncated with two prominent eyes. Back is fairly clear and is edged with two rows of black spots, approximately quadrangular in shape, which diminish and stop before the head. Among them can be distinguished two brown longitudinal bands which appear to be formed by the epidermic pigment. The sole, taking up two-thirds of the width of the body, bears the mouth at 10 mm. from the head. After clearing, the small cylindrical pharynx is visible, but no copulatory apparatus is visible.

Fiji: Ovalau, near Vuma, 800 to 1,000 ft., E. C. Zimmerman, July 14, 1938.

The species is described from one Hamburg Museum specimen of the same origin as *P. lineolatus* with which Grube confused it. It is possible that he was right, but furthermore, that there is also confusion of *P. bistratus*, which could give its name to the entire group. The copulatory apparatus may well be identical, and in the variations of ornamentation it is only a question of the condensation in bands or in spots of the pigmentary streaks.

**Platydemus zimmermanni**, new species (figs. 4, 5).

The solitary specimen was unbroken but very fragile and the non-sectioned part partially disintegrated. It measures  $16 \times 3$  mm., is fairly thick, the head tapering, a little hollowed underneath, with two large eyes slightly protruding and two glandular pads. The sole takes up almost the entire width, the mouth at 9 mm., the genital pore at 4 mm. from it. The coloration is characteristic. The brown color, which is partly excoriated due to the epidermis, is superimposed upon a ground of ivory white, on which are two contrasting completely marginal narrow black bands and a series of large spots, vaguely quadrangular or pentagonal in shape, which divide into two very irregular rows; among these are some smaller spots which subsist alone, interspersed with streaks toward the extremities.

In complete contrast to all our other specimens, the ground remains opaque and whitish in light reflected upon the animal when completely cleared in cedar oil or in methyl salicylate. Its pigment is formed of flakes of very small grayish grains, localized between and under the dorsal longitudinal muscles, which are

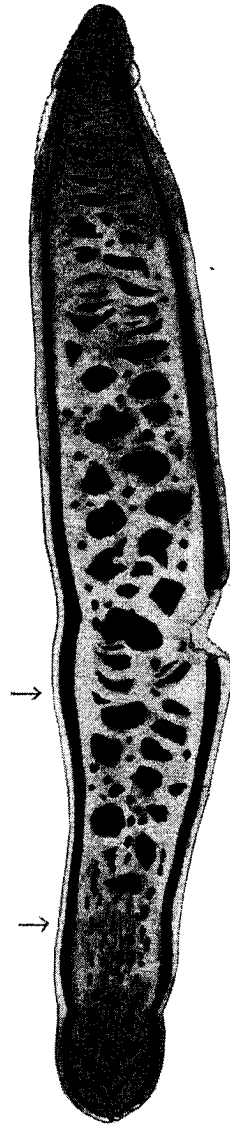


FIGURE 4.—*Platydemus zimmermanni*: Dorsal view of entire animal  $\times 9$ . Arrows indicate level of mouth and of genital pore.

crossed by the brownish cutaneous glands; the whole of these layers can be peeled and detached as fragments from the recumbent tissues which enclose the melanotic spots, above which the gray pigment is missing, with the result that their design appears in distinct (negative) outline on the detached pellicle. All this is very aberrant; it is doubtless a case of a subcutaneous deposit of excremental matter, but I am not aware of any mention of such in a Turbellarian. It can be distinguished on the sections only with great difficulty.

The copulatory apparatus is, notwithstanding, of the type described above. The male portion is very long and almost without distinct regions. It is surrounded by a muscular layer the fibers of which terminate in a dome crossed by the two deferent canals, which reunite dorsally in a small seminal vesicle with a flattened epithelium. A short canal opens into the first part of the male duct the epithelium of which thickens, and where infiltrate pink glands, the secretion of which coagulates in the hole and sections badly. Their radiating lines cross the musculature. This part corresponds to the ejaculatory canal, but there is no trace of a penis. Only a small dorsal projection with the same structure separates it from the male atrium which extends up to the pore. It is lined by a low epithelium in irregular folds, infiltrated with pink by a thin glandular layer. In about the first third, there exists underneath a layer of longitudinal muscles crossed by small blue glands, and the longitudinal fibers of the periphery curve toward the hole and are intermingled with the circular fibers. A little lower down, the epithelium thickens slightly and the blue glands are large and spaced out; the internal longitudinal fibers disappear, and are then replaced by the circulars which at the very base form a true sphincter crossed by glands and separating the common atrium, which is scarcely more than the pore. The epithelium is still pink and is formed of tall, thin cells.

Just below, the very short female duct opens dorsally and a little to the right. It includes only one ovoid ootype (Drusensäck), the ciliated epithelium of which is infiltrated by the pink granular shell-glands which extend dorsally toward the tail. There are no circular muscles except at the orifice. Right at the posterior end it receives the slightly longer common oviduct which curves back dorsally and bifurcates. The latter has, as is customary, a flat epithelium surrounded by a circular musculature, the whole being colored in violet and not in pink as is the rest.

Fiji: Ovalau, near Vuma, 800 to 1,000 ft., E. C. Zimmerman, July 14, 1938. One specimen. (Type in Bishop Museum.)

It may be seen that this description sufficiently characterizes this species in relation to the preceding ones, without any great deviation. It is not entirely certain whether the four species of *Platydemus* from Fiji just described, and perhaps some of the others mentioned, do not really form a single large species *sensu lato*. The distribution of the black pigment is essentially variable, and perhaps the special *zimmermanni* pigment does not exist throughout the whole of their life. In the copulatory apparatus the small differences of proportions, development of muscles and glands, and effacement of the penis, can also be more or less contingent. It would be necessary to establish whether in the local breeds there is any correlation of internal and external

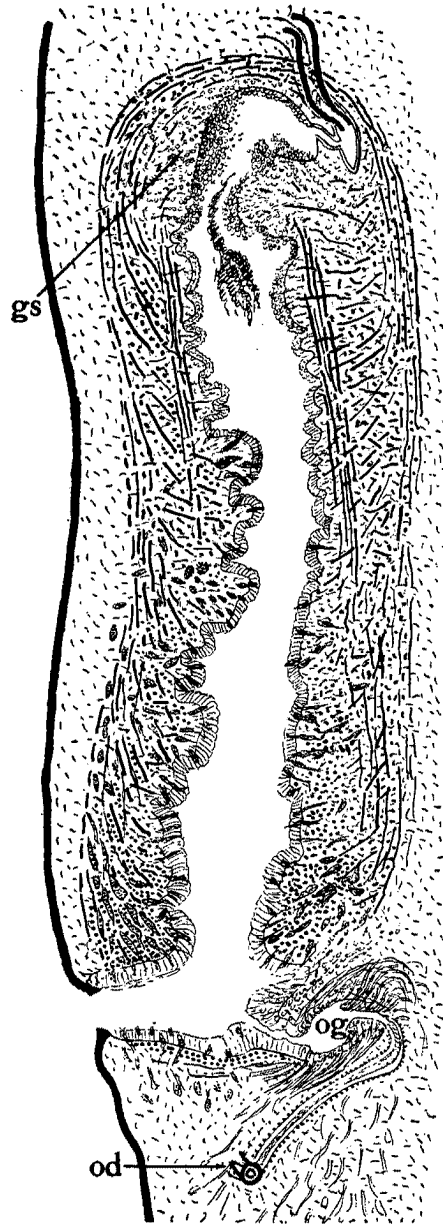


FIGURE 5.—*Platydemus zimmermanni*: Semi-diagrammatic sagittal section of copulatory apparatus (*gs*, glands of seminal vesicle; *od*, paired oviducts; *og*, ootype).

characteristics. In any case, the preponderance in Fiji of this homogenous and essentially Austro-Malayan type would not be surprising. Two species from Africa and Comores are unknown anatomically and probably do not belong to it. This is equally true of the Ceylon species, which is perhaps imported; and Miss Hyman (8) has just removed from this genus one of the species from Palau.

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