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ENDEMIC AND EXOTIC LAND PLANARIANS IN THE UNITED STATES WITH A DISCUSSION OF NECESSARY CHANGES OF NAMES IN THE RHYNCHODEMIDAE

By LIBBIE H. HYMAN

Accumulated material of land planarians collected in the United States has furnished the occasion for this article. Some of the material was lent for study by the U. S. National Museum; the California specimens came from Dr. W. M. de Laubenfels, Pasadena, Prof. W. K. Fisher, Carmel Valley, and Mr. John L. Mohr, Berkeley; and Dr. H. I. Strohecker, Kenyon College, Gambier, Ohio, very kindly searched for and forwarded to me some slides made by the late Dr. L. B. Walton. Following the publication of a preliminary report in *Science* (Hyman, 1940b), Dr. Leslie Hubricht of the Missouri Botanical Gardens sent a large and valuable collection of land planarians he had found in greenhouses and out of doors, and information about *Bipalium kewense* in New Orleans was sent by Drs. Harold Cummins and F. H. Wilson of Tulane University. Thanks are here expressed to all these zoologists for their interest and cooperation.

GEOPLANIDAE

GEOPLANA STIMPSON, 1857

Geoplana mexicana Hyman, 1939

Figures 1, 2

MATERIAL.—Many specimens sent by Dr. de Laubenfels, Dr. Fisher and Mr. Mohr, mostly juveniles.

FORM.—Typically geoplanid, flat, elongate, anterior end narrowing to a blunt tip, posterior end broader, coming to an abrupt point; to 20 mm. long, specimens under 15 mm. in length are juvenile without sex organs. Figure in Hyman, 1939, p. 424, Fig. 48B.

COLOR.—Appears black but closer inspection shows two light dorsal stripes

which therefore enclose between them a very narrow black middorsal stripe. Along the margin there is a light line bordered below by a dark line. The midventral region shows the usual white band of the creeping sole, slightly raised. To either side of this is a wide, slightly darkened band bordered laterally by a light stripe, which in turn is next to the dark marginal line referred to above. Thus the ventral surface has a faint banded appearance.

EYES.—In a single irregular row along the entire body margin, crossing the anterior tip, smaller and more scattered in the posterior body fourth. Some California specimens show the eyes along the anterior margin more widely spaced than in the original Mexican specimens (Fig. 1), but others are like the Mexican ones so that this difference probably results from methods of killing.

COPULATORY APPARATUS.—In my original account of this species, I was unable for lack of mature specimens to describe the copulatory apparatus. I am therefore glad to be able to complete the description of the species from sexual material sent by Dr. de Laubenfels. Testes ventral. Common genital pore about 2 mm. posterior to mouth, about 4 mm. from posterior end of a 20-mm. specimen. Sagittal view of sexual apparatus in Fig. 2. Common genital pore leads by narrow vertical passage into somewhat small genital atrium. Penis oval, elongated, muscular, of muscle fibers running chiefly lengthwise and curving around proximal end of penis. Here common vas deferens ascends through muscle coat and enlarges into a wide S-shaped canal lined by a glandular epithelium; this canal is divided

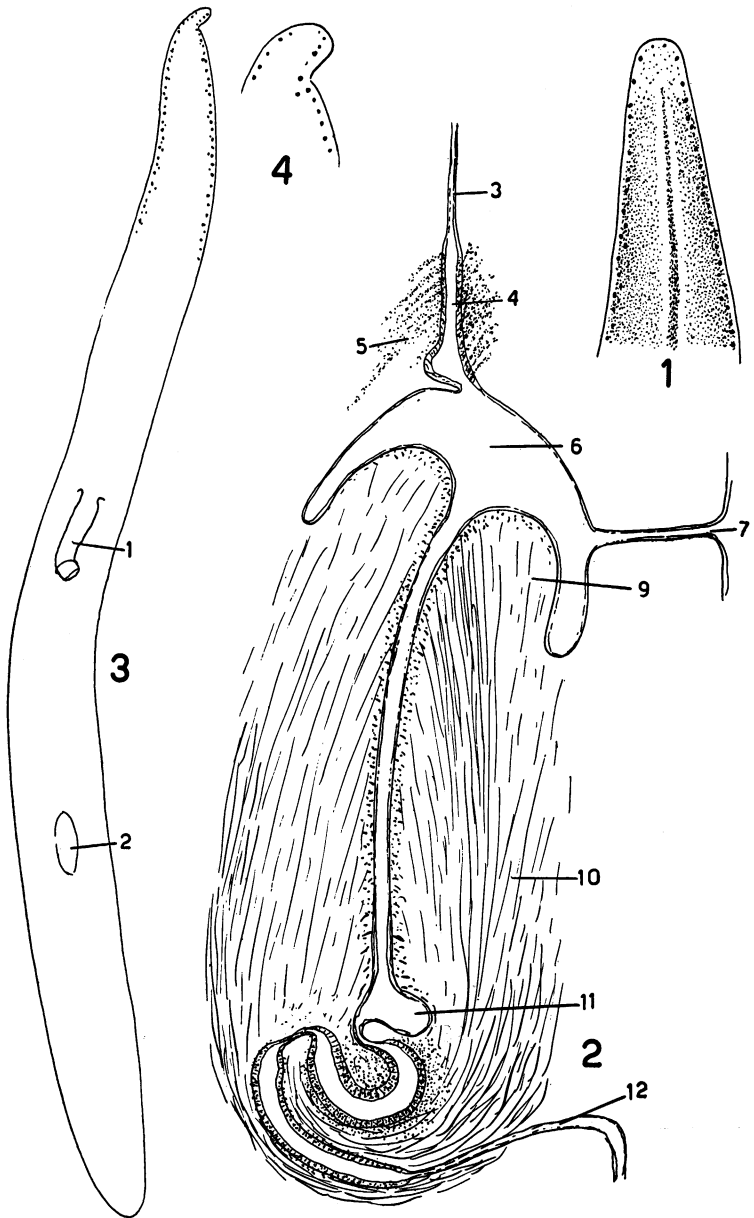


Fig. 1. *Geoplana mexicana*, head of Californian specimen.
 Fig. 2. *Geoplana mexicana*, sagittal view of the copulatory apparatus.
 Fig. 3. *Geoplana vaga*, type specimen.
 Fig. 4. *Geoplana vaga*, enlarged view of head to show eyes.

into two curved portions by a short narrowed section. Probably the whole S-shaped canal should be regarded as a seminal vesicle; it is accompanied by numerous gland cells which open through its epithelium. Finally male canal opens into small chamber from which straight narrow canal underlain by muscle fibers, chiefly circular, proceeds to penis tip. Penis papilla very short, consisting of a short truncate projection into the genital atrium. Female apparatus simple, consists of glandular duct extending backward from posterior wall of genital atrium. Glandular duct receives numerous glands and becomes continuous with the oviducts. The distinguishing features of the copulatory apparatus of *G. mexicana* are the curved tubular seminal vesicle and the short broad penis papilla.

LOCALITY.—Gardens, California (Pasadena, Carmel Valley, Berkeley), under leaf mold or other objects, common. Previous specimens on which the original description was based were taken at Laredo, Texas, on shipments of flowers from Mexico, three specimens in September, 1935, and three more in March, 1939. The species, which has become established in California, would therefore seem to be a native of Mexico.

SPECIMENS.—Whole mount and vial of preserved specimens deposited in A.M.N.H., Cat. No. 293.

***Geoplana vaga*, new species**

Figures 3-5

MATERIAL.—One mature specimen sent by Dr. de Laubenfels.

FORM.—Flat, elongated, narrowing abruptly at anterior end, tapering behind middle to blunt posterior end (Fig. 3); nearly 40 mm. long preserved, presumably longer in life, 2.6 mm. wide; mouth about 20 mm. from anterior end, genital pore about 10 mm. behind mouth; notable for wide separation of mouth and genital pore.

COLOR.—Stated to have been very dark bluish black in life; preserved, dorsal surface was bright cerulean blue, composed of coarse granules.

EYES.—Because of coarse dark pigment granules, eyes could not be followed beyond anterior few mm.; they form a single irregular file along the anterior margin (Fig. 3) but do not cross the anterior tip (Fig. 4).

COPULATORY APPARATUS.—Specimen was in full sexual maturity; sagittal view of copulatory apparatus in Fig. 5. Common genital pore leads by wide opening into male copulatory

apparatus anteriorly, female genital atrium posteriorly. Male apparatus bounded from parenchyma by muscular stratum from which muscle fibers pass into it. Vasa deferentia enter anterior end of muscular stratum from below; common duct ascends and widens into a dorso-ventrally elongated chamber. From posterior side of this, below its dorsal end (Fig. 5), ejaculatory duct begins as narrow tube, at once widens and passes back as coiled canal, surrounded by gland cells which open through its epithelium. It soon opens into the lumen of the long penis, which lacks a definite papilla, being made instead of many irregular folds. Under their covering epithelium, these folds have a muscular stratum of outer longitudinal and inner circular fibers. Female atrium is a wide elongated chamber extending posteriorly for some distance beyond the common genital pore and has a slightly sinuous wall lined by a very high epithelium. Atrium lies in a slightly muscular area bounded from the general parenchyma by muscle fibers. From posterior end of female atrium, a short canal leads backwards and soon enlarges into a chamber with greatly folded walls, receiving numerous gland cells. This chamber appears to represent the glandular duct; its posterior end receives the oviducts.

No testes were seen in the short piece containing the copulatory apparatus that was sectioned, but numerous yolk glands are present, both above and below the intestinal branches.

DIFFERENTIAL DIAGNOSIS.—*G. vaga* differs from other members of the genus in the combination of color and details of the copulatory apparatus.

LOCALITY.—Garden, Pasadena, California; presumably introduced, original habitat unknown.

TYPE.—One whole mount; sexual region as serial sagittal sections (five slides), deposited in A.M.N.H., Cat. No. 294.

REMARKS.—The genus *Geoplana* comprises a very large number of species having the same general appearance and eye arrangement but differing considerably in the structure of the male copulatory apparatus. Contrasted with a group of species having a definite projecting penis papilla are those like the present species totally devoid of a penis papilla and having instead a male apparatus consisting of an elongated hollow muscular organ with a highly folded wall. It is probable, however, that when in use some of these folds erect and act as a penis papilla. Of the species without a penis papilla there are also some of dark blue color, and *G. caeruleo-nigra* Riester, 1938, from Brazil seems to

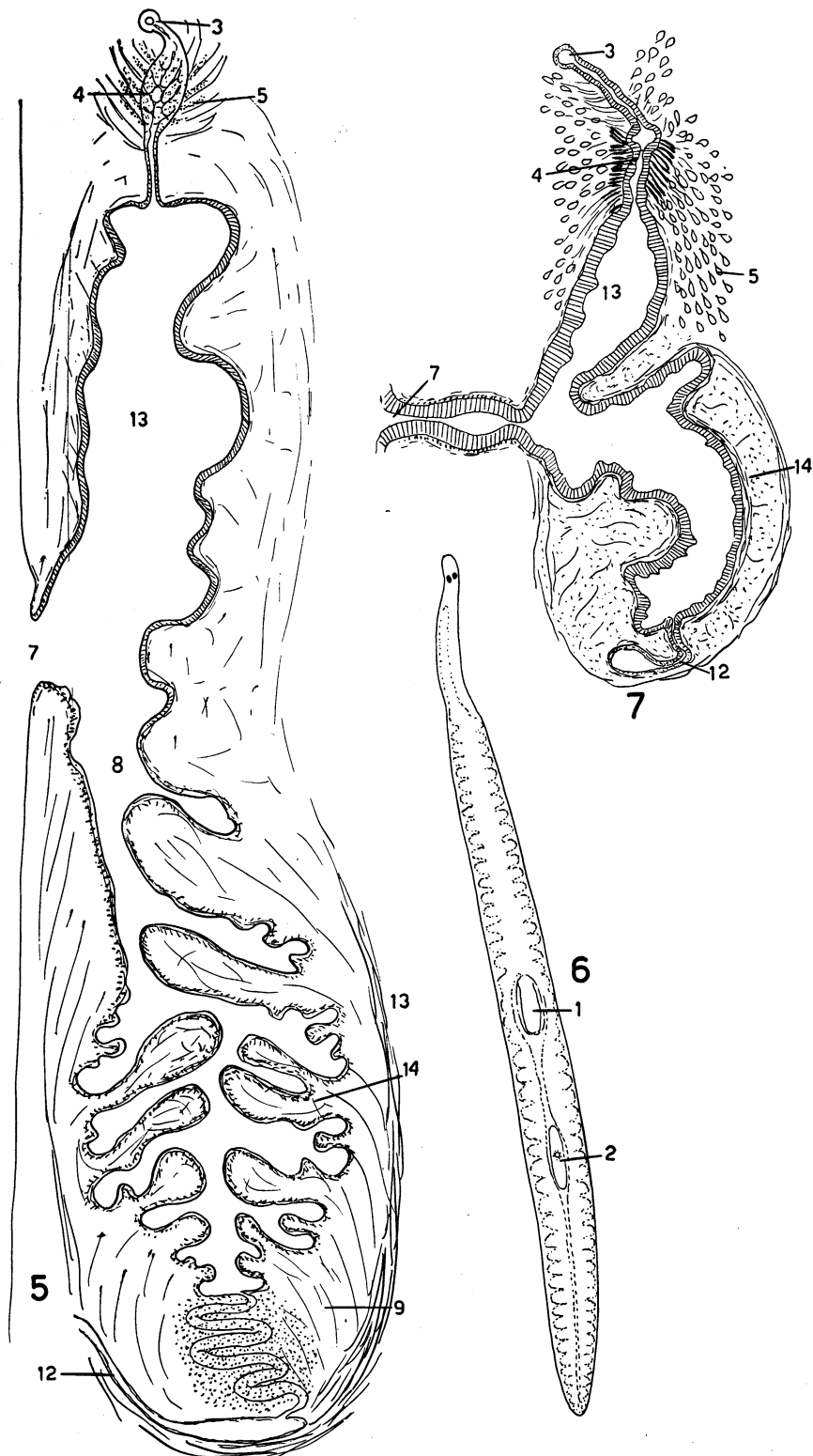


Fig. 5. *Geoplana vaga*, sagittal view of copulatory apparatus.

Fig. 6. *Rhynchodemus sylvaticus*, from Walton's whole mount.

Fig. 7. Copulatory apparatus of *Rhynchodemus sylvaticus*, sagittal view, from set of sections made by Walton.

come rather close to the present species. However, none of the species which combine a bluish black color with the type of male apparatus shown in Fig. 5 appear to be identical with *G. vaga*.

RHYNCHODEMIDAE

Dolichoplaninae, new name

(=Desmorhynchinae Heinzl, 1929)

RHYNCHODEMUS LEIDY, 1851

Syn.: *Desmorhynchus* Heinzl, 1929.

Rhynchodemus sylvaticus (Leidy), 1851

Syn.: *Planaria sylvatica* Leidy, 1851.

Figures 6-8

MATERIAL.—One whole mount labeled *Rhynchodemus* sp., and one set of serial sections labeled *Rhynchodemus sylvaticus*, both made by Dr. L. B. Walton; a number of specimens sent by Dr. Hubricht.

FORM.—Small, below 10 mm. in length, slender, elongated, anterior fifth cylindrical with rounded tip, notably narrower than the rest of the body, rest of body plump, convex above, flattened below, posterior end acute (Fig. 6).

COLOR.—According to Leidy, grayish above with two longitudinal brown stripes, paler below. Girard's drawings (1893), apparently made from Leidy's specimens, agree with Leidy's description except in one case where a streaky dark pattern on a lighter ground is shown. The specimens sent by Dr. Hubricht agreed perfectly with Leidy's description. Walton (1907) found specimens near Gambier, Ohio, agreeing with Leidy's account but also reported more lightly colored worms (apparently lacking the dorsal stripes). Presumably the whole mount mentioned above labeled *Rhynchodemus* sp. was one of these lighter specimens. Sections of its copulatory apparatus proved it to be *R. sylvaticus*. It is therefore probable that all Walton's specimens were *R. sylvaticus* and that this animal is somewhat variable in color and color pattern.

EYES.—All rhynchodemids have a pair of eyes near the anterior tip; these are remarkably large in *R. sylvaticus* (Figs.

6, 8) in comparison with the narrowed ("probosciform" in Leidy's description) anterior region. In the set of sections made by Walton, the anterior end was sectioned transversely, the posterior part sagittally. Fig. 8 shows a section through the eyes from this series. The eye is seen to be relatively large and well differentiated and situated close to the external surface. The section also passes through the brain ganglia and the anterior tip of the intestine.

HISTOLOGY.—Since the work of Heinzl (1929) it has become necessary to examine rhynchodemids in transverse section before they can be allocated generically. Heinzl pointed out that rhynchodemids fall into two groups, those in which the longitudinal muscles of the body wall are strongly developed and arranged in discrete bundles, and those with a weak layer of longitudinal fibers not aggregated into bundles. For the former group he proposed the subfamily Desmorhynchinae based on his new genus *Desmorhynchus*, and for the latter he created the subfamily Rhynchodeminae in which he placed the genus *Rhynchodemus* as he understood it. Examination of cross sections of *Rhynchodemus sylvaticus* (Fig. 8A) shows that in this species the subepidermal longitudinal muscles are well developed and arranged in bundles. The implications of this fact for the taxonomy of the Rhynchodemidae are discussed at the end of this paper.

Transverse sections through the probosciform anterior region are flat or slightly concave below, convex above; through more posterior levels, they are broadly oval with a midventral ridge, similar to Fig. 11. Otherwise no evident histological differences appear between these two regions except that the probosciform part of the body is more compact and muscular.

Epidermis of cuboidal cells, thinner ventrally, ciliated only on the creeping sole which occupies about one-fourth the body circumference. Beneath epidermis is a thin stratum of circular muscle fibers and immediately below this a layer composed of the oval bundles of longitudinal fibers. These bundles appear to be adherent to the circular fibers. Although not so sharply set off as in some other

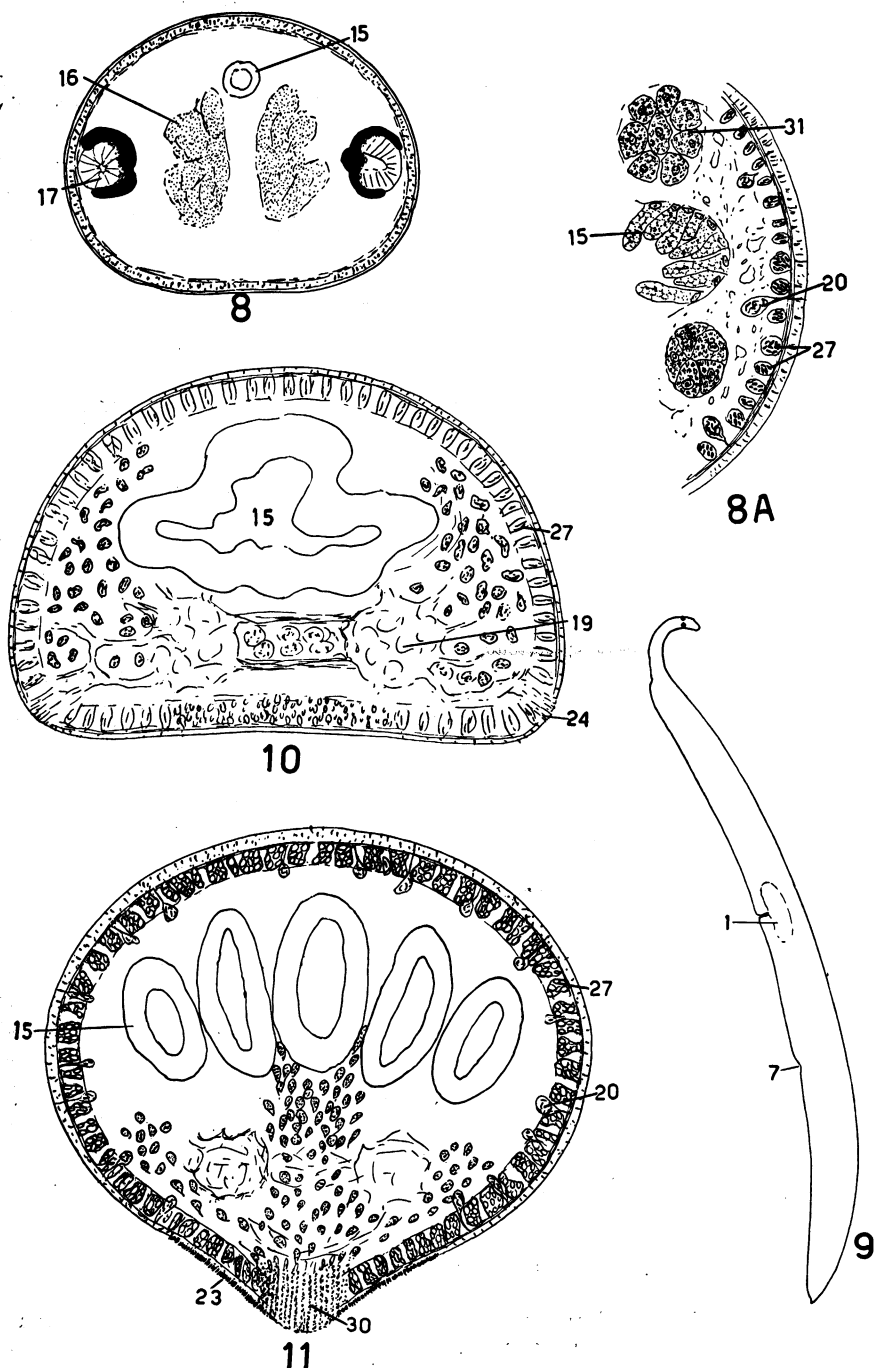


Fig. 8. Transverse section through the head at the level of the eyes of *Rhynchodemus sylvaticus*.
 8A, transverse section through lateral part of body, showing longitudinal muscle bundles.
 Fig. 9. *Rhynchodemus americanus*, showing body form.
 Fig. 10. Section through the anterior part of *Rhynchodemus americanus*, showing sensory tracts at the margins.
 Fig. 11. Transverse section near the caudal end of the beak region, showing two ciliated tracts enclosing midventral glandular prominence.

rhynchodemids, probably because of the small size of *R. sylvaticus*, the longitudinal bundles are, nevertheless, perfectly apparent, especially in the probosciform region. Between the longitudinal muscle bundles occur rhabdite-secreting cells whose necks pass to the epidermis.

COPULATORY APPARATUS.—The Walton set of sections is that of a mature worm, and the copulatory apparatus is well shown despite the faded condition of the stain. Sagittal view of apparatus in Fig. 7. Apparatus very simple; male part is a hollow oval organ marked off from parenchyma by a thin bounding stratum of muscle fibers. Organ lined by a tall epithelium underlain by slight layer of muscle fibers. Vasa deferentia approaching from in front unite to form a small chamber from which the short, narrowed, ejaculatory duct turns posteriorly to enter the anterior end of the lumen of the male organ. Female apparatus also of simple construction. Female atrium, an elongated chamber lined by a high epithelium, extends posteriorly from common genital atrium and narrows into glandular duct, which receives numerous cement glands. Common oviduct ascends to open into posterior end of glandular duct. From common genital atrium, common genital canal proceeds directly ventrally and opens in midventral line by common genital pore. Relative positions of mouth and common genital pore shown in Fig. 6.

LOCALITY.—*R. sylvaticus* was originally recorded from Philadelphia, under flower pots, boards, leaves, and stones in gardens, and also in woods near the city. Prof. J. Percy Moore of the University of Pennsylvania informs me that he was formerly able to find the species in woods near Philadelphia but at present cannot find any specimens in places where they were known to occur in the past. Later (1858) Leidy recorded finding one specimen in the mountains of western Pennsylvania and fourteen specimens along a fence in Newport, Rhode Island. The next published record of the species is that of Walton (1904, 1905), who found a number of specimens at Gambier, Ohio, on a vine and under a stone in a meadow. Later (1912)

Walton reported that he had found the species common at Urbana, Ohio, Gambier, Ohio, and Meadville, Pennsylvania. I know of no findings in nature since Walton's records, and apparently the animal is very rare out of doors at the present time. The many specimens sent by Dr. Hubricht came from a greenhouse in Forest Park, St. Louis, Missouri. The animal therefore appears to be distributed throughout the northern half of the eastern United States.

SPECIMENS.—Set of serial sections made by Walton; whole mount made by Walton, rear half sectioned by Hyman; whole mount of some of Hubricht's specimens; and cross sections of one of Hubricht's specimens deposited in A.M.N.H., Cat. Nos. 304, 305 and 295, respectively.

REMARKS.—The above description is based on Walton's and Hubricht's material. I have not been able to obtain material from the type locality, but there are no grounds for doubting the identification. It is unfortunate that Walton published only very brief and unsatisfactory notes. His belief that he had more than one species of the *sylvaticus* type appears to have been mistaken.

***Rhynchodemus americanus*, new species**

Figures 9-12

MATERIAL.—A number of specimens sent by Dr. Hubricht.

FORM.—Slender, elongate, to 15 mm. in length, anterior end narrowed and beak-like as in *R. sylvaticus* but this region relatively shorter as compared to body length than in *R. sylvaticus*; rest of body cylindroid, oval in section, tapering to a blunt point (Fig. 9). On the ventral side the creeping sole forms a narrow white band which terminates at the proximal end of the "beak" in a transverse swelling.

COLOR.—Grayish or brownish black above, uniform, paler below, sole white.

EYES.—Two, large as in *R. sylvaticus* (Fig. 9).

HISTOLOGY.—The beak-like anterior region is flat below, convex above (Fig. 10), hence similar to this region in *R. sylvaticus*. At the margins of the ventral surface there is a sensory tract on each side where rhabdites are absent (Fig. 10). There do not appear to be any such sensory tracts in *R. sylvaticus*. Under the epidermis is a thin layer of circular muscle fibers and beneath this are very evident oval bundles of longitudinal fibers. These are similar to but more obvious than those of *R. sylvaticus* (Figs. 10, 11). Between the muscle bundles lie pig-

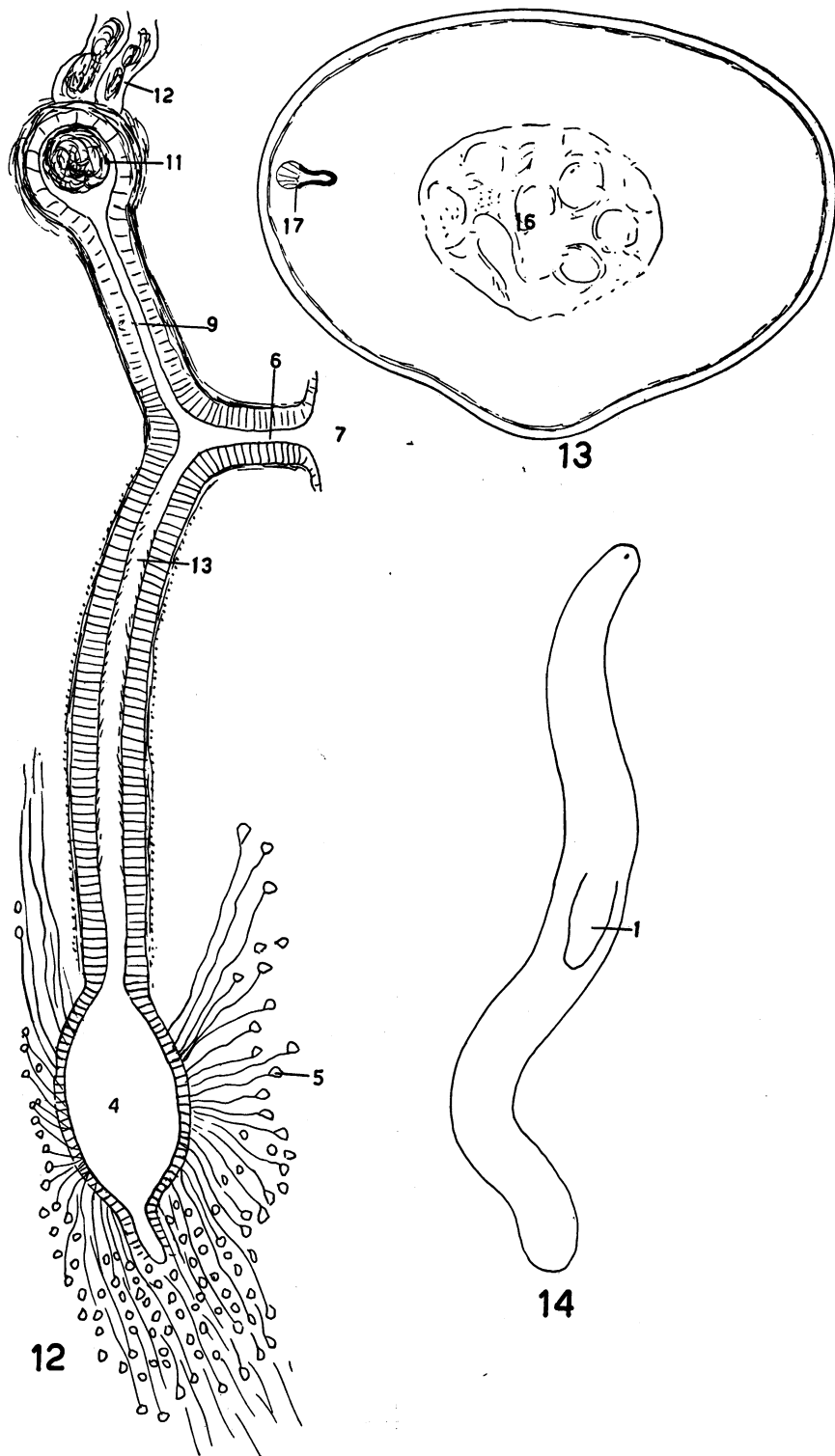


Fig. 12. Sagittal view of the copulatory apparatus of *Rhynchodemus americanus*.

Fig. 13. Transverse section through the anterior end of *Geodesmus atrocyanus*, showing an eye (as the section is slightly oblique, it passes through only one eye); from set of sections made by Walton.

Fig. 14. *Geodesmus atrocyanus*, specimen collected by Hubricht.

ment granules and rhabdite-secreting cells. The ventral nerve cords in the proboscidiiform region are farther apart than in *R. sylvaticus* and often connected by two cross commissures. Eyes similar in size, structure and position to those of *R. sylvaticus* and hence not figured. In regions shortly behind the eyes large rhabdite-forming cells are particularly numerous and conspicuous. Approaching the rear end of the beak region, the sections become more oval and a pair of especial ciliated tracts appears on the ventral surface; these finally enclose between them a midventral prominence on which open numerous cyanophilous glands (Fig. 11). This region appears to coincide with the transverse swelling seen in the whole animal at the anterior end of the creeping sole. Posterior to this, the midventral elevation gradually smooths out, and the ciliated tracts merge to become the usual creeping sole. This occupies about one-third of the ventral half of the circumference, bears peculiar short stiff cilia and is formed of a lower epidermis than the rest of the surface, also characterized by its lack of rhabdites. More posteriorly, the creeping sole flattens out and the ventral surface becomes plane, with a sensory strip on each side where the ventral surface joins the convex dorsal surface. The creeping sole is much narrower posteriorly than at more anterior levels.

REPRODUCTIVE SYSTEM.—The position of the genital pore relative to the mouth is shown in Fig. 9, and a section of the copulatory apparatus is drawn in Fig. 12. The testes are ventral in position, moderate in numbers, and in the specimen sectioned were not found posterior to the level of the copulatory apparatus. The very numerous yolk glands occur throughout the body length. The copulatory apparatus is of the same simple type as in *R. sylvestris*. From the genital pore the straight genital canal proceeds dorsally and forks into the male canal running anteriorly and the female canal running posteriorly. The former is a simple tube widening at its anterior end into a rounded chamber filled with sperm into which open the two vasa deferentia separately (Fig. 12). It is lined throughout by a tall epithelium underlain by a slight layer of muscle fibers, mostly longitudinal. The female canal is twice or more the length of the male canal and at its posterior end widens into an oval chamber to which there are attached numerous long-stalked glands. This chamber hence corresponds to the glandular duct of other land planarians; at its narrowed rear end it receives the common oviduct. The glandular chamber is lined by a low epithelium penetrated by the outlets of the attached glands. The lining of the female canal is taller, ciliated and underlain by a slight layer of muscle fibers.

DIFFERENTIAL DIAGNOSIS.—*R. americanus* differs from all other species now in the genus *Rhynchodemus* except *R. sylvaticus* in the beak-like anterior region, and differs from the latter species in color and

the details of the copulatory apparatus as shown by comparing Figs. 7 and 11.

LOCALITY.—Greenhouses, Forest Park, St. Louis, Missouri, about ten specimens, collected January 18, 1936; greenhouses, Riverton, New Jersey, one specimen.

TYPE.—Cotypes (three specimens) mounted whole on slide; set of sagittal serial sections of copulatory apparatus and cross sections through anterior end deposited in A.M.N.H., Cat. No. 296.

REMARKS.—Although this species has been found only in greenhouses, it must be supposed to be endemic to the United States because of its strong similarity to *R. sylvaticus*, as regards the beak-like anterior region and the copulatory apparatus. As *R. sylvaticus* is endemic, having been found nowhere else, and is the only previously known *Rhynchodemus* with the beak-like anterior differentiation, one is forced to conclude that the closely related *R. americanus* must also be native to the United States. As noted above, *R. sylvaticus* has migrated into greenhouses, and this may be expected to occur with any of our land planarians.

Rhynchodemus sp. A

Figures 19, 21

MATERIAL.—Several juvenile specimens sent by the U. S. National Museum.

FORM.—Slender, elongate, tapering to both ends (Fig. 19), cross section broadly oval (Fig. 21). Largest specimen (juvenile) nearly 60 mm. long, 3.4 mm. in diameter; pharynx anterior to middle (Fig. 19).

COLOR.—Preserved specimens yellowish or brownish gray, probably lighter in life, with two dorsal longitudinal dark stripes, continuing to both ends. Fig. 19, side view, shows only one of the stripes; their location is given on the cross sections, Fig. 21.

EYES.—Usual pair of eyes somewhat back from the anterior end (Fig. 19).

CROSS SECTION.—This (Fig. 21) shows under the epidermis the zone of longitudinal muscle bundles characteristic of the Dolichoplaninae as here defined (= Desmorhynchinae Heinzl). From the shape of the section and the occurrence of

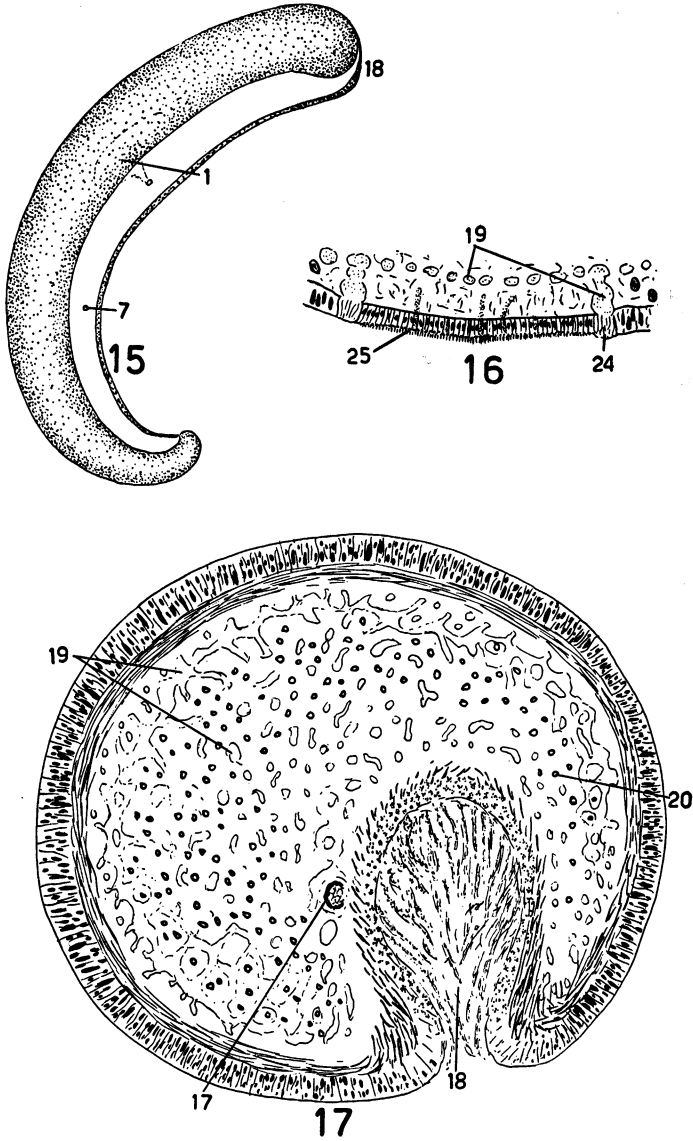


Fig. 15. *Diporodemus indigenus*, type specimen before sectioning.

Fig. 16. Part of section through the head of *D. indigenus*, showing sensory tract to either side of the creeping sole.

Fig. 17. Transverse section through the anterior end of *D. indigenus*, showing general histology, adhesive cleft and one eye; the section is unfortunately somewhat diagonal. Figs. 8, 13 and 17 are not to scale—13 and 17 are very much larger compared to 8 than shown.

these bundles there seems little doubt that the animal belongs to *Rhynchodemus* as here defined.

LOCALITY.—Taken in 1914–1916 in the greenhouses of the U. S. Department of Agriculture, Washington, D. C.; original locality unknown; presumably imported with plants.

SPECIMENS.—Largest specimen as whole mount, U.S.N.M.; others left in original vial returned to U.S.N.M.; also slide of cross sections deposited in U.S.N.M.

REMARKS.—In the absence of sexual material, the worm cannot be carried farther than genus. The animal corresponds in all respects to *Dolichoplana bosci* Graff, 1899, Madagascar, which is undoubtedly a *Rhynchodemus* (present definition), not a *Dolichoplana*. However, von Graff's description is very brief and despite later collections of land planarians from Madagascar, the species has not been refound. The distinguishing character of *D. bosci* is a pair of black longitudinal stripes on a dull yellow to yellowish gray ground. The sex organs have not been described for *bosci*, so that even had the present specimens been sexually mature, the identification would still have remained in doubt.

Rhynchodemus sp. B

Figure 22

MATERIAL.—About twenty specimens sent by Hubricht, all juvenile.

FORM.—Elongate, very slender, tapering to both ends, to 20 mm. long, pharynx posterior to middle (Fig. 22).

COLOR.—Uniform yellowish gray, slightly darker dorsally.

EYES.—Usual two near anterior end.

CROSS SECTION.—Similar to Fig. 21, shows oval shape and longitudinal muscle bundles characteristic of *Rhynchodemus* (as here defined).

LOCALITY.—Taken in greenhouses, Forest Park, St. Louis, Missouri, February 15, 1936, in company with *R. sylvaticus*; presumably imported with plants, original locality unknown.

SPECIMENS.—Whole mount deposited in A.M.N.H., Cat. No. 297.

REMARKS.—There seems little doubt that this species is distinct from the preceding one, *Rhynchodemus* sp. A. In addition to the difference in color pattern, the difference in location of the pharynx is noteworthy. In sp. A, the pharynx is anterior to the middle; in B, posterior to the middle. In view of the lack of sexual specimens, it does not seem desirable to name the form.

DOLICHOPLANA MOSELEY, 1877

Dolichoplana striata Moseley, 1877

MATERIAL.—Many specimens of various sizes sent by Hubricht, juvenile.

FORM.—Very elongated, flattened, to 120 mm. long; for figure see Hyman, 1940.

COLOR.—Ground color yellowish brown with six longitudinal dark stripes, paired median, lateral and marginal. Median stripes very narrow, fading away posteriorly shortly behind pharynx, may be absent, especially in young specimens. Lateral stripes very conspicuous, black, sharply defined, beginning at level of eyes, and continuing to posterior tip. Marginal stripes less dark, diffuse, ill defined, fading away posteriorly. Creeping sole white, bordered on each side by diffuse pigmentation.

EYES.—Two, on rounded anterior end.

COPULATORY COMPLEX.—Has never been described; this species is apparently rarely in the sexual state and reproduces by fragmentation.

LOCALITY.—Greenhouses, Forest Park, St. Louis, Missouri, January 18, 1936, also March 24, 1937; Bourdet's greenhouse, Laramie County, near St. Louis, Missouri, April 4, 1936. Original habitat, Indo-Malay region, very common, one of the most common land planarians of the Pacific Islands; not hitherto recorded for greenhouses in the United States.

REMARKS.—For more complete descriptions of this species see the original description by Moseley, also the accounts in von Graff, 1899, and Hyman, 1940a. Preserved specimen deposited in A.M.N.H., Cat. No. 298.

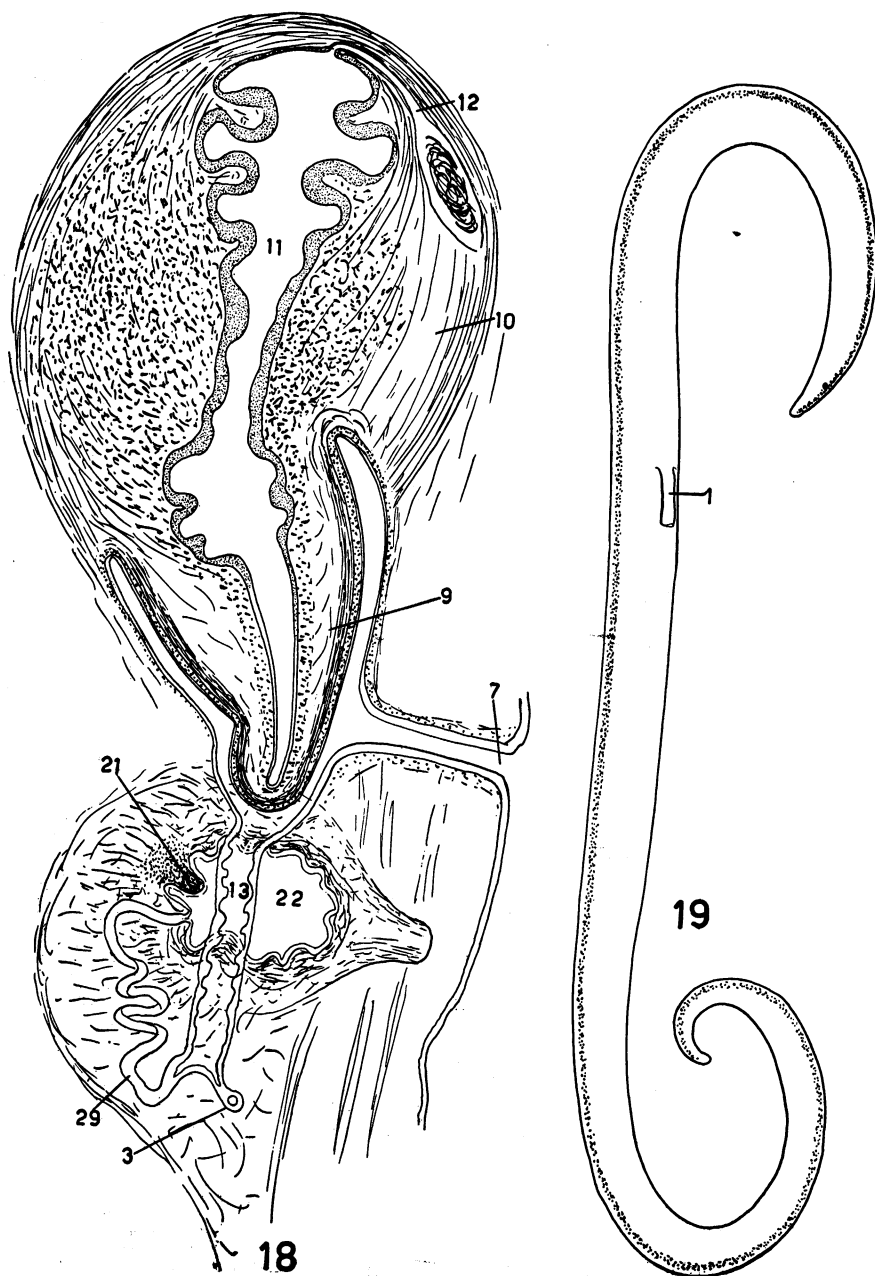


Fig. 18. Sagittal view of the copulatory apparatus of *Diporodemus indigenus*; the seminal bursa is really to the left of the median line; in this specimen the pore has closed.

Fig. 19. View of *Rhynchodemus*, sp. A, possibly *R. bosci* (Graff) from Madagascar.

Geodesminae, new name(= *Rhynchodeminae* Heinzel, 1929)**GEODESMUS** MECZNIKOW,¹ 1866Syn.: *Rhynchodemus* emend. Heinzel, 1929.**Geodesmus atrocyaneus** (Walton), 1912Syn.: *Rhynchodemus atrocyaneus* Walton, 1912.

Figures 13, 14

MATERIAL.—One set of serial sections labeled *Rhynchodemus atrocyaneus*, made by Walton; anterior end cut transversely, posterior part sagittally; immature. Nine specimens collected by Hubricht, all juvenile.

FORM.—Elongated, cylindroid (Fig. 14), 20 mm. or more in length, tapering slightly to either end; cross section oval anteriorly (Fig. 13) to circular through center of body; pharynx at about middle.

COLOR.—Stated by Walton to be a uniform dark blue; according to Hubricht is dark purple above when young, becoming black when older; white or light gray below; preserved specimens appear black above.

EYES.—Relatively small (Fig. 13) but fully differentiated; nearly as close to the surface as in *R. sylvaticus*, hence probably visible in life; easily seen in cleared mounted specimens. Section through the eyes also passes through the brain.

HISTOLOGY.—In the absence of sexual material, diagnostic histological details were sought, but nothing except subfamily characters was noted by studying Walton's series of sections. The somewhat thick epidermis contains numerous oval cells with granular contents, presumably gland cells. Beneath the epidermis is a thin stratum of transverse muscle fibers which appears to rest directly on the parenchyma. Longitudinal fibers, if present, are weakly developed, and there is no trace of the longitudinal bundles characteristic of *R. sylvaticus* and

americanus. Hence it is clear that *atrocyaneus* belongs to a different subfamily than these two species. The parenchymal musculature is well developed.

REPRODUCTIVE SYSTEM.—All available specimens were unfortunately immature so that at sexual maturity the worm must exceed 20 mm. in length. Walton's sectioned specimen is at the beginning of sexual maturity, with numerous ventrally located testes; cavity some distance behind pharynx indicates beginning of copulatory apparatus.

LOCALITY.—Type locality, Gambier, Ohio. Hubricht's specimens bore the following data: No. 2375, collected October 20, 1935, under log near Fountain Gap, Monroe County, Illinois, one fragment in bad condition; No. 2506, collected March 1, 1936, Glencoe, St. Louis County, Missouri, under log, two young specimens; No. 3502, collected April 11, 1937, under rock at Maltese, St. Louis County, Missouri, one young specimen, sectioned; No. 3907, collected August 19, 1937, side of Pine Mountain, Pineville, Bell County, Kentucky, one large specimen, slightly damaged, mounted whole; No. 5042, collected August 10, 1939, ten miles south of Gatlinburg, Sevier County, Tennessee, one large specimen in bad condition; No. 5594, collected July 7, 1940, in Mecker Cave, near Longtown, Perry County, Missouri, one intact specimen but much curled; No. 6771, collected September 6, 1942, Stair Bluff, Marion County, Arkansas, one fair-sized specimen in fair condition; No. 6872, collected November 14, 1942, under logs at base of bluff, Bliss, Washington County, Missouri, one small but perfect specimen, mounted whole.

SPECIMENS.—Walton's series of sections and whole mount, No. 3907, deposited in A.M.N.H., Cat. Nos. 303 and 299.

REMARKS.—This species cannot be fully known until a sexually mature specimen is available for study. There seems to be little doubt that Hubricht's specimens belong to this species. The above data indicate that the species is not uncommon in humid habitats, under logs, etc., in the central states.

¹ Usually anglicized to Metchnikoff; the spelling here employed is that of the original article.

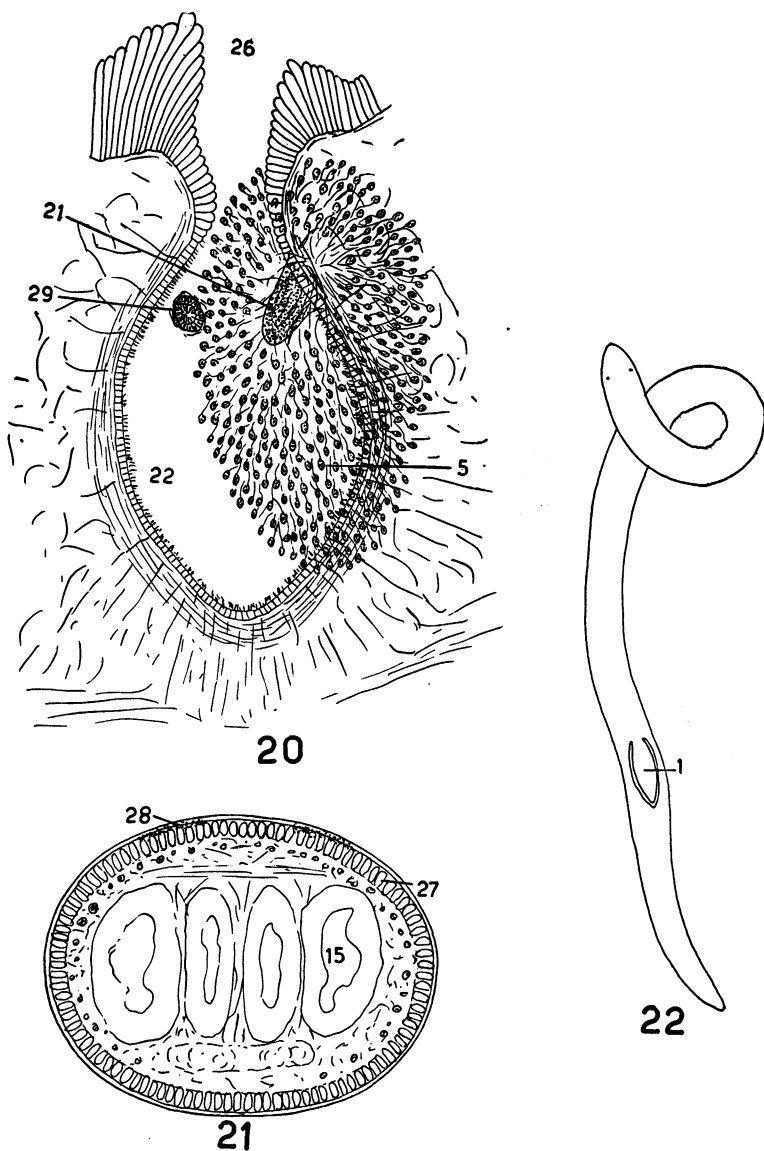


Fig. 20. Enlarged view of the seminal bursa of *D. indigenus*, showing genito-intestinal connection and cluster of gland cells.

Fig. 21. Transverse section of *Rhynchodemus*, sp. A, showing muscle bundles under epidermis and location of pigment stripes.

Fig. 22. *Rhynchodemus*, sp. B.

***Geodesmus terrestris* (O. F. Müller),
1774**

Syn.: *Fasciola terrestris* O. F. Müller, 1774.

Planaria terrestris O. F. Müller, 1776.

Rhynchodemus terrestris Leidy, 1851.

REMARKS.—In 1939, I reported on a single black cylindroid land planarian, 12 mm. long, which had been found in rotten wood in a forest near Oconomowoc, Wisconsin, in 1927. This animal was in full sexual maturity, but through an unfortunate mishap the set of serial sections made from it was seriously damaged so that identification was uncertain. I referred the animal to *Rhynchodemus terrestris*, a common European land planarian. After the discovery of *Diporodemus indigenus*, the new land planarian from the eastern United States, some suspicion arose in my mind that the Wisconsin worm might be this latter species, as the external appearance is closely similar. Reexamination of the fragmentary sections (kindly sent by the U. S. National Museum) failed to support this suspicion. The Wisconsin worm is clearly not identical with the new form, and the identification as *R. terrestris* may stand until new material is found.

DIPORODEMUS HYMAN, 1938

***Diporodemus indigenus*, new species**

Figures 15-18, 20

MATERIAL.—Five preserved specimens sent by the U. S. National Museum, collected by J. P. E. Morrison of that institution; two specimens collected by Hubricht.

FORM.—Stout, cylindroid, anterior end thicker than posterior, but this may be result of contraction on killing, both ends rounded (Fig. 15); section circular (Fig. 17); with evident broad creeping sole, narrowing anteriorly to a point, which forms a cleft in some specimens (Fig. 17); to 15 mm. long.

COLOR.—Grayish brown to black except creeping sole, which is of a lighter hue or white.

EYES.—Detectable only in sections (Fig. 17); very small and set deep in the interior near anterior termination of the sole.

HISTOLOGY.—Dorsal epidermis high, especially anteriorly (Fig. 17), diminishing in height posteriorly and ventrally; underlain by a subepidermal muscle stratum of outer circular and inner longitudinal fibers. The circular fibers are especially well developed anteriorly (Fig. 17); the longitudinal fibers are readily seen but show not the slightest tendency to aggregate into bundles. Zone of rhabdite-forming cells and

eosinophilous glands internal to subepidermal muscles. Parenchymal musculature shows usual longitudinal strands around intestine, especially below this structure where they form several thick strata.

The most interesting features of the histology are the glandular cleft and the cephalic sensory tracts. Glandular cleft on ventral surface of head is anterior end of creeping sole but does not form a cleft in all specimens, hence apparently a temporary structure due to muscle action. Cleft not well preserved in available material; appears to lack definite epithelial lining; forms elongated depression filled with glandular secretion (Fig. 17). Wall of cleft contains bodies of gland cells furnishing the secretion and internal to them well-developed muscle stratum continuous with regular subepidermal muscle layer. Internal to muscle layer run numerous nerves, branches from the cerebral ganglia.

Sensory tracts are two longitudinal bands on ventral surface of head, beginning just behind cleft, thus bounding the creeping sole (Fig. 16). Each tract consists of clear narrow cells apparently lacking cilia and having strong nervous connections (Fig. 16). These tracts obviously resemble those of *Diporodemus yucatani* Hyman, 1938, but the latter are depressed and ciliated.

REPRODUCTIVE SYSTEM.—Testes numerous, ventral. Sagittal view of copulatory apparatus in Fig. 18. Penis large, typical, composed of bulb and papilla. Swollen vasa deferentia filled with sperm enter muscular coat of penis bulb; each narrows quickly to slender duct which ascends and opens into anterior end of penis bulb. Latter has muscular coat, of outer fibers forming contour of bulb, inner thick mass of circular fibers. Lumen lined by tall glandular epithelium, more or less folded; lumen narrowed at about center of bulb where circular fibers are thickest. Penis papilla conical with thin surface epithelium, underlain by circular, then longitudinal fibers; lumen a narrow canal with thin epithelium, underlain by circular fibers. Male atrium not much larger than penis papilla, leads by narrowed canal ventrally to common genital pore. From rear wall of atrium, vagina with ruffled epithelium extends backward, receives oviduct from below and gives off above a narrow canal which pursues a sinuous course anteriorly, entering dorsal wall of seminal bursa. Latter is large sac narrowing ventrally and approaching ventral surface where it may open to exterior by pore. This pore found only in one of three sexual specimens sectioned; this one was not fully mature. Apparently, then, bursa opens to exterior only at beginning of sexual maturity and closes later. Opening is shortly behind common genital pore but to the left side, not in midventral line. Vagina, sinuous connecting canal and bursa are all enclosed in a muscular region separated from general parenchyma by thin muscle layer.

Seminal bursa (Fig. 20) lined by ciliated epithelium, underlain by muscle stratum form

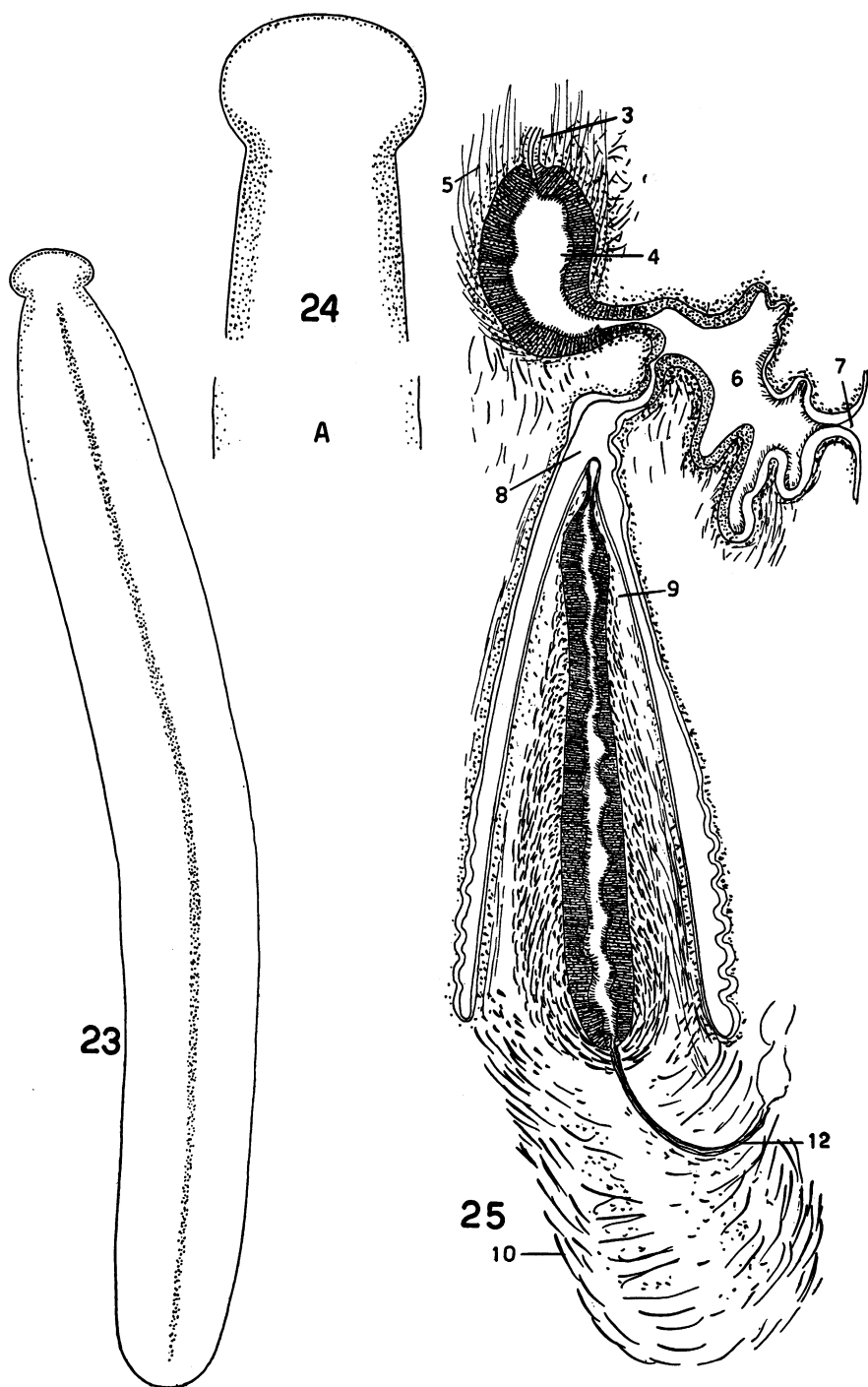


Fig. 23. *Bipalium adventitium*, type specimen, dorsal view.

Fig. 24. *Bipalium adventitium*, ventral view of anterior end, to show eye arrangement; A, region behind middle, showing eyes.

Fig. 25. Sagittal view of the copulatory apparatus of *Bipalium adventitium*.

ing its contour. Bursa opens above by wide aperture into the intestine. Connecting canal apparently corresponds to glandular duct of other rhynchodemids but here receives no glands. Instead the necks of an immense cluster of eosinophilous gland cells converge to a papilla opening into the dorsal wall of bursa near opening of connecting canal (Figs. 18, 20).

DIFFERENTIAL DIAGNOSIS.—*D. indigenus* is distinguished from other species of the genus by the presence of a genito-intestinal communication, lack of a typical glandular duct, cluster of gland cells opening directly into the seminal bursa on a papilla and closure of the external opening of the bursa in full sexual maturity.

LOCALITY.—Found in the Appalachian region, under logs, boards, in leaf mold, etc. The following are the records of the seven specimens so far found. U.S.N.M. No. 140883, Blue Ridge Mountains, West Virginia, near Charleston, at 800 feet elevation, September 22, 1935; U.S.N.M. No. 149034, in wet, very deep leaf mold, at 2920 feet elevation, on Negro Mountain, Garrett County, Maryland, July 23, 1938; U.S.N.M. No. 150650, under a board in a grassy pasture near Bolding's Spring, Staunton, Virginia, October 9, 1938; U.S.N.M. No. 157515, two specimens in deep leaf mold on heavily wooded slope in the Blue Ridge Mountains, Virginia, near Fort Royal, at 1830 feet elevation, August 25, 1940; No. A4403, in Hubricht collection, two specimens found near the Potomac River, near Georgetown, D. C., March 8, 1938. Dr. Morrison of the U. S. National Museum informed me in a letter that he had seen what he believed to be the same species under boards near stagnant water at Lexington, Kentucky, under a log at the margin of a swamp near Springfield, Illinois, and in the Turkey Run State Park, Indiana. The species apparently has a wide distribution, although few in numbers.

TYPE.—Set of serial sections, anterior end transverse, posterior end sagittal, made from No. 140883, deposited in U.S.N.M. No. 20616; paratype, whole mount, No. 149034, deposited in U.S.N.M. No. 20617; another whole mount deposited in A.M.N.H., Cat. No. 300.

REMARKS.—This is the third species of

Diporodemus to be found in the Americas. The first, *D. yucatan* Hyman, 1938, came from Yucatan and is distinguished by two ciliated cephalic grooves, the very muscular seminal bursa and the Beauchamp's canal between the glandular duct and the bursa. The second, *D. plen* Hyman, 1941, from Barro Colorado Island, Canal Zone, Panama, lacks cephalic sensory tracts, has a glandular cleft on the ventral side of the head and a thin-walled bursa without a Beauchamp's canal. The present species resembles *D. yucatan* in having cephalic sensory tracts and is like *D. plen* in the presence of a glandular cleft but differs from both in the genito-intestinal connection, the gland cluster opening on a papilla in the bursa and the closure of the bursa pore in later stages of sexuality. This last-named fact throws some doubt on the propriety of putting this species in the genus *Diporodemus* which was erected for rhynchodemids with an independent external pore for the bursa, but the fact that this pore does occur in early sexuality and the general other resemblances seem to justify the generic placing. In sexually mature specimens evidences of the bursa pore are still noticeable histologically in the lack of rhabdites at the site.

BIPALIIDAE

BIPALIUM STIMPSON, 1857

Bipalium kewense Moseley, 1878

Syn.: *Placocephalus kewensis* Graff, 1899.

REMARKS.—As is well known this species is cosmopolitan, having become established out of doors in many localities in tropical and subtropical countries, and in greenhouses and conservatories in the temperate zones, where, however, it never becomes sexually mature. Specimens for identification have been received as follows: greenhouses of the U. S. Department of Agriculture at New Orleans, Louisiana, and Washington, D. C., also greenhouses at Encanto, California, Jersey City, New Jersey, Urbana, Ohio, and Savannah, Georgia, sent by the U. S. National Museum; conservatory in Washington

Park, Chicago, and Dreer's greenhouses at Riverton, New Jersey, sent by Hubricht. Specimens have also been taken out of doors in Puerto Rico, near Silver Springs, Florida, and in New Orleans and Baton Rouge, Louisiana. It may be expected that this species will become common in gardens and plantations in the West Indies, Florida and California. This worm is also common in the Hawaiian Islands and in the tropical parts of South America. I recently published some notes and drawings of the species (Hyman, 1939). It is easily recognized by the lunate head and the five dark stripes, purple to black, on a yellow, olive or grayish ground; the broad lateral stripes meet the narrow marginal stripes to form a characteristic dark patch at the "neck" of the animal, on each side. Preserved specimen from New Orleans deposited in A.M.N.H., Cat. No. 301.

***Bipalium adventitium*, new species**

Figures 23-25

MATERIAL.—One specimen sent by M. W. de Laubenfels, and three specimens sent by J. L. Mohr.

FORM.—Elongate, flattened, may reach 75 mm. in length extended, head said to be fan-shaped in life, in preserved specimens is rounded and contracted (Figs. 23, 24), posterior end rounded.

COLOR.—Light brown above with a dark brown middorsal stripe, not extending onto the head (Fig. 23); color may be lost on preservation.

EYES.—On dorsal side (Fig. 23), the eyes occur in a single row around the anterior margin of the head, become more numerous at the "neck," then proceed along the body margin

for a short distance, reducing to a single row which soon dies out. Ventrally (Fig. 24, 24A), eyes continue along the whole length of the body margin but the band gradually diminishes posteriorly (Fig. 24A).

COPULATORY APPARATUS.—Typical of the genus; sagittal view in Fig. 25. Penis consists of muscular bulb, mainly of dense cross fibers, and of elongated conical papilla. Vas deferens ascends through muscles of penis bulb and enters proximal end of penis lumen, which forms an elongated seminal vesicle. Lumen lined by tall ciliated glandular epithelium, outside of which is thick muscle layer, chiefly of circular fibers. Penis papilla covered by flat epithelium under which is thin stratum of transverse muscular fibers followed by a few longitudinal fibers. The same layers continue as wall of male atrium, an elongated chamber fitting closely to penis papilla. Narrow canal connects male atrium with common genital atrium, of irregular form with folded walls, lined above by glandular, below by non-glandular ciliated epithelium. From roof of common atrium there leads an oval chamber which curves posteriorly and receives oviducts into its posterior end. This chamber apparently represents the glandular duct and is so called in the literature on *Bipalium*. It is lined by a ciliated glandular epithelium of very tall narrow cells underlain by a layer of muscle fibers, mostly transverse. The glands which open through the epithelium were not very evident but appeared to be situated posterior to the organ and to open through the epithelium by long ducts, represented by lines in Fig. 25.

DIFFERENTIAL DIAGNOSIS.—Color pattern, eye arrangement and details of the copulatory apparatus are diagnostic.

LOCALITY.—Garden, Pasadena, California; campus of the University of California, Berkeley, under boards; introduced, original habitat unknown.

TYPE.—Whole mount deposited in A.M.N.H., Cat. No. 302.

NECESSARY CHANGES OF NAMES IN THE RHYNCHODEMIDAE

In 1851, Leidy created the genus *Rhynchodemus* for an endemic United States land planarian which he had previously called *Planaria sylvatica*. Into the genus *Rhynchodemus*, Leidy also placed the European land planarian *Planaria terrestris* (O. F. Müller), 1774, but with a question mark. In 1929, Heinzel declared *Planaria terrestris* to be the type of the genus *Rhynchodemus*. This is unacceptable, for the International Rules declare

(Art. 30, II, e), "The following species are excluded from consideration in determining the types of genera: species which the author of a genus doubtfully referred to it." As Leidy included *terrestris* in *Rhynchodemus* with a question mark it is clear that he was doubtful of its belonging to this genus. Hence it is incontrovertible that *R. sylvaticus* must be the type of the genus *Rhynchodemus*.

The sexual anatomy of *R. sylvaticus*

was, however, unknown up to the present publication. Hence it was not possible to erect a proper definition of the genus *Rhynchodemus*. Because of this, large numbers of species of variable sexual anatomy have been thrown into the genus. In 1929, Heinzel attempted to remedy this situation. He showed that the Rhynchodemidae are divisible into two groups of genera, those in which the subepidermal longitudinal layer is weak and not formed into bundles and those in which it is strong and the fibers are aggregated into bundles. For those species having such bundles which had previously been put into *Rhynchodemus*, Heinzel created the genus *Desmorhynchus*, and he allotted the genera to two subfamilies, the Rhynchodeminae without, and the Desmorhynchinae with, such longitudinal bundles. The general histological picture presented by a cross section of a desmorhynchine rhynchodemid is well shown in Pl. XLIV, figs. 5-7 of von Graff's classical monograph of the land planarians (1899).

However, as shown in this article, *Rhynchodemus sylvaticus* has these longitudinal muscle bundles; in short, it corresponds to Heinzel's definition of the genus *Desmorhynchus*. But, as just shown, *R. sylvaticus* is the type of the genus *Rhynchodemus*. Hence *Desmorhynchus* becomes a synonym of *Rhynchodemus*, and the subfamily name Desmorhynchinae can no longer be retained. As it would cause confusion to apply the name Rhynchodeminae to this subfamily, for Heinzel used this name for the other subfamily, it has seemed best to me to form the subfamily name of another genus of this group. Hence I propose the subfamily name Dolichoplaninae for rhynchodemids in which the subepidermal longitudinal muscle layer is arranged in bundles.

It now becomes necessary to find an available generic name for those species previously put in the genus *Rhynchodemus* which lack these muscle bundles. The next available name appears to be *Geodesmus* Meczniow, 1866. Meczniow created this name for a European land planarian, *Geodesmus bilineatus*. Although the anatomy of this species is not too well known,

Kennel (1882) added considerably to the original description and above all gave a sagittal view of the copulatory apparatus. It seems clear enough from the available material that *G. bilineatus* lacks the longitudinal muscle bundles and has a large and typical penis papilla, hence belongs to the second subfamily. As the generic name *Geodesmus* appears to be valid, I propose for this subfamily, which lacks longitudinal muscle bundles under the epidermis, the name Geodesminae. Into the genus *Geodesmus* must be transferred *Rhynchodemus terrestris* and all other species previously put into *Rhynchodemus* which lack the bundles in question. The arrangement of the Rhynchodemidae then becomes the following.

Subfamily Dolichoplaninae

(= Desmorhynchinae Heinzel)

Rhynchodemidae with strong subepidermal musculature of which the longitudinal layer is arranged into bundles conspicuous in transverse section. Mostly of elongated form, anterior end often flattened; eyes well developed. Penis papilla small or lacking; masculine antrum hence relatively large, bounded by a muscle stratum. Female apparatus simple, without bursa seminalis or genito-intestinal connection.

Genus *Rhynchodemus* Leidy, 1851. Syn. *Desmorhynchus* Heinzel, 1929. Body slender, mostly oval in section, without peculiarities of parenchymal musculature or nervous system. Type, *Planaria sylvatica* Leidy, 1851.

Genus *Dolichoplana* Moseley, 1877. Elongate but flattened, cross section broad, flattened with median dorsoventral indentation; parenchymal longitudinal muscle fibers occur only ventral to the intestine. Heinzel declared *D. feildeni* Graff, 1899, to be the type of *Dolichoplana*. This again is contrary to the International Rules which state (Art. 30, I, c), "A genus proposed with a single original species takes that species as its type." Hence it is clear that *D. striata* Moseley, 1877, must be the type of *Dolichoplana*. Anyway, it is

practically certain that *D. feildeni* is conspecific with *striata* (see Beauchamp, 1929; Hyman, 1940a).

Genus *Platydemus* Graff, 1896. Cross section broad, flattened, nerve cords plate-like. Heinzel selected *P. grandis* (Spencer), as the type, and this selection appears to be valid.

Subfamily Geodesminae

(= Rhynchodeminae Heinzel)

Rhynchodemidae with weak subepidermal musculature of which the longitudinal fibers are inconspicuously developed and are not aggregated into bundles. Mostly of short, plump, cylindroid form; eyes may be small or retrogressed. Copulatory apparatus often complicated; male apparatus with a well-developed, often large penis papilla; female apparatus with or without seminal

bursa, may have genito-intestinal connection, bursa may have more than one exit.

Genus *Geodesmus* Mecznirow, 1866. Syn. *Rhynchodemus*, part. With or without seminal bursa; this has only one exit. Type, *G. bilineatus* Mecznirow, 1866.

Genus *Artiocotylus* Graff, 1896. Seminal bursa very large; has two exits, one to female canal, other to common genital atrium. Type, *A. speciosus* Graff, 1896.

Genus *Pseudartiocotylus* Ikeda, 1911. Because of the incomplete nature of the original description, this genus cannot be defined at present. Type, *P. ceylonicus* Ikeda, 1911.

Genus *Diporodemus* Hyman, 1938. Seminal bursa well developed, has two exits, one (Beauchamp's canal) to female canal, other to exterior, forming a genital pore (lateral, not in median line) in addition to usual common genital pore. Type, *D. yucatani* Hyman, 1938.

SUMMARY

1. Three exotic land planarians have established themselves out of doors in California and are reproducing sexually. These are *Geoplana mexicana* Hyman, 1939, *G. vaga*, new species, and *Bipalium adventitium*, new species. The sexual anatomy of all three species is herein described.

2. In addition, various other exotic land planarians have been found in greenhouses in the United States. The most common ones are *Dolichoplana striata* and *Bipalium kewense*. The latter is also established out of doors in Louisiana and southern Florida.

3. The anatomy of the North American endemic land planarian, *Rhynchodemus sylvaticus* Leidy, 1851, is described for the first time, and it is shown that this species has the anatomy of the genus *Desmorhynchus* Heinzel, 1929. As *R. sylvaticus* is the type of the genus *Rhynchodemus*, *Desmorhynchus* becomes a synonym of *Rhynchodemus*. This necessitates changes in the subfamily names of the Rhynchodemidae. Dolichoplaninae is proposed in place of Desmorhynchinae Heinzel and Geodesminae in place of Rhynchodeminae

Heinzel. *Geodesmus* Mecznirow, 1866, is the next available name for species previously put in the genus *Rhynchodemus* which do not agree with *R. sylvaticus* in general anatomy.

4. Three other endemic North American land planarians are described: *Rhynchodemus americanus*, new species, *Geodesmus atrocyaneus* (Walton), 1912, and *Diporodemus indigenus*, new species. The first closely resembles *R. sylvaticus* in general appearance and sexual anatomy. Of the second, not again recorded since the original description, a number of specimens were taken in the central states. Unfortunately no sexually mature specimen has been found. The third species occurs throughout the Appalachian region in humid habitats and is a very interesting form with several peculiarities of the sexual complex.

For All Figures

1, pharynx; 2, copulatory apparatus; 3, oviduct; 4, glandular duct; 5, gland cells opening into glandular duct; 6, common genital atrium; 7, common genital pore; 8, male atrium; 9, penis papilla; 10, penis bulb; 11, seminal vesicle; 12, vas deferens; 13, female atrium; 14, penis; 15, intestine; 16, brain; 17, eye;

18, glandular cleft; 19, nervous tissue; 20, rhabdite-forming cells; 21, glandular papilla; 22, seminal bursa; 23, ciliated tracts; 24, sensory tract; 25, creeping sole; 26, genito-intes-

tinal opening; 27, longitudinal muscle bundles; 28, pigment stripes; 29, connecting canal from female atrium to seminal bursa; 30, glandular tract; 31, yolk gland.

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