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A NEW FAMILY, GENUS, AND SPECIES OF CAVE-ADAPTED PLANARIAN FROM MEXICO (TURBELLARIA, TRICLADIDA, MARICOLA)

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The purpose of this paper is to describe a unique triclad turbellarian representing a new family, genus, and species living as a troglobitic marine relict in the freshwaters of a cave, Las Grutas de Coconá, in the Mexican state of Tabasco.

Class **TURBELLARIA**

Order **TRICLADIDA**

Suborder **MARICOLA** (= **RETROBURSALLIA**)

Family **DIMARCUSIDAE**, new family

Definition.—Aquatic triclad turbellarians having two gonopores, one the usual common gonopore, the other a posterior, midventral bursal pore; copulatory bursa lying posterior to penis; ovaries anterior; ovovitelline ducts separately entering a dorsal, tubular diverticulum of the bursal stalk; sperm ducts uniting to form a common duct before entering the penis bulb.

Type genus.—For the type and only known genus, we propose the name:

Dimarcus, new genus

Definition.—Dimarcusidae of normal body form; white, eyeless troglobites; head essentially rounded, lacking auricles; an adhesive slit anteroventrally on head; testes numerous, extending throughout the length of the body; penis normal, consisting of bulb and papilla; the two sperm ducts uniting to form a common duct prior to entering penis bulb and bulbar cavity; ovaries in the usual anterior position; two

midventral gonopores, one opening into the common antrum, the other into the copulatory bursa; copulatory bursa posterior to the penis; oovittelline ducts separately entering a dorsal, tubular diverticulum of the bursal stalk.

Etymology.—The generic name is formed by adding the Greek *di* meaning two to the proper name Marcus. We take pleasure in naming this genus after the late Dr. Ernst Marcus and his wife Eveline du Bois-Reymond Marcus of the Universidade São Paulo, Brazil, in honor of their invaluable contributions to the systematics of Turbellarians.

Type Species.—The type and only known species is named and described as follows:

***Dimarcus villalobosi*, new species**

Type series.—Holotype, a set of serial sagittal sections (1149c, 2 slides), deposited in the Division of Worms, the U.S. National Museum. Five paratypes also deposited in the U.S.N.M., two sets of serial sagittal sections (1149e, 2 slides; 1149m, 2 slides), one set of serial frontal sections (1149w, 3 slides), one set of serial transverse sections (1149x, 5 slides), and one whole mount (1149y). Two other paratypes deposited in the National Science Museum (Department of Zoology), Tôkyô, one a set of serial sagittal sections (1149n, 2 slides), the other a whole mount of a prepharyngeal piece (1149v') and a set of serial sagittal sections of the postpharyngeal piece of the same specimen (1149v, 2 slides). The remaining paratypes are retained by the authors (Mitchell's laboratory at Texas Tech University and Kawakatsu's laboratory at Fuji Women's College). These include 17 specimens represented by serial sagittal sections (1149a, b, d, f-l, o-u) and two whole mounts (1149z and aa). All specimens constituting the type series were taken in Las Grutas de Coconá, Teapa, Tabasco, México, on 26 August 1972 by Robert W. Mitchell, Rexell Mitchell, and William H. Russell.

Description.—A small, slender, delicate, unpigmented, eyeless troglöbite (appearance in life is shown in Figs. 1, 2, 4, 5); body white when unengorged, especially that portion containing the intestine; margins of the body translucent (Fig. 1); gut contents of engorged animals readily visible through integument; ventral side appears somewhat more translucent than dorsal side. In general appearance, this species bears some superficial resemblance to some white subterranean species of *Phagocata*, such as *Phagocata albata* Ichikawa and Kawakatsu, 1962, from Hokkaidô in northern Japan.



FIG. 1.—*Dimarcus villalobosi* in life. Note the slight protrusion of the anterior margin of the head, the absence of auricles, the translucent whiteness of that part of the body containing the gut, the transparency of the head and body margins, and the partly visible pharynx, penis, and copulatory bursa.

Fully mature, living specimens measure about 6 to 8 millimeters in length and 0.8 to 1 in width. The head is not elaborate and is without auricles (Figs. 1, 2). In quietly gliding animals, the anterior end is

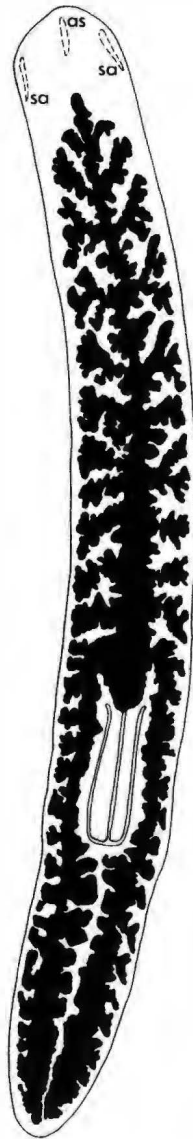


FIG. 2.—Drawing from photograph of a gliding specimen showing primarily the intestine and its nonanastomosing diverticula. The illustrations in this paper employ the following symbols: as, adhesive slit; bc, bulbar cavity; bp, bursal pore; bs, bursal stalk; bsd, bursal stalk diverticulum; cb, copulatory bursa; cg, cement gland; cgp, common genital pore; csd, common sperm duct; ed, ejaculatory duct; m, mouth; ma, male antrum; od, ovovitelline duct; pb, penis bulb; ph, pharynx; pp, penis papilla; sm, sperm mass; sv, spermiducal vesicle; t, testes.



FIG. 3.—Ventral view of preserved specimen showing locations of mouth and two genital pores.

FIG. 4.—Living individual in early stage of leechlike movement. Adhesive slit has just attached and body is being drawn forward expanding the head.

FIG. 5.—Individual in later stage of leechlike movement. Body is drawn well forward greatly expanding the head.

slightly protruded and the anterolateral corners slightly projected, but rounded (Fig. 1). Clear sensory areas of a willow leaf shape occur laterally on each side of the head (Fig. 2). There is no "neck" or narrowing of the body behind the head. Posterior to the head the body widens, quickly reaching its greatest width. The body margins then run parallel to each other to about the level of the mouth and copulatory apparatus where they again begin to converge, meeting in a rather pointed posterior end. In mature animals, the pharynx is situated behind the middle of the body, and the mouth is located at the posterior end of the pharyngeal chamber. The copulatory apparatus

occupies the mid-portion of the postpharyngeal region. The common gonopore lies at the beginning of the middle one-third of the postpharyngeal region, and the bursal pore at the beginning of the last one-third of this region. Both of these pores are more readily visible in preserved specimens (Fig. 3) than in living ones.

This species is capable of two distinct types of locomotion: normal gliding, which is very rapid, and a leechlike movement permitted by an adhesive zone located anteroventrally on the head. When the adhesive device is attached to the substrate and the body drawn forward, the head assumes an expanded shape (Figs. 4, 5). The adhesive organ is a shallow concavity, appearing in living animals as an indistinct, opaque, short, longitudinal area or zone (Figs. 2, 6) for which the term adhesive slit is descriptive.

The anterior trunk of the intestine bears 10 to 15 pairs of rebranching diverticula, and each posterior trunk bears 15 to 20 similar, but shorter, branches (Fig. 2). No intestinal anastomoses were seen in any of several living and preserved specimens examined. In some specimens, coagulated masses of spermatozoa were found in the lumen of the pharynx (Fig. 7) or in the intestine or both. Histologically, there is no evidence to suggest that these spermatozoa entered the gut from the sperm ducts as has been reported to occur in a Japanese dendrocoelid, *Bdellocephala brunnea* (see Teshirogi, 1952), nor does *D. villalobosi* possess a gastrointestinal canal as do several other species of triclads. Perhaps an excess sperm mass is discharged from the bursal pore after copulation, then to be taken up by the pharynx.

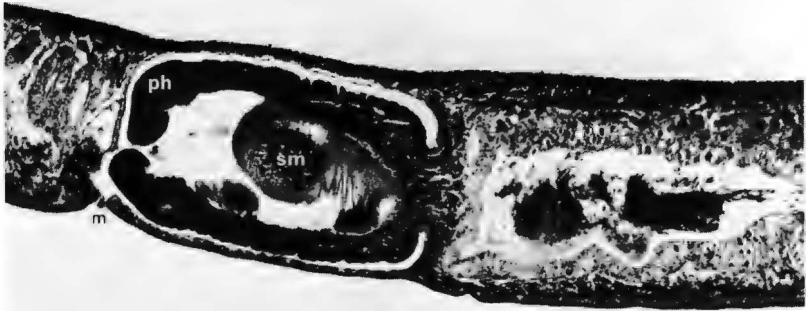
The dorsal epidermis is thicker than the ventral and also contains more rhabdites. The adhesive slit appears as a slightly sunken area of nonciliated epithelium (Fig. 8). The area around the adhesive slit is provided with feeble gland ducts containing a coarsely granular, strongly eosinophilic secretion. The adhesive slit is not provided with a musculature. It is similar to an adhesive area represented by a caved-in epithelium in *Phagocata albata* (Ichikawa and Kawakatsu, 1962:31, Fig. 2). As a distinct structure, however, it is better differentiated in *D. villalobosi*. Further, it seems to be similar to, but smaller than, an anterior adhesive zone in *Rhodax evelinae* Marcus, 1946.

A pair of small ovaries occurs ventrally between the fourth or fifth lateral branches of the anterior intestinal trunk. The two ovovitelline ducts converge at the posterior level of the penis, then bend upward, finally to enter separately, and subterminally, into the distal end of a dorsal, tubular diverticulum of the bursal stalk (Fig. 9). Yolk glands occur along each side of the body from their beginning just anterior to the ovaries.

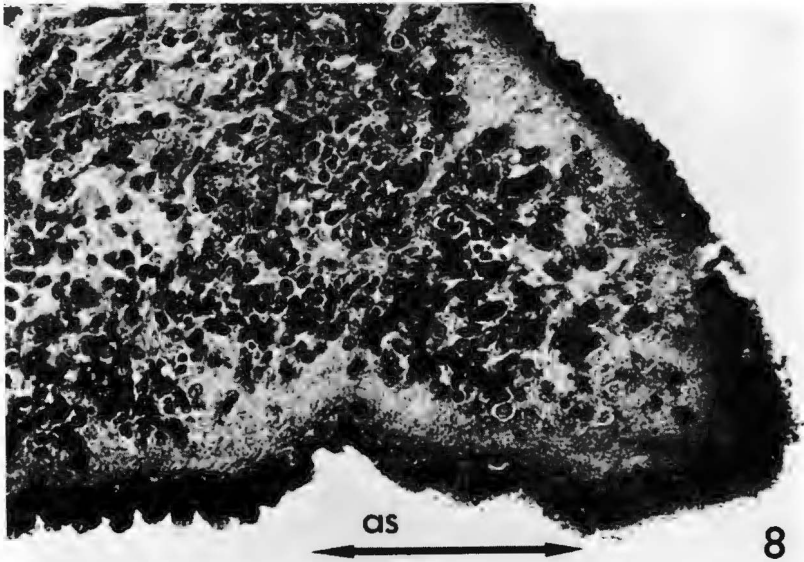


FIG. 6.—Ventral view of anterior end of a whole mount showing the adhesive slit.

The testes are numerous, of small size, and for the most part situated ventrally. They are arranged in longitudinal zones occurring on each side of the body. These zones extend from a level just posterior to the ovaries almost to the posterior end of the body. In both of the outermost rows of these zones, the testes often occupy the greater part of the dorsoventral space in the parenchyma between the intestinal diverticula (Fig. 11). The more medial testes are entirely ventral (Fig. 12). In large, fully mature specimens, the testes apparently number 300 or more in each longitudinal zone. The sperm ducts form remarkably developed spermiducal vesicles (Fig. 13) packed with spermatozoa from a level near the posterior part of the pharynx to the anterior level of the penis bulb. On the posterolateral sides of the



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FIG. 7.—Midsagittal section through pharynx showing coagulated sperm mass in lumen of pharynx.

FIG. 8.—Midsagittal section of anterior end showing the adhesive slit.

penis bulb each spermiducal vesicle ascends through the bulb finally to curve posteroventrally. They then converge in the posterior part of the penis bulb uniting to form a single, slender duct that continues on into the bulb to open into the bulbar cavity (Fig. 9).

The two gonopores and the posterior bursa (Figs. 3, 9) immediately point up the singular nature of this triclad. The common gonopore

leads immediately into a small cavity representing the common genital antrum. Posterodorsally, this space continues with the narrow, terminal part of the bursal stalk; anterodorsally, it communicates with the male antrum, a narrow, conical cavity, wide anteriorly and tapering toward the common antrum. The walls of both common and male antra are clothed with a tall, glandular, nucleate epithelium below which occur two muscle layers, an outer one of circular fibers and an inner one of longitudinal fibers. The epithelial cells of the roof of the common antrum are much taller than are those of the male antrum (Figs. 9, 10).

The penis consists of a very large, oval-shaped bulb and a small, short, conical papilla (Figs. 9, 10) of a moderately asymmetrical shape. The fibers of the muscular coat of the bulb are arranged in concentric layers. The bulb contains a moderately wide, elongated, oval-shaped cavity of irregular outline, the bulbar cavity. The cavity continues into the papilla as a narrow, short ejaculatory duct that opens on the ventral side of the papilla (Figs. 9, 10). There is no diaphragm between the bulbar cavity and the ejaculatory duct. The penis lumen is lined with a tall, glandular, nucleate epithelium, which is much more prominently developed in the bulbar cavity than in the ejaculatory duct. This epithelium is accompanied beneath by two muscle layers, an outer one of circular fibers and an inner one of longitudinal fibers. The bulbar cavity receives the common sperm duct immediately at its anterior end. Penis glands are weakly differentiated. The asymmetrical papilla is covered with a low, cuboid, nucleate epithelium, below which is a layer of circular muscle fibers followed by a layer of longitudinal ones.

The copulatory bursa is a large sac of smooth, rounded form (Figs. 9, 10) located some distance posterior to the common gonopore. Anteriorly, the bursa connects with a narrow duct of near uniform diameter, the bursal stalk, which runs anteroventrally along the midline of the body, finally to open posterodorsally into the roof of the common genital antrum (Figs. 9, 10). The bursal stalk widens slightly in its midportion where it gives rise to a dorsal, tubular diverticulum that receives the ovovitelline ducts. The canal of the stalk is lined with a glandular epithelium and contains circular and longitudinal muscle fibers. The terminal part of the bursal stalk diverticulum is provided with strongly eosinophilic shell glands. Numerous eosinophilic glands (probably cement glands) open into the common genital antrum near its gonopore.

The copulatory bursa (Figs. 9, 10) contains a moderately wide cavity, which opens by a small midventral pore, the bursal pore. The short tube that connects the posteroventral part of the bursa with the

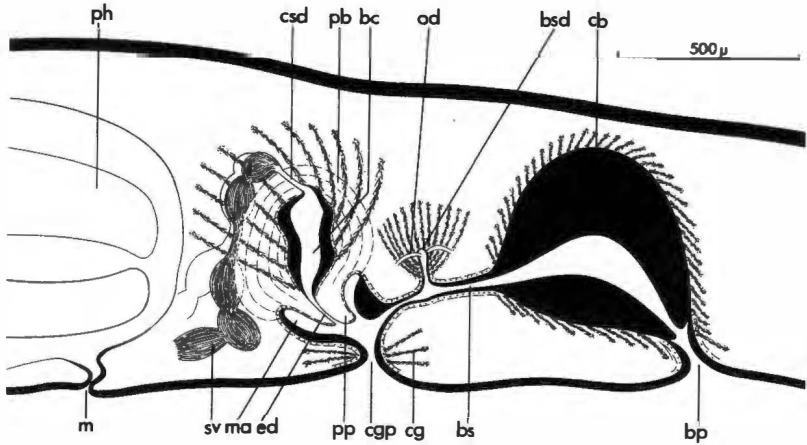


FIG. 9.—Semidiagrammatic midsagittal view of the copulatory apparatus constructed chiefly from the holotype.

pore probably represents a canal for discharge of excess spermatozoa. The internal wall of the bursa is lined with a very tall, highly glandular epithelium (Fig. 10). Surrounding this epithelium is a slight musculature. The bursa is encircled by numerous, long-necked, feebly cyanophilic glands. The distal portions of the epithelial cells of the copulatory bursa are filled with fine eosinophilic granules. Many feebly eosinophilic gland cells occur in the adjacent parenchyma.

Some variability was encountered in the genital anatomy of the several specimens examined in section, a large part of which was due no doubt to differing states of sexual maturation. Almost all specimens showed the penis in various degrees of differentiation. A fully developed copulatory bursa was found in many specimens, but in individuals not fully matured, this structure was represented as a narrow, blind tube or a small blind sac. The mature bursa with pore occurred in 12 of 24 specimens examined, 1149a, c, e, g, j, m, n, o, s, v, w, and x.

The egg capsule, or cocoon, of this species is not known.

Affinities.—So distinctive is *Dimarcus villalobosi* in its posterior copulatory bursa with posterior, midventral bursal pore that none of the families of aquatic triclads, as presently defined, can contain it. Following is a listing of these families with the particular characteristics of each which preclude that group from receiving our new species:

Planariidae (Kenk, 1930 emend.): A single genital opening, the common gonopore. Copulatory bursa anterior to the penis bulb.

Kenkiidae Hyman, 1937 (referred to the Planariidae by Mitchell, 1968): As in the preceding family, a single genital opening and an anterior bursa.

Dendrocoelidae (Kenk, 1930 emend.): As in the preceding families, a single genital pore and an anterior bursa.

Procerodidae (Holmquist and Karling, 1972 emend.): A single genital opening, the common gonopore.

Bdellouridae Diesing, 1862: Two copulatory bursae and three genital pores including a pore for each bursa and a common gonopore.

Uteriporidae Wilhelmi, 1909: Copulatory bursa anterior to the penis bulb. Bursal pore, when present, anterior to the common gonopore.

Probursidae Hyman, 1944 (referred to the Uteriporidae by de Beauchamp, 1961): A single genital opening, the common gonopore; copulatory bursa anterior to the penis bulb.

Nesionidae Hyman, 1956 (referred to the Procerodidae by de Beauchamp, 1961): Two genital openings, a common gonopore and a mid-dorsal bursal pore.

Nexilidae Holleman and Hand, 1962: Common ovovitelline duct entering the penis bulb.

The current arrangement of the preceding families places the first three in the suborder Paludicola (= Probursalia) and the remainder in the Maricola (= Retrobursalia), but Holmquist and Karling (1972) recently questioned this scheme. *Dimarcus villalobosi* can now be added to that growing number of species that surely will lead to the rearrangement of the Tricladida. For the present, however, we follow Holmquist and Karling's retention of Maricola and Paludicola for the sake of convenience, but suggest that the time has come for a detailed review of the Tricladida.

We have given the Dimarcusidae a somewhat narrow definition even though we realize that monotypic triclad families have not fared well. Most have been referred to other families (e.g., the Probursidae and the Nesionidae), or other species have been "forced" into them (e.g., the Uteriporidae). Surely the number of contained species is not necessarily germane to the problem of justifying higher taxa. Although the sole purpose of this paper is to describe *Dimarcus villalobosi*, our examination of the pertinent literature led us to some opinions that should be expressed. The most general opinion is that triclad heterogeneity is not reflected at the familial level. Probursidae and Nesionidae probably should be reinstated, whereas Uteriporidae should be returned to its monotypic status. Nesionidae should remain monotypic, whereas certain species now assigned to other families could be trans-

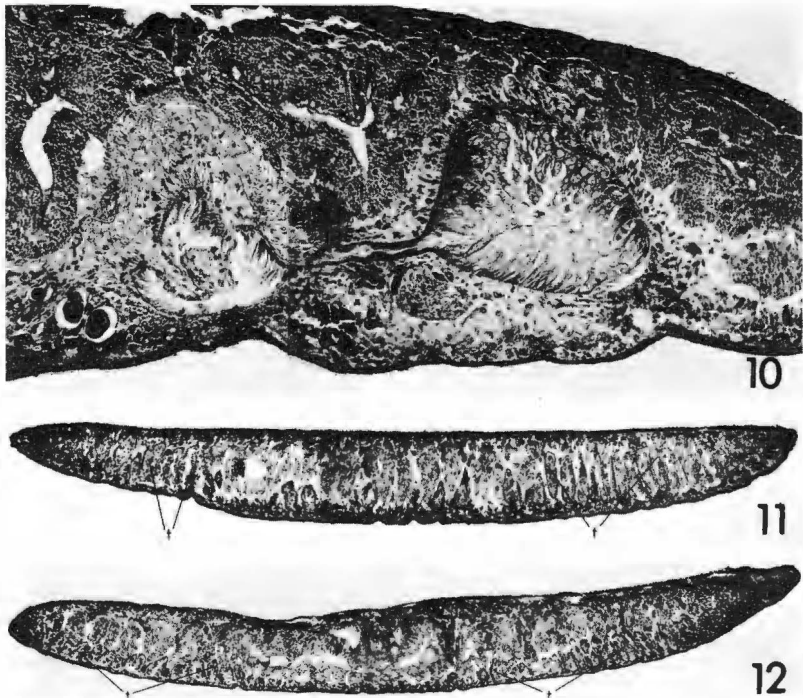


FIG. 10.—Near midsagittal section of the copulatory apparatus of the holotype.

FIG. 11.—Sagittal section near body margin showing occurrence of testes in the greater part of the dorsoventral space between intestinal diverticula.

FIG. 12.—Sagittal section, more medial than that of Fig. 11, showing ventral location of the testes.

ferred easily to Probursidae. Surely a good argument could be made that at least a few justifiable families are masquerading presently under the Procerodidae.

It might seem that *D. villalobosi* is most closely related to *Nesion arcticum* Hyman, 1956. This is apparently the only other aquatic triclad having a single posterior bursa with an external communication. In *N. arcticum*, however, the bursal pore is middorsal. It also differs strikingly from *D. villalobosi* in having a strongly recurved bursal stalk, an exceedingly long and slender penis papilla, and sperm ducts that enter separately into the penis papilla, rather than the penis bulb. If there are affinities between these two species, they seem not to be too close.

These latter two planarians may be used to illustrate a cogent point. Perhaps we could have ignored a few structural features and placed

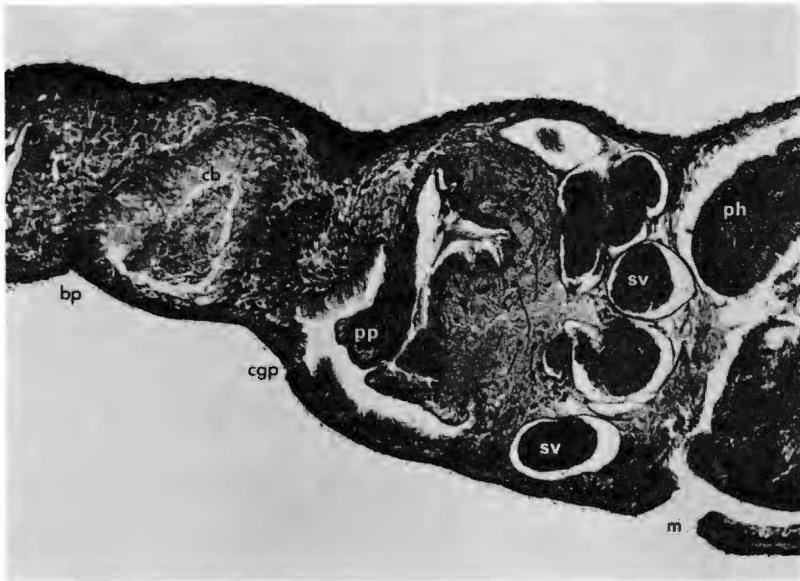


FIG. 13.—Near midsagittal section of the copulatory apparatus showing especially the great development of the spermiducal vesicles.

D. villalobosi into the Nesionidae in the same way as *Probursa* and *Centrovarioplana* were moved to the Uteriporidae. However, the Nesionidae has been referred to the Procerodidae (de Beauchamp, 1961), thus *D. villalobosi* would have come to rest in a group of animals from which it is distinct. Such is the present state of triclad, especially “maricolan,” systematics.

Also, it might be suggested that *D. villalobosi* is related to *Bopsula evelinae* Marcus, 1946, inasmuch as the latter is the only other freshwater triclad having two distinct genital pores. In these two species, however, the “secondary” genital pores are entirely nonhomologous, among such other distinct differences as the anterior bursa of *B. evelinae*.

D. villalobosi seems most closely related to *Rhodax evelinae* Marcus, 1946. Similarities of *R. evelinae* to *D. villalobosi* include a small anterior adhesive “zone,” yolk glands extending anterior to the ovaries, a “common ovovitelline duct” that appears from Marcus’ drawing to be instead a diverticulum of the bursal stalk, fusion of the sperm ducts prior to entry into the penis bulb, and a posterior bursa. Differences include features of *R. evelinae* such as ventral fusion of the testes to form a continuous tube, an extrapenial “seminal vesicle,” and a gastrointestinal canal rather than an exterior bursal pore. We

regard the latter characteristic alone as sufficient to preclude classifying these two planarians in the same family. Although *Rhodax* probably should be accorded familial status, nevertheless, *R. evelinae* and *D. villalobosi* appear to be each other's closest relative.

No problem is posed by the occurrence of a "marine" planarian in the freshwaters of Las Grutas de Coconá. This planarian is simply a marine relict, which probably colonized the cave waters directly from marine waters with recession of the sea from this low-lying part of México. Also inhabiting these cave waters is a relict marine amphipod, *Bogidiella tabascensis* Villalobos, 1960. Las Grutas de Coconá lies at about the same elevation as do the caves of the Yucatán Peninsula where marine relicts constitute a large percentage of the aquatic troglobite fauna. There is no doubt that *Rhodax evelinae*, occurring in a variety of freshwater habitats in the vicinity of São Paulo, Brazil, also is a marine relict.

Dimarcus villalobosi becomes the third troglobite planarian known from México. It joins two entirely different species of the genus *Dugesia* that are to be described by Mitchell and Kawakatsu (in press) from caves of the Sierra de Guatemala of Tamaulipas.

Distribution.—Known only from the type locality.

Etymology.—The specific name is derived from the proper name Villalobos. We take pleasure in naming this distinctive planarian after Dr. Alejandro Villalobos of the Instituto de Biología, Universidad Nacional Autónoma de México, in recognition of his discovery of the animal (Villalobos, 1960).

Materials and methods.—Thirty-two specimens of this planarian were collected. Immediately after color photographs were made of several individuals in the field, 25 were killed and fixed in standard Bouin's fluid at ambient temperature. They remained in this fluid for approximately two weeks, after which time they were transferred to 70 per cent ethyl alcohol. Seven specimens were returned alive to the laboratory of the senior author and two were subsequently sent alive to the laboratory of the junior author. After study, the latter two individuals were killed and fixed in Sugino's fluid. All fixed specimens were prepared for study in the laboratory of the junior author where, in accord with that author's cataloging system, they were designated as Specimen Lot 1149. Five individuals remained alive in the laboratory of the senior author for approximately six weeks, at the end of which time they suddenly disintegrated. Two weeks prior to their disintegration, the senior author had provided them with a blood meal.

Of the 27 fixed specimens, most were cut in serial section at 8 microns; a few were mounted whole. Staining employed Delafield's

hemotoxylin and eosin. Twenty-two animals were cut in serial sagittal section (1149a-v, of which 1149v was only a postpharyngeal piece). One specimen (1149w) was cut in serial frontal section, and another animal (1149x) was cut in serial transverse section. Four specimens were prepared as whole mounts (1149v', y, z, and aa, of which v' and aa were prepharyngeal pieces only). Approximately one-half of the slide-mounted animals were fully sexually mature.

ACKNOWLEDGMENTS

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ADDENDUM

When this paper was in page proof, we received a recently published note (Benazzi, 1972, Rend. Acc. Naz. Lincei, 52:403-405) containing a *nomen nudum*, *Opisthobursa mexicana*, which may be referable to the species, *Dimarcus villalobosi*. Although a few characters of the planarian were mentioned, they are insufficient to diagnose the species, and it was stated further that the description (by Benazzi and Giannini) was "in progress."