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New and Known Umagillid Rhabdocoels from Echinoderms

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The family Umagillidae comprises a group of dalyellioid rhabdocoels that inhabit the coelom or digestive tract of echinoderms and sipunculoids, hence are exclusively entoparasitic, presumably feeding on the tissues and body fluids of the host or on contents of the digestive tract. The family is of special interest as constituting the main parasitic group to be found among the Turbellaria, an essentially free-living class. They form a basis for the generally accepted opinion that trematodes and cestodes stem from rhabdocoels that adopted a parasitic mode of existence. It is suggestive, too, that nearly all umagillids parasitize echinoderms, which of course are placed along the line of evolution that led to vertebrates.

Von Graff (1913) gave no grounds for altering the family name to Anoplodiidae but presumably did so on the basis that *Anoplodium* is the oldest genus in the family. However, there is no nomenclatorial rule to the effect that a family must be named after the oldest genus. To the contrary, an author of a family has the right to name the family after any genus of the family, and subsequent authors may not alter his decision. The correct family name is therefore Umagillidae Wahl, 1910.

A thorough discussion of the family, with an exhaustive bibliography, was published by Stunkard and Corliss (1951). They further gave

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a key to the genera and species known at the time. Other recent valuable contributions to the knowledge of the family are the articles of Marcus (1949) and Westblad (1953).

The material on which the present report is based was contributed by zoologists working primarily on echinoderms. It had been crudely preserved in alcohol or formalin and hence is in poor histological condition. Therefore I am not able to provide complete descriptions and illustrations of the histology and sexual anatomy of the worms but believe sufficient details are here presented to justify the erection of new species. Specimens were sectioned at 6 μ and stained with haematoxylin and eosin and Mallory's triple stain.

NUMBERING FOR ALL FIGURES

1, Pharynx; 2, yolk glands; 3, testis; 4, ovary; 5, egg capsule; 6, filament of egg capsule; 7, uterus; 8, yolk ducts; 9, seminal receptacle; 10, vagina; 11, ovovitelline duct; 12, seminal vesicle; 13, ejaculatory duct; 14, penis papilla; 15, uterine stalk; 16, common genital antrum; 17, oviduct; 18, cluster of gland cells; 19, cement glands; 20, glandular hillock; 21, sperm ducts; 22, seminal bursa; 23, altered epidermis over gland; 24, intestine; 25, mouth; 26, fragments of capsule filament in the uterine stalk; 27, penis stylet; 28, sphincter.

FAMILY UMAGILLIDAE WAHL, 1910

DEFINITION: Entoparasitic dalyellioid rhabdocoels with ventral pharynx situated in the anterior body third; gonopore or pores at or near the posterior end; yolk glands compact or (usually) branched, distinct from the single or paired ovary; vagina terminating proximally in a seminal receptacle that also connects with the junction of yolk ducts and oviduct or oviducts; ovovitelline duct (ductus communis) springing from this junction and opening into common genital antrum or uterine stalk; long-stalked uterus extending inward from the genital antrum; vagina with or without a seminal bursa (copulatory sac) as a definite enlargement or sacciform appendage; egg enclosed in a hard capsule drawn out into a long filament; without eyes or rhabdites.

GENUS *ANOPLIDIUM* SCHNEIDER, 1858

DEFINITION: Umagillids with lobulated to highly branched yolk glands, single ovary, and two large, elongated testes; pharynx small; penis in the form of a low papilla, unarmed; without sacciform seminal bursa appended to vagina; parasites of holothurians.

TYPE SPECIES: *Anoplodium parasita* Schneider, 1858.

Anoplodium ramosum, new species

Figures 1-8

MATERIAL: Several specimens of this species were kindly presented by Dr. Arthur Humes who had found them in washings from *Stichopus variegatus* Semper, 1868, while working on parasitic copepods at the Station Océanographique, Nossi-Bé, Madagascar, in June, 1955. Hence location in the host is unknown.

GENERAL CHARACTERS: No information is available as to shape and color in life. The preserved specimens are broadly oval (fig. 1), averaging 0.86 mm. in length, with rounded ends. The most conspicuous feature of the anatomy in the cleared whole worm are the extremely branched yolk glands. They extend nearly to the posterior end but anteriorly leave a triangular area free from yolk glands. At the apex of this area occurs the small, weak pharynx, well back from the anterior margin. Directly ventral to the yolk glands occur the elongated oval testes with slightly sinuous contours. The testes do not extend to the anterior limits of the yolk glands. In the median line posterior to the middle is seen the hard pyriform egg capsule, with a nearly straight filament recurved at its tip. A single egg capsule was also present in other specimens. Near the posterior end on the right side is located the single ovary, of compact form, with one or two protrusions housing the youngest ovocytes.

COPULATORY COMPLEX: Not all details can be furnished from the available material. What could be ascertained from the best series of sections, a frontal series, is depicted in figure 2. The seminal receptacle is spherical, with a wall of wedge-like cells bounding a small lumen containing sperm. From the posterior wall of the seminal receptacle the vagina proceeds posteriorly, separated from the receptacle by a very narrow neck encircled by a sphincter muscle. The slightly expanded proximal end of the vagina, containing a mass of sperm, may be considered a copulatory sac (bursa copulatrix), also called seminal bursa, but is not delimited from the rest of the vagina which continues from it as a tube with cellular walls. This enters the common genital antrum to the right of the penis papilla. Laterally the seminal receptacle communicates with the junction of yolk ducts and oviduct. From this junction springs the ovovitelline duct (usually called ductus communis). Unfortunately this could be followed for only a short distance posteriorly; the wall of this proximal part appeared to be strongly cuticularized.

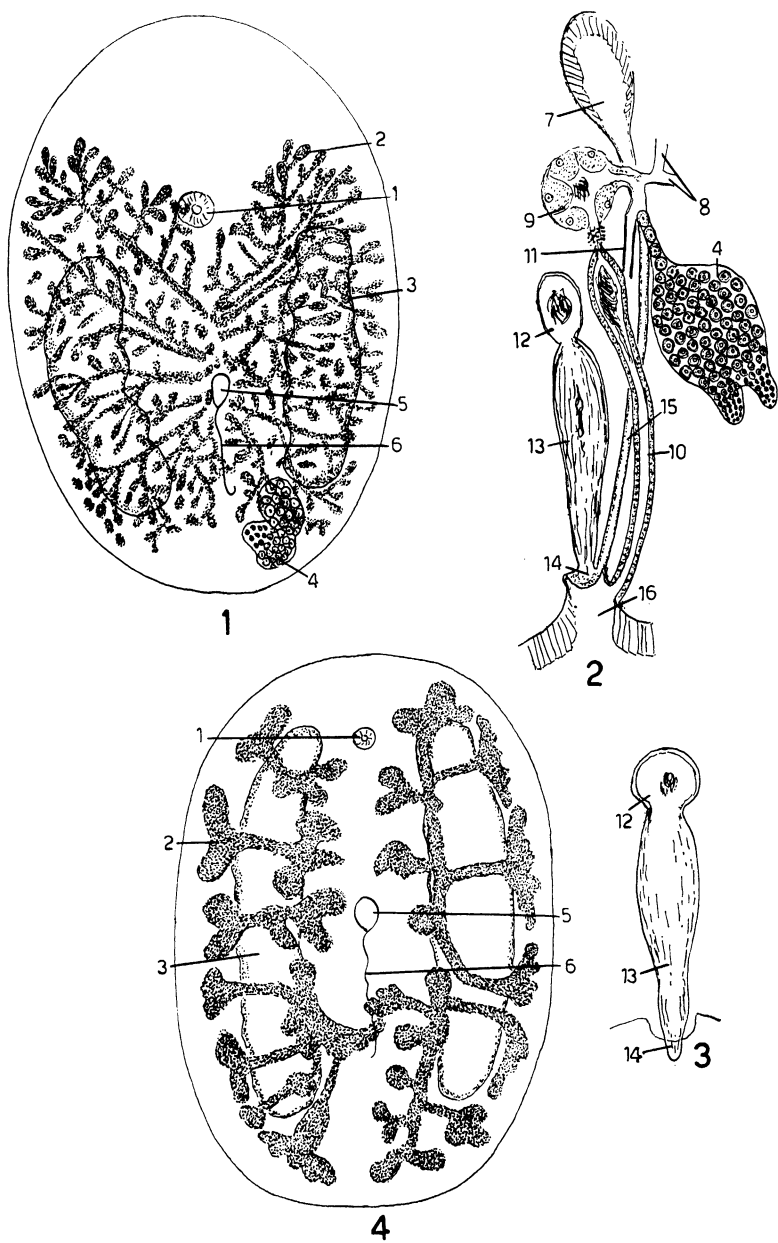
The male apparatus comprises a rounded seminal vesicle separated

by a constriction from the broad ejaculatory duct, terminating in a small rounded penis papilla projecting into the common antrum. The seminal vesicle appeared devoid of musculature, but the striations of the ejaculatory duct presumably represent longitudinal muscle fibers. Figure 3 depicts the male apparatus of another specimen with penis protruded.

The oval uterus, located anterior to all other parts of the copulatory apparatus, connects with the genital antrum by a long slender stalk that passes ventral to the male apparatus. In the available material it contained only one capsule.

DIFFERENTIAL DIAGNOSIS: The present species differs from all other described species of *Anoplodium* in the excessive branching of the yolk glands. Other features are the right-sided position of the ovary and the rounded seminal vesicle set off by a constriction from the remainder of the male apparatus. According to Westblad (1953) there have been described six valid species of *Anoplodium*. The type species, *A. parasita* Schneider, 1858, best figured by Westblad (1953), has a left-sided ovary and a tubular male apparatus, which does not extend anteriorly to the level of the seminal receptacle. In *A. graffi* Monticelli, 1892, excellently redescribed by Westblad (1953), the ovary is also on the left side, the yolk glands are slightly lobulated, not branched, and a distinctly delimited seminal vesicle is wanting. In *A. stichopi* Bock, 1925, with deeply lobulated yolk glands and definite seminal vesicle, the penis papilla is represented by a hillock of tall epithelium without lumen. Bock does not clearly state the position of the ovary, but one may assume that it is on the left side from Bock's remark that it has the position usual in the genus. The medial position of the ovary characterizes *A. mediale* Ozaki, 1932. *Anoplodium evelinae* Marcus, 1949, agrees with the present species in the right-sided location of the ovary and distinct rounded seminal vesicle, but the ovary is of unusual elongated shape, the yolk glands are lobulated rather than branched, and the antrum is constricted into anterior and posterior chambers; the penis papilla is represented by a small projection made of elongated epithelial cells, somewhat as in *A. stichopi*. The sixth species, *A. tubiferum* Westblad, 1953, is characterized by the slightly lobed yolk glands, left-sided ovary, and long tubular male apparatus extending far anteriorly beyond the seminal receptacle and lacking a delimited seminal vesicle.

HOLOTYPE: One set of sections deposited in the American Museum of Natural History; also a whole mount with two worms.



FIGS. 1-3. *Anoplopidium ramosum*. 1. Dorsal view of entire cleared worm. 2. Copulatory complex from frontal sections. 3. Male apparatus of another specimen.

FIG. 4. *Anoplopidium longiductum*, dorsal view of cleared whole mount.

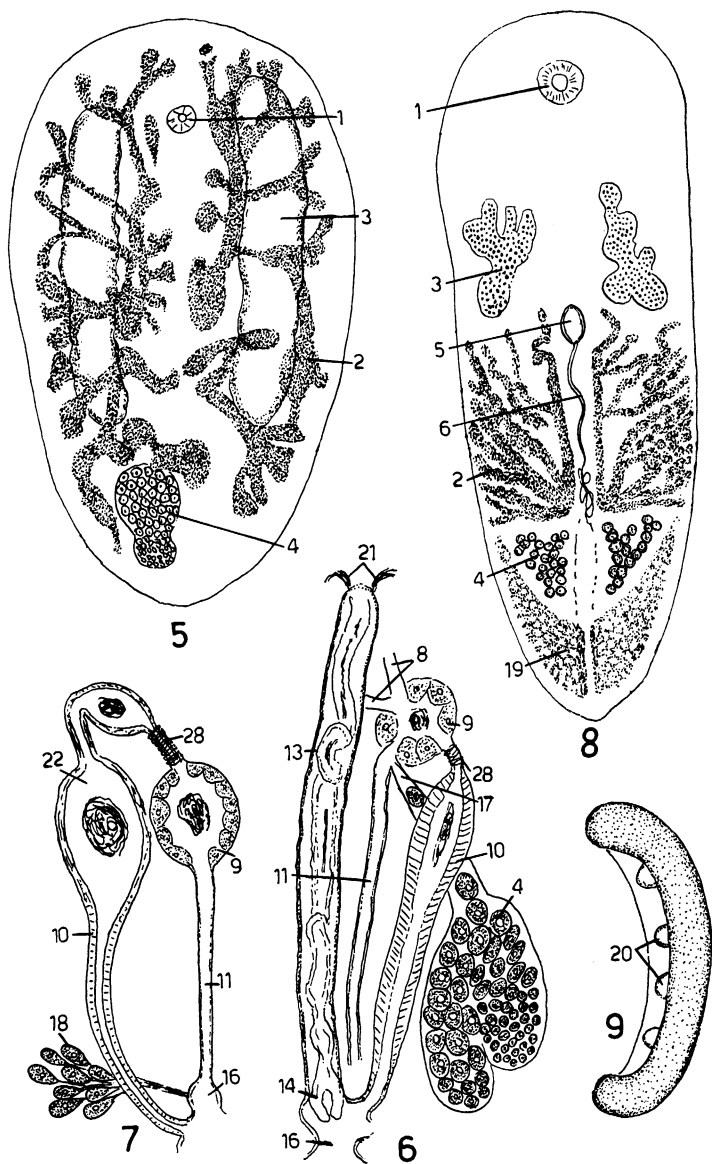
Anoplodium longiductum, new species

Figures 4-7

MATERIAL: Six specimens were presented by Dr. Arthur Humes who recovered them from washings of an unidentified species of *Actinopyga* under the same circumstances as given for the preceding species.

GENERAL CHARACTERS: No information is available as to shape and color in life or location in the host. The preserved specimens are broadly oval (figs. 4 and 5), measuring 0.84 to 1.2 mm. in length, preserved. As usual the most conspicuous feature in the cleared whole mount are the yolk glands, here coarsely branched. Figures 4 and 5 give two patterns of the branching. The small pharynx occurs between the more anterior branches. Ventral to the yolk glands are located laterally the two testes, of elongated oval form with smooth contours; anteriorly they extend almost to the anterior end of the yolk glands but posteriorly fall somewhat short of the posterior ends of these glands. The ovary is situated on the right side near the posterior end (fig. 5). In one specimen (fig. 4) an oval capsule with slightly sinuous filament is seen at about the middle of the worm.

COPULATORY COMPLEX: The results of intensive study of three sets of sections appear in figures 6 and 7. The spherical seminal receptacle with cellular wall and lumen containing a ball of sperm receives into its left side the two main yolk ducts that unite on entering the receptacle. From the right side of the receptacle there issues a curved duct provided with a sphincter of circular muscles. This continues as the vagina, expanded anteriorly and gradually decreasing in diameter to its entrance into the common antrum. The vagina has cellular walls and contains sperm in its expanded distal part which is not set off as a seminal bursa. From the posterior wall of the seminal receptacle the ovovitelline duct (ductus communis), receiving the oviduct immediately, proceeds posteriorly as a slender duct of uniform diameter. It could not be followed to its termination in the set of sections from which figure 6 was drawn, but in another set of sections, depicted in figure 7, the ovovitelline duct was found to enter the antrum by way of little terminal expansion that receives a cluster of glands. A peculiarity of the female apparatus in this set of sections is the long, arched tube that connects the seminal receptacle with the vagina and is provided with an expansion containing sperm. The single ovary, situated on the right side, has the usual protrusions housing young stages of oogenesis. The ovary sends its oviduct to connect with the ovovitelline duct just as the latter leaves the seminal receptacle. The uterus could not be identified.



FIGS. 5-7. *Anoplodium longiductum*. 5. Ventral view of another specimen. 6. Copulatory complex from sections. 7. Part of copulatory complex from another specimen.

FIGS. 8, 9. *Syndesmis glandulosa*. 8. Dorsal view of entire cleared specimen. 9. Whole worm from side to show glandular hillocks.

The male apparatus takes the form of a long tube that extends anteriorly well beyond the level of the seminal receptacle. It receives the two sperm ducts at its proximal end and contains a sinuous ejaculatory lumen that terminates in a small penis papilla projecting into the common antrum. It is somewhat of a question what name should be applied to this long male tube. Westblad's (1953) designation as "seminal vesicle" does not appear suitable, as in some species of the genus there is present a definite seminal vesicle set off by a constriction (fig. 2). Possibly the structure should be called simply "ejaculatory duct."

DIFFERENTIAL DIAGNOSIS: There are three species of *Anoplodium* in which the male copulatory apparatus takes the form of a long tube. In *A. parasita* the ejaculatory duct is short, not reaching anteriorly the level of the seminal receptacle. In *A. tubiferum* the ejaculatory duct extends well anterior to the level of the seminal receptacle as in the present species, but the ovary is on the left side, the yolk glands are only slightly lobulated, and the ejaculatory duct is continued distally by a long, tubular, male antrum.

HOLOTYPE: One set of sections deposited in the American Museum of Natural History.

GENUS *SYNDESMIS* SILLIMAN, 1881

DEFINITION: Umagillids with small anterior pharynx, a pair of lobulated testes in the anterior body third, followed by a pair of dendritic yolk glands, followed by a pair of lobulated ovaries; with long tubular ejaculatory duct housing distally the armed penis; with seminal bursa appended to the vagina; uterus very long, with sacciform expansion shortly behind the pharynx; capsule with long flexible filament coiled back and forth in the uterine stalk; parasites of echinoids.

TYPE SPECIES: *Syndesmis echinorum* François, 1886.

Syndesmis franciscana (Lehman, 1946)

Syndisyrix franciscanus LEHMAN, 1946.

Syndesmis antillarum STUNKARD AND CORLISS, 1951.

REMARKS: Three specimens in poor histological condition were sent by Dr. Richard Boolootian who had obtained them from the gut of the sea urchin *Allocentrotus fragilis* off Los Angeles in 125 meters of water, March 14, 1957. Giese (1958) also recorded the presence of this umagillid in *Allocentrotus fragilis* as well as in *Strongylocentrotus franciscanus* and *purpuratus* off California. In the *Strongylocentrotus* species the worms are found in the oral half of the gut. Lehman erected

a new genus, *Syndisyrix*, for this species on the grounds of the cuticularization of the ducts entering and leaving the seminal bursa, but Meixner (1926) showed that similar cuticularizations exist in the type species, *S. echinorum*. Present opinion considers *Syndisyrix* a synonym of *Syndesmis*.

Syndesmis franciscana also exists in West Indian echinoids. Several specimens that I assigned to this species were sent by Sra. Evelyn Zoppi of the Institute of Marine Biology at Mayaguez, Puerto Rico, who had collected them locally during July and August, 1958, from the gonads and intestine of *Lytechinus variegatus*. Westblad (1953) also recorded the occurrence of *S. franciscana* in the coelom of *Diadema antillarum*, a common West Indian urchin. I concur with Westblad that the umagillid from the coelom of *Diadema antillarum* at Tortugas described and figured by Powers (1936), but not named, is also *Syndesmis franciscana*. Hence the specific name *antillarum* suggested by Stunkard and Corliss (1951) for Powers' worm becomes a synonym of *franciscana*.

Syndesmis glandulosa, new species

Figures 8-12

MATERIAL: About 20 specimens were presented by Dr. Arthur Humes who had collected them from the sea urchin *Diadema setosum* at Madagascar under the same circumstances already related. As before there is no information as to color, shape, or location in the host.

GENERAL CHARACTERS: The worms are of elongated oval shape (fig. 8), about 1.4 mm. long, broadest anteriorly and narrowing to the blunt posterior end. All were curved towards the ventral side (fig. 9). The general features as seen in cleared whole worms (fig. 8) are typical of the genus. Near the anterior end occur the small pharynx and, some distance behind this, the pair of broadly lobulated testes. The testes could not be seen in the whole specimens, even after staining, and have been added to the figure from sections. Posterior to the testes are located the two clusters of highly branched yolk glands, the most conspicuous feature of the worm. Behind the yolk glands appear the pair of ovaries, slightly branched. The posterior end is filled with dark cement glands that open directly into the adjacent female antrum. At about the center of the worms occurs an oval egg capsule contained in the proximal expansion of the uterus. As typical of the genus, the capsule has a long sinuous filament or whip, of which the distal thin part is coiled in the stalk of the uterus.

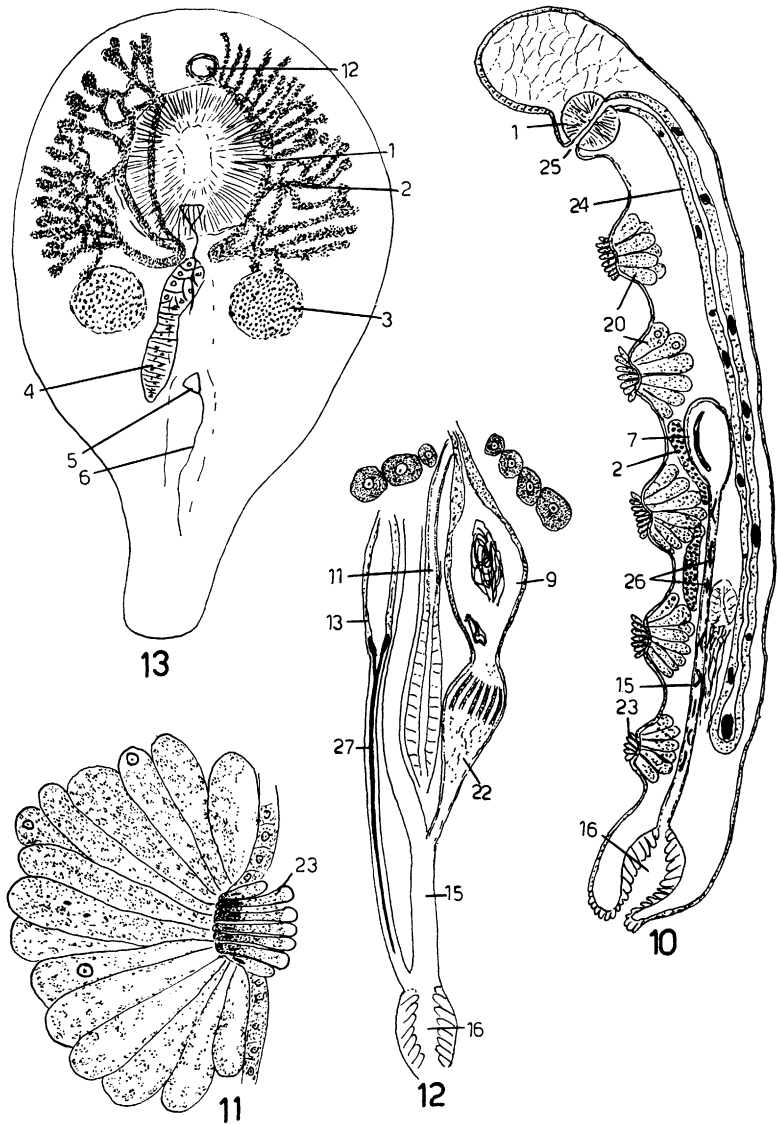
ADHESIVE GLANDS: In examining a lot of cleared worms in a watch glass, I noticed as they were turned over a row of hillocks in the mid-

ventral line (fig. 9). Sagittal sections show that these are rather remarkable multicellular glands (fig. 10), presumably of adhesive nature. The number of these glands increases with growth in size, reaching four or five in the larger specimens. Each gland (fig. 11) consists of a hemispherical mass of large cells that converge to a surface depression covered with altered epidermal cells continuous with the regular epidermal layer of the body wall. The gland cells contain granular material obviously coagulated by poor fixation, but the spherules usual in turbellarian gland cells appear wanting. No opening to the exterior could be found. The depression towards which the gland cells converge is completely covered with altered epidermal cells having a narrowed base of densely granular cytoplasm and a bulging, somewhat vacuolated tip.

COPULATORY COMPLEX: What could be ascertained about this complex is shown in figure 12. The long ejaculatory duct contains distally the penis stylet as typical of the genus, here about one-fifth of the length of the animal. The ejaculatory duct enters the common antrum. The oval uterus, situated at about the middle of the animal, at the level of the anterior ends of the yolk glands, sends its long stalk, containing the filament of the egg capsule, into the common antrum. The fusiform seminal receptacle, containing a mass of sperm, appears to continue posteriorly directly into the expanded proximal end of the vagina, usually called seminal bursa, which narrows posteriorly to a duct that enters the stalk of the uterus. About six tubular structures in the proximal part of the seminal bursa might be ducts from the seminal receptacle, but no lumen could be found in them. They appeared filled with deeply staining granular material. Between the uterine stalk and the seminal receptacle-bursal complex is seen the ovovitelline duct (ductus communis), of which the relations of the two ends were not clear.

DIFFERENTIAL DIAGNOSIS: *Syndesmis glandulosa* differs from all other species of the genus in the presence of a midventral row of large, multicellular glands. Other features are the rather posterior position of the uterus and the apparently direct continuity of seminal receptacle and bursa. There are four valid species of *Syndesmis* described in the literature. The type species, *S. echinorum* François, 1886, best figured by Russo (1895), is distinguished by the short penis stylet, measuring, according to Russo's figure, about one-tenth of the length of the animal, and by the forward curvature of the ducts of the cement glands to enter the proximal end of the female antrum. In all the other species these ducts enter the sides of the antrum. In *S. franciscana* (Lehman,

1946), the penis stylet measures about one-fourth of the body length and the seminal bursa connects anteriorly with the seminal receptacle



FIGS. 10-12. *Syndesmis glandulosa*. 10. Median sagittal section, showing midventral row of glandular hillocks. 11. One gland enlarged. 12. Copulatory complex, frontal view.

FIG. 13. *Cleistogamia holothuriana*, ventral view of cleared worm.

and posteriorly with the vagina by a slender, cuticularized duct. The length of the stylet was not given for *S. dendrastrorum* Stunkard and Corliss, 1951, of which the distinctive characters seem to be the considerable distance between the pharynx and the testes, and the location of the uterus with its egg capsule in the posterior third of the body. In *S. echinorum*, *franciscana*, and *punicea* the uterus is anteriorly located, at the level of the testes or even anterior to them. In *S. punicea* Hickman, 1956, the relations of seminal receptacle and seminal bursa are similar to those of *S. franciscana*; the stylet is said to equal one-fifth of the body length. It appears doubtful that what Shipley (1901) identified as *S. echinorum* can be this species.

SYNTYPE: One whole mount with several specimens deposited in the American Museum of Natural History; also one set of sagittal sections to show the glands.

GENUS *CLEISTOGAMIA* FAUST, 1924

DEFINITION: Umagillids with large anterior pharynx surrounded by the very anteriorly located dendritic yolk glands; with a pair of spherical testes behind the yolk glands; with a single ovary on the right side; with long penis stylet almost equaling the body length; and with very large, anteriorly extended female antrum.

TYPE SPECIES: *Cleistogamia holothuriana* Faust, 1924.

Cleistogamia holothuriana Faust, 1924

Figure 13

REMARKS: Three specimens of this species were presented by Dr. Arthur Humes who found them in washings from the sea cucumber *Actinopyges echinites* (Jaeger) at Madagascar under the circumstances already related. This appears to be the first refinding of the species since the original record from the Andaman Sea. The specimens, about 2.0 mm. in length, agree well with Baer's (1938) redescription of Faust's material. In the cleared whole mount (fig. 13) are seen the large conspicuous pharynx surrounded by the two clusters of highly branched yolk glands, the single dextral ovary, and the two spherical testes. The specimen depicted (fig. 13) contains two egg capsules of triangular contour provided with the usual long filament. Another specimen contains 11 such capsules crowded into the region occupied by the more posterior capsule in figure 13.

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