

Two new species of *Syndesmis* (Turbellaria :
Neorhabdocoela : Umagillidae) from the sea urchins
Strongylocentrotus droebachiensis
and *Allocentrotus fragilis*

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Résumé : Deux nouvelles espèces des Neorhabdocoèles Umagillides, symbiontes intestinaux d'oursins recueillis à Washington, sont décrites ici. *Syndesmis inconspicua* sp. nov., trouvée dans l'intestin de *Strongylocentrotus droebachiensis*, se différencie de *Syndisyrix franciscanus* Lehman, 1946, plus souvent rencontrée chez le même hôte, par sa couleur brun rosâtre, plutôt que rouge. *Syndesmis neglecta* sp. nov. est hébergée dans l'intestin de *Allocentrotus fragilis*.

Abstract : Two species of umagillid neorhabdocoels are described from sea urchins collected in Washington. *Syndesmis inconspicua* sp. nov., is found in the intestine of *Strongylocentrotus droebachiensis*, but is less common in this host than *Syndisyrix franciscanus* Lehman, 1946. It is easily distinguished from *S. franciscanus* by its color, which is tan or pinkish brown, rather than red. *Syndesmis neglecta* sp. nov. inhabits the intestine of *Allocentrotus fragilis*.

INTRODUCTION

On the Pacific coast of North America, five sea urchins are known hosts for the intestine-inhabiting umagillid neorhabdocoel *Syndisyrix franciscanus* Lehman (1946). These are *Strongylocentrotus franciscanus* (the species from which Lehman obtained his material), *S. purpuratus*, *S. droebachiensis*, *S. pallidus*, and *Lytechinus anamesus* (*L. pictus*). In *Strongylocentrotus droebachiensis*, however, we have occasionally encountered another umagillid. It is more slender than *S. franciscanus* and characteristically tan or pinkish brown rather than red. It belongs to *Syndesmis*, but is distinct from all properly described species of this genus.

A *Syndesmis* that occurs in the intestine of *Allocentrotus fragilis* is also undescribed. It is perhaps the one that Boolootian, Giese, Tucker, and Farmanfarmanian (1959) observed in this host. They noted that the worm was similar to "*Syndesmus franciscanus*," but did not provide any details concerning its morphology.

The purpose of this paper is to describe the new umagillids from *S. droebachiensis* and *A. fragilis*, and to discuss the criteria by which the genera *Syndesmis* and *Syndisyrix* may be distinguished.

MATERIALS AND METHODS

The specimens of *Strongylocentrotus droebachiensis* examined by us were collected subtidally at several localities in the San Juan Archipelago of Washington. *Allocentrotus fragilis* was dredged in the Strait of Juan de Fuca near Slip Point, Washington. All worms were fixed in Bouin's fluid, sometimes after being quieted in sea water to which a small amount of an isotonic solution of magnesium chloride had been added. Specimens prepared as whole mounts were kept flat under coverglasses while being fixed, and were stained in borax carmine. Those to be embedded in paraffin and sectioned serially were, in the case of the species from *S. droebachiensis*, restrained slightly under coverglasses to keep them from curling. In the case of the species from *A. fragilis*, specimens that had already been prepared as whole mounts were embedded and sectioned. Sections were cut at 6 or 8 μm and stained with iron hematoxylin.

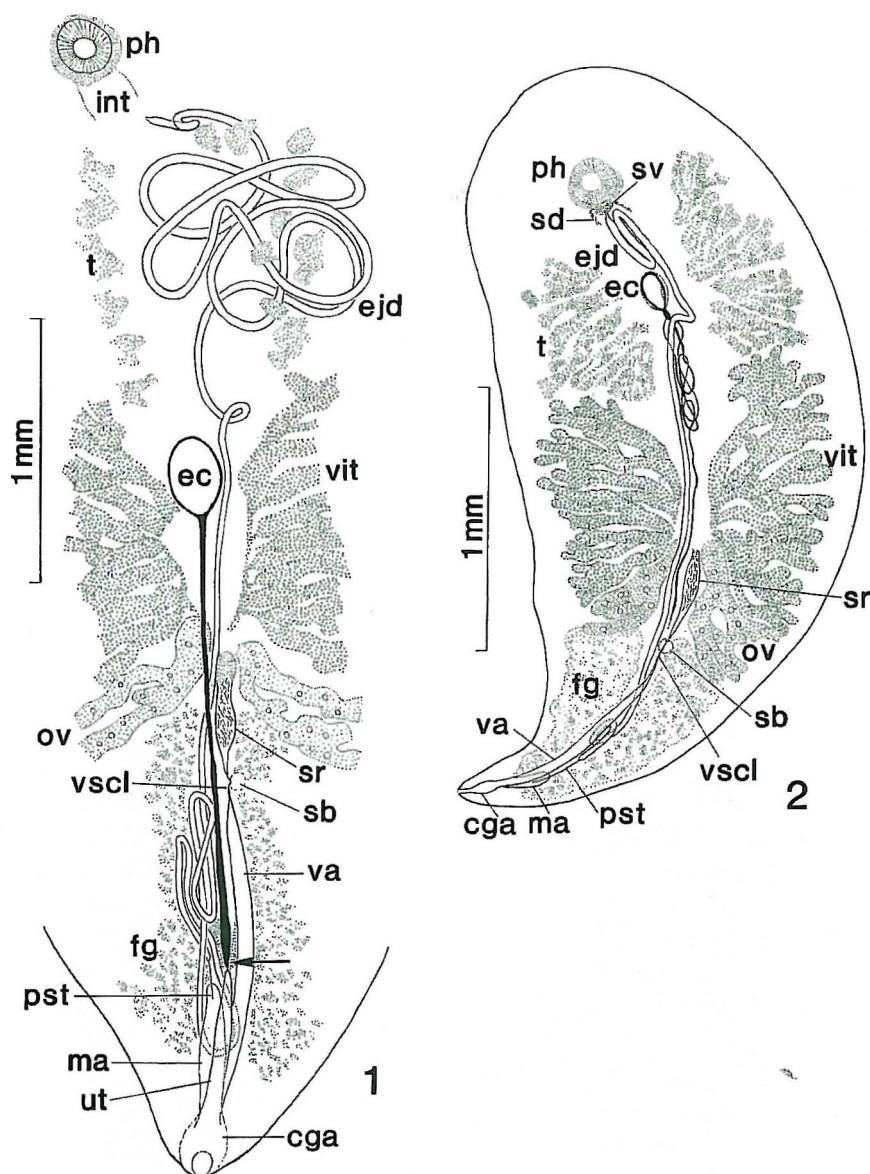
DESCRIPTIONS

Syndesmis inconspicua sp. nov. (Figs. 1, 3-12)

This species inhabits the intestine of *Strongylocentrotus droebachiensis*, but it is much less common than *Syndisyrix franciscanus*. Between 1985 and 1990, we examined 213 specimens of *S. droebachiensis* collected at various localities in the San Juan Archipelago. All but six were parasitized by *S. franciscanus*, but we found *S. inconspicua* in only 12. Living worms, viewed in reflected light, are tan or pinkish brown. The largest, when fully extended and actively gliding, are about 5 mm long and 2.5 mm wide. The anterior end is evenly rounded, whereas the posterior end tapers to a nearly acute tip. The greatest width is anterior to the middle of the body. The mouth, on the ventral surface, is about one-eighth of the body length from the anterior edge. The intestine, which succeeds the pharynx, terminates at the beginning of the last one-sixth of the body. The entire ventral surface is ciliated, but cilia are lacking from the dorsal surface except in the first two-thirds of the area anterior to the pharynx.

The two testes (Figs. 1, 3-5), which have about 15 to 25 ultimate branches, are in the ventral half of the body. They begin just behind the pharynx and reach back to the vitellaria. Their medial portions are close to the intestine, and their lateral portions reach about halfway from the intestine to the lateral margins of the body. A sperm duct originates on the medial side of each testis, extends anteromedially, then turns posteromedially to join the ejaculatory duct. There is no obvious seminal vesicle at this point. The ejaculatory duct (Fig. 1), with circular muscle external to longitudinal muscle, is much coiled, and the coils are sometimes concentrated, sometimes scattered. Their arrangement probably depends to some extent on the degree to which a specimen has been compressed.

The sclerotized penis stylet, extending from the posterior end of the ejaculatory duct (Fig. 1), is about 200 μm long. It projects into the male antrum for a distance of about

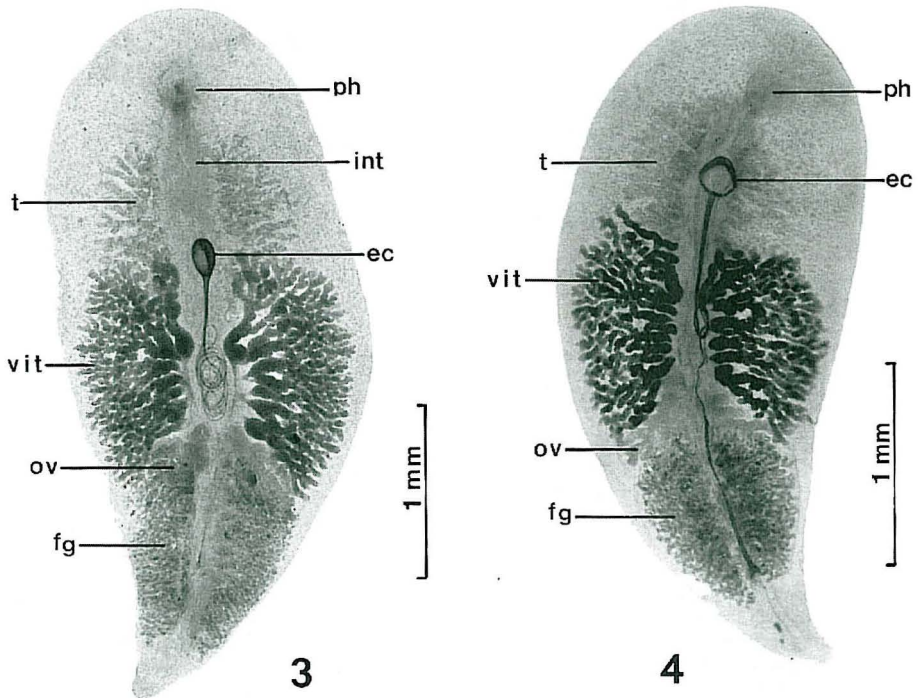


Figs. 1-2: *Syndesmis inconspicua* sp. nov. and *S. neglecta* sp. nov.; whole mounts, stained with borax carmine, drawn with the aid of a camera lucida. 1. *S. inconspicua*, ventral view. Compression of the specimen during fixation caused some coils of the anterior part of the ejaculatory duct to be displaced from their normal position near the midline. 2. *S. neglecta*, holotype, dorsal view.

Abbreviations (for all figures): bv, bursal valve; cga, common genital antrum; dc, ductus communis; ec, egg capsule; ejd, ejaculatory duct; fg, filament glands; int, intestine; ma, male antrum; ov, ovary; ovid, oviduct; ph, pharynx; pst, penis stylet; sb, seminal bursa; sd, sperm duct; sr, seminal receptacle; sv, seminal vesicle; t, testis; ut, uterus; va, vagina; vit, vitellaria; vscl, sclerotized portion of vagina, entering bursal valve.

75 μm . The male antrum has a rather thick outer layer of longitudinal muscle and a thin inner layer of circular muscle. In some specimens, the anterior part of the male antrum, where the stylet enters it, is inverted to the extent of about 25 μm . As in other species of *Syndesmis*, the cells forming the epithelial lining of the male antrum are elongated and folded.

The two vitellaria (Figs. 1, 3, 4) have seven or eight primary trunks, each dividing more or less dichotomously two or three times, so that there are about 30 ultimate lobes. The ovaries, just posterior to the vitellaria (Figs. 1, 3, 4), have four to seven lobes. The main trunk of each ovary extends for only a short distance anteromedially before it joins the vitellarium on the same side to form a short ovovitelline duct (Fig. 6). This enters the anteriormost part of the seminal receptacle (Fig. 6), which is occupied by large, secretion-filled cells, between which there are channels through which sperm pass. The arrangement of cells and channels is much like that in *S. echinorum* (Kozloff and Westervelt, 1987), *S. rubida* and *S. albida* (Kozloff & Westervelt, 1990), and *S. aethopharynx* (Westervelt & Kozloff, 1990). The remainder of the seminal receptacle is elongated, with a spacious lumen, at least when it is filled with sperm. Posteriorly, the seminal receptacle tapers to a short sclerotized duct that enters the seminal bursa through a sclerotized bursal valve (Figs. 7, 8). Also located on



Figs. 34 : *Syndesmis inconspicua* sp. nov. ; whole mounts stained with borax carmine. 3. Holotype, dorsal view. 4. Paratype, ventral view.

the valve is the opening of the slender sclerotized anterior portion of the vagina (Fig. 9). The posterior part of the vagina is much like the male antrum with respect to the arrangement of its musculature and the folding of its epithelial cells.

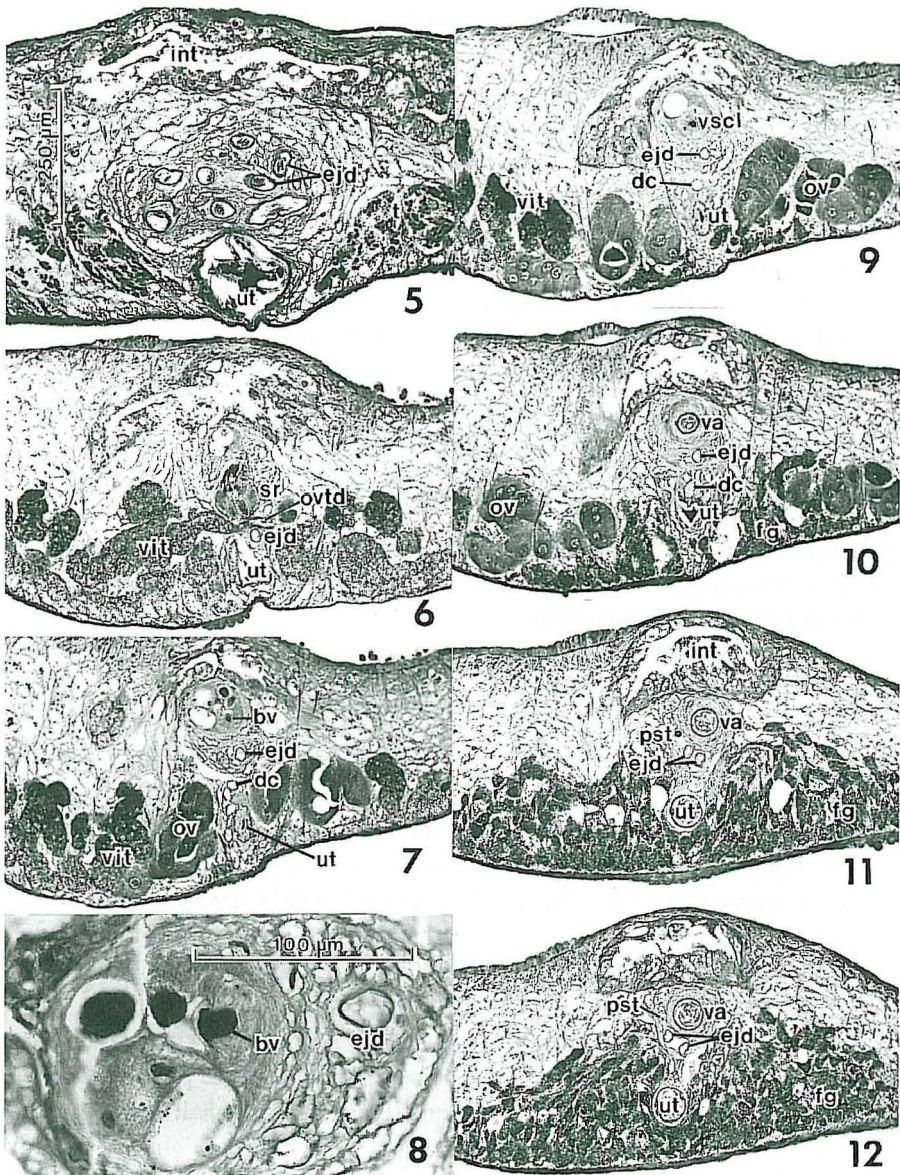
The uterus (Figs. 1, 5-7, 9-12), also with longitudinal muscle external to circular muscle, is ventral to the male antrum. When it contains a fully developed egg capsule (Figs. 1, 3, 4), it may extend anteriorly into the second quarter of the body. The filament glands (Figs. 1, 3, 4, 10-12), occupying much of the last quarter of the body, are dense, and their ducts enter the posterior portion of the uterus. The ductus communis (Figs. 7, 9, 10), through which eggs and yolk pass to the uterus, originates on the ventral side of the anteriormost part of the seminal receptacle. It reaches the dorsal side of the uterus at approximately the same transverse level as the ducts from the filament glands. Egg capsules are about 250 μm long by 150 μm wide. They were present in all of the specimens we studied. The common genital antrum (Fig. 1), entered by the male antrum, vagina, and uterus, opens to the exterior at the posterior tip of the body.

The holotype (United States National Museum, Helminthological Collection, n° 81560) and paratype (n° 81561), both whole mounts stained with borax carmine, were taken from specimens of *Strongylocentrotus droebachiensis* dredged at a depth of 120 meters off Point Caution, San Juan Island, Washington.

Syndesmis neglecta sp. nov. (Figs. 2, 13-18)

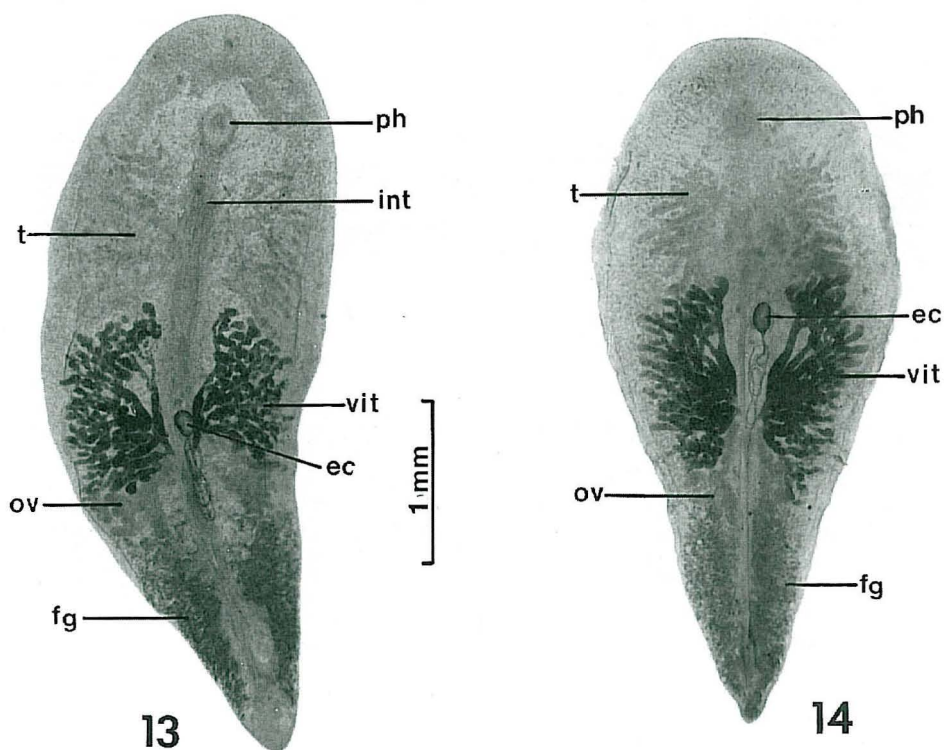
This umagillid inhabits the intestine of *Allocentrotus fragilis*. It was present in all of the 13 individuals we examined, and was the only neorhabdocoel we found. The largest worms, when fully extended, are about 3.5 mm long by 2 mm wide. The color of our specimens was not recorded. As in *S. inconspicua*, the anterior end is evenly rounded and the posterior end tapers to a nearly acute tip. The width is greatest slightly anterior to the middle. All areas of the epidermis are ciliated. The mouth is about one-eighth or one-ninth of the body length from the anterior edge, and the intestine (Figs. 2, 13) reaches to the last one-eighth of the body.

The testes (Figs. 2, 13, 14) are similar to those of *S. inconspicua* with respect to the area they occupy. They extend from the level of the posterior edge of the pharynx to the vitellaria. They generally have about 11 to 19 lobes and reach laterally to halfway or two-thirds of the distance from the gut to the margins of the body. A sperm duct originates on the medial side of each testis and extends anteromedially for a short distance, then turns posteromedially to enter the anterior side of a small seminal vesicle (Fig. 2). A short duct (Fig. 2) joins the seminal vesicle to the ejaculatory duct (Figs. 2, 15-18). The latter is shorter and less extensively coiled than the ejaculatory duct of *S. inconspicua*, but it usually does have one to three sets of coils. The penis stylet (Fig. 2) is about 125 to 160 μm long and projects into the male antrum, reaching to about the middle of this structure. The layer of longitudinal muscle is thicker than the layer of circular muscle, and is external to the latter. The anterior portion of the male antrum does not become inverted.



Figs. 5-12: *Syndesmis inconspicua* sp. nov.; photomicrographs of transverse sections stained with iron hematoxylin. Figs. 6, 7, and 9-12 are to the scale shown on Fig. 5. 5. Uterus (with egg capsule), testes, several coils of ejaculatory duct, intestine. 6. Anterior part of seminal receptacle, ovovitelline duct, vitellaria, uterus. 7. Bursal valve, ductus communis, vitellaria, ovary, uterus, ejaculatory duct. 8. Bursal valve, ejaculatory duct. (In this photomicrograph, the ventral side is on the right). 9. Sclerotized anterior portion of vagina, ovary, uterus, ductus communis, ejaculatory duct. 10. Ovary, uterus, ductus communis (just before entering uterus), vagina, ejaculatory duct. 11. Proximal portion of penis stylet, coils of ejaculatory duct, vagina, uterus, filament glands. 12. Penis stylet, coils of ejaculatory duct, vagina, uterus, filament glands.

The four to seven primary trunks of the vitellaria (Figs. 2, 13, 14) branch dichotomously to form about 14 to 28 ultimate divisions. In general, the vitellaria of this species are less dense than those of *S. inconspicua*. The ovaries (Figs. 2, 13, 14) have three to seven branches. The main trunk of each ovary, directed anteromedially, may be up to 175 μ m long. It joins the vitelline duct on the same side of the body to form an ovovitelline duct (Fig. 15) that enters the anteriormost part of the seminal receptacle (Fig. 16). This portion of the seminal receptacle, which is turned anteroventrally, is filled with large cells, between which are channels through which sperm pass. The remainder of the seminal receptacle is long and has a spacious lumen, at least when it is filled with sperm. Posteriorly, the seminal receptacle narrows to a slender sclerotized duct that enters the seminal bursa through the bursal valve (Fig. 17). As in other species of the *Syndesmis-Syndisyrix* complex, the bursal valve also receives the sclerotized duct of the anteriormost part of the vagina (Fig. 18). The rest of the vagina, to one side and above the ejaculatory duct, and also above the male antrum, extends to the common genital antrum (Fig. 2). The posterior part of the vagina is much like the male antrum with respect to the arrangement of its musculature and folding of its epithelial cells.



Figs. 13-14: *Syndesmis neglecta* sp. nov. ; whole mounts stained with borax carmine. 13. Paratype, dorsal view. 14. Another specimen, ventral view.

The uterus (Figs. 15-18) is the most nearly ventral component of the reproductive system. When it contains a fully developed egg capsule (Figs. 2, 13, 14) characterized by a long filament, it may extend anteriorly to the end of the first quarter of the body length. The egg capsule is usually about 170 to 180 μm long and 100 to 110 μm wide. Thirty of the 44 specimens we examined had an egg capsule. The ductus communis (Figs. 16-18), originating on the ventral side of the place where the ovovitelline ducts join the seminal receptacle, is dorsal to the uterus for its entire length, and empties into the uterus at about the same level as the ducts from the filament glands. The filament glands (Figs. 2, 13, 14, 17, 18), as in *S. inconspicua*, occupy much of the last quarter of the body. The common genital antrum (Fig. 2), which is entered by the male antrum, vagina, and uterus, opens to the outside at the posterior tip of the body.

The holotype (United States National Museum, Helminthological Collection, n° 81562) and paratype (n° 81563) are whole mounts of specimens stained with borax carmine. They were taken from *Allocentrotus fragilis* collected by dredging at a depth of about 180 m in the Strait of Juan de Fuca, off Slip Point, Washington.



Figs. 15-18 : *Syndesmis neglecta* sp. nov. ; photomicrographs of transverse sections stained with iron hematoxylin. All figures are to the scale shown on Fig. 15. 15. Ejaculatory duct, ovovitelline duct, uterus, vitellaria. 16. Ejaculatory duct, seminal receptacle, ductus communis, uterus. 17. Ejaculatory duct, bursal valve, ductus communis, uterus, filament glands. 18. Ejaculatory duct, sclerotized anterior part of vagina, ductus communis, uterus, filament glands.

DISCUSSION

Syndisyrix franciscanus, and the two species of *Syndesmis* dealt with in this paper, are the only members of the *Syndesmis-Syndisyrix* complex that have been described from regular urchins of the Pacific coast of North America. The systematic status of an unidentified umagillid that has been found in *Strongylocentrotus franciscanus*, *S. purpuratus*, and *Lytechinus anamesus* (*L. pictus*) in California (Mettrick & Jennings, 1969) remains unknown. There are perhaps other species in urchins whose distribution extends southward from southern California.

When Lehman (1946) described the genus *Syndisyrix*, he pointed out that a distinctive feature of *S. franciscanus*, the type species, was the presence of a bursal valve, a structure that had not been reported for any species of *Syndesmis*. The discovery (Kozloff & Westervelt, 1987) of a bursal valve in *Syndesmis echinorum*, the type species of its genus, has made us seek other distinctions between *Syndesmis* and *Syndisyrix*.

Syndisyrix franciscanus has a slender male antrum within which the penis stylet slips freely back and forth. In the several species of *Syndesmis* that we have studied, the male antrum is broad, and the stylet seems to be bound tightly to tissue. At the present time, this difference in the structure of the male antrum is perhaps the most useful feature for separating *Syndesmis* from *Syndisyrix*. Whether the ejaculatory duct is coiled or not is probably of little value. In *Syndesmis aethopharynx*, a parasite of *Paracentrotus lividus* at Banyuls-sur-Mer, the male antrum is decidedly of the *Syndesmis* type, but the ejaculatory duct, unlike that of other species we have assigned to the genus, is almost straight (Westervelt & Kozloff, 1990). Several species of the *Syndesmis-Syndisyrix* complex have not been described in sufficient detail, and it seems best not to insist that they belong to one genus or the other. Although Hertel, Duszynski, and Ubelaker (1990) attempted to do this, their work predates our descriptions of *Syndesmis rubida*, *S. albida*, and *S. aethopharynx*.

Because *S. inconspicua* and *S. neglecta* are the only species of *Syndesmis* known to occur in regular urchins in California, Oregon, Washington, and British Columbia, it will be useful to compare them. The vitellaria of *S. inconspicua* have more ultimate lobes than the vitellaria of *S. neglecta*, and the ejaculatory duct of *S. inconspicua* is much more extensively coiled than that of *S. neglecta*. The anteriormost portion of the seminal receptacle of *S. neglecta*, moreover, is turned anteroventrally, instead of being directed straight forward. In this respect it is somewhat similar to the anterior part of the seminal receptacle of *S. albida*, which inhabits *Echinus esculentus* in European waters (Kozloff & Westervelt, 1990).

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