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Syndesmis patagonica n. sp. (Rhabdocoela: Umagillidae) from the sea urchin *Arbacia dufresnii* (Echinodermata: Echinoidea) in Patagonia, Argentina

MARTÍN I. BROGGER[1] & VERÓNICA A. IVANOV[2]

[1]*CONICET, Lab. de Ecosistemas Costeros, Museo Argentino de Ciencias Naturales "Bernardino Rivadavia", Av. Ángel Gallardo 470, C1405DJR, Buenos Aires, Argentina; Lab. de Invertebrados 1, FCEyN, UBA. E-mail: mbrogger@bg.fcen.uba.ar*
[2]*CONICET, Lab. Helmintología, Departamento de Biodiversidad y Biología Experimental, Facultad de Ciencias Exactas y Naturales, Universidad de Buenos Aires, Ciudad Universitaria, Pabellón II, piso 4, C1428EHA, Buenos Aires, Argentina.*
E-mail: ivanov@bg.fcen.uba.ar

Abstract

The umagillid *Syndesmis patagonica* **n. sp.** is described from the intestinal tract of the sea urchin *Arbacia dufresnii*, which represents a new host record for the genus. The hosts were collected from the coast of Patagonia (Argentina), and *S. patagonica* **n. sp.** is the first species of *Syndesmis* reported from South America. *Syndesmis patagonica* **n. sp.** can be distinguished from all other species in the genus by the possession of a stylet that is extremely short (less than 50 µm long), and a combination of other characters including the position of the testes, body size, body color and host. An updated overview of the distribution of all species of *Syndesmis* is also presented.

Key words: ***S****yndesmis*; new species; taxonomy; biogeography; endosymbiosis; Puerto Madryn

Introduction

Echinoderms are often reported as hosts of symbionts belonging to a wide variety of taxa (Jangoux 1990): Hallangiidae and Isodiametridae (Acoela), Nemertodermatidae (Nemertodermatida), Umagillidae, Acholadidae and Leptoplanidae (Platyhelminthes). In echinoids, Doignon and Artois (2006) report 22 species of umagillid flatworms. An additional species was described by Beltagi and Mandura (1991), a description obviously unnoticed by Doignon and Artois (2006) and also not mentioned in the Turbellarian Taxonomic Database (Tyler *et al.* 2006–2009).

Representatives of 2 genera, *Syndesmis* Silliman, 1881 and *Syndisyrinx* Lehman, 1946, have been traditionally recognized as umagillid endosymbionts of echinoids. However, the validity of the later genus is often doubted. Lehman (1946) erected *Syndisyrinx* to host all species in which the ducts entering and leaving the seminal bursa are sclerotized. Cannon (1982, 1987) supported the distinction of the genus *Syndisyrinx* based on the presence of a sclerotized bursal valve, which he considered a valid apomorphy for the genus. However, Kozloff and Westervelt (1987) observed a bursal valve in *Syndesmis echinorum* François, 1886, the type species of *Syndesmis*, which makes the distinction between the two genera invalid, at least when based on this character. Kozloff and Westervelt (1987) proposed to preserve the genus *Syndisyrinx* based on other diagnostic features: e.g., a distinct seminal vesicle, a short, narrow and straight ejaculatory duct, and a long penis stylet in species of *Syndisyrinx*, vs. unnoticed seminal vesicle, long, broad and extensively coiled ejaculatory duct, and a short penis stylet in *Syndesmis*. In further studies on several species in both genera, Kozloff and Westervelt (1990) and Westervelt and Kozloff (1990, 1992) come to the conclusion that only one character can be used to distinguish between both genera: the male antrum is slender and narrow and the stylet slips freely back and forth in it in species of *Syndisyrinx*, whereas the male antrum is broad and the stylet seems to be bound tightly to its wall in *Syndesmis*. Tyler *et al.* (2006–2009) present both genera separately in the Turbellarian Taxonomic Database. However, as indicated by these authors, most taxa have not yet been checked for accuracy in synonymy in the database.

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Both genera were synonymized by Marcus (1949) based on observations made by Meixner (1926), who showed that a similar sclerotization of the genital ducts (as described by Lehman in 1946 for *Syndisyrinx*) is also present in *Syndesmis echinorum*. The synonymy was later supported by Stunkard and Corliss (1951) and Hyman (1960), and by Moens *et al.* (1994) and Jondelius (1996), who considered the diagnostic characters of *Syndisyrinx* proposed by Kozloff and Westervelt (1987, 1990) and Westervelt and Kozloff (1990, 1992) a consequence of incomplete description of the male penis stylet complex. Recently, a literature survey of the taxon was conducted by Doignon and Artois (2006), who also considered the distinction between these two genera to be arbitrary. Thus, all umagillid species infecting echinoids were included in the genus *Syndesmis*.

Defined as such, the genus *Syndesmis* comprises 23 valid species (Beltagi & Mandura 1991; Doignon & Artois 2006). Members of the genus occur in North Atlantic, North Pacific, Western Pacific, Mediterranean, Red Sea, Indian Ocean, Gulf of Mexico and Caribbean Sea, but there are no species recorded from the South Atlantic and Eastern South Pacific.

Most species of *Syndesmis* have been found within the gut of their echinoid hosts, and there are a few reports from the coelomic cavity (Jennings & Mettrick 1968; Komschlies & Vande Vusse 1980a, b). However, Kozloff and Westervelt (1987) suggested that the reports from the coelomic cavity might be a result of a broken gut wall during dissections.

The extent of the symbiotic relationship between umagillids and their hosts has been controversial. Whereas some authors consider umagillids as commensals (Hyman 1955; Snyder 1980), others have reported them feeding also on intestinal tissue (Shinn 1981; Cannon 1982). More recently, Jennings (1997) alleged that Umagillidae represents a complete transition from entozoic predation to endoparasitism.

In this work, a new species of *Syndesmis* found in the gut of the sea urchin *Arbacia dufresnii* Blainville from Puerto Madryn, Argentina, is described in detail based on living and preserved specimens. Updated distribution map of the genus, along with summarized information on some diagnostic characters for all the valid species in the genus are also provided.

Material and methods

The worms were collected from the intestine of 120 specimens of the echinoid *A. dufresnii*, captured at 4–6 m depth in Puerto Madryn, Argentina, during November and December 2003. After dissection of the echinoids, the coelomic fluid and intestine were examined for flatworms with the aid of a dissecting microscope. The flatworms were observed and photographed while still alive using light microscopy, and then fixed in 10% hot formaline. Specimens prepared for whole mounts were hydrated in a graded ethanol series, stained with Harris' haematoxylin, dehydrated in a graded ethanol series, cleared in methyl salicylate, and mounted in Canada balsam. Four specimens were embedded in paraffin for sagittal and cross serial sectioning (7–9 µm thick sections). All sections were stained with Harris' haematoxylin and counterstained with eosin. Measurements include the range followed in parentheses by the mean, standard deviation and number of worms examined (n). Figures were drawn with the aid of a drawing tube on a Zeiss Axioskop microscope. Measurements of sectioned specimens and whole mounts were taken from digital images using the software package Axiovision v. 4.4. Pictures were taken with an Axiocam HRc digital camera, mounted on the Zeiss Axio Imager Z1 microscope.

Type specimens are deposited in the Colección Parasitológica - Museo Argentino de Ciencias Naturales, Buenos Aires, Argentina (MACN-Pa).

Results

Family Umagillidae Wahl, 1910

Genus *Syndesmis* Silliman, 1881
Syndesmis patagonica n. sp.
(Figs. 1, 2)

Type locality: Puerto Madryn (42º46'S; 65º02'W), Argentina.

Type material: Holotype: 1 entire specimen prepared as a whole mount. Paratypes: 3 entire specimens prepared as whole mounts, 1 slide with sagittal section of 1 specimen, and 1 slide with cross sections of 1 specimen (MACN-Pa N 495/1–6).

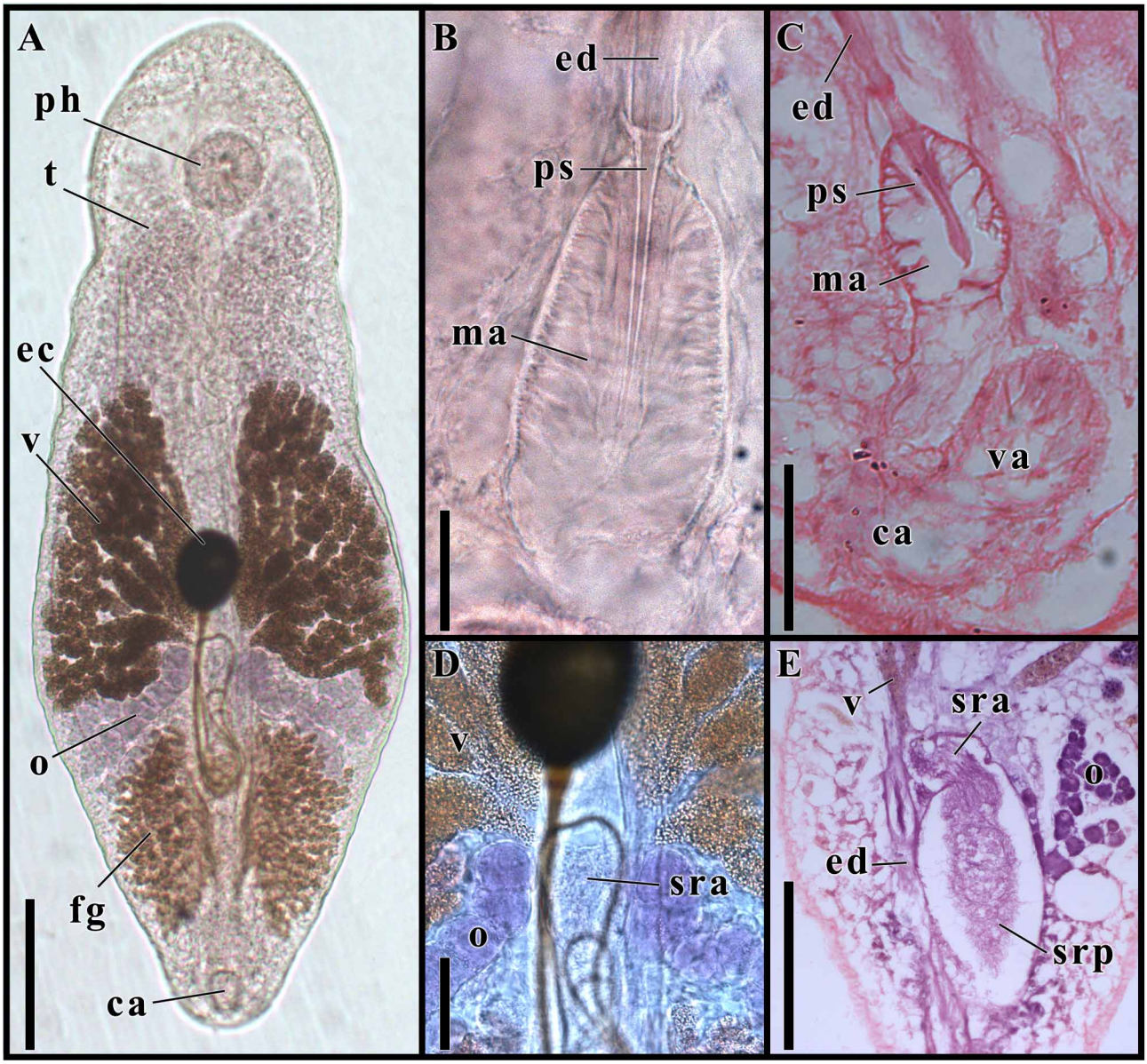

FIGURE 1. Digital photographs of *Syndesmis patagonica*, new species. **A.** Entire worm, holotype; **B.** Detail of the penis stylet, holotype; **C.** Detail of the penis stylet in sagittal section, paratype. **D.** Detail of the anterior part of the seminal receptacle, holotype; **E.** Detail of the seminal receptacle in cross section, paratype.
Scale bars: A and E = 200 µm, B = 20 µm, C and D = 50 µm. Abbreviations: ca, common antrum; ec, egg capsule; ed, ejaculatory duct; fg, filament glands; ma, male antrum; o, ovary; sra, anterior portion of seminal receptacle; srp, posterior portion of seminal receptacle; ph, pharynx; ps, penis stylet; t, testis; v, vitellarium; va, vagina.

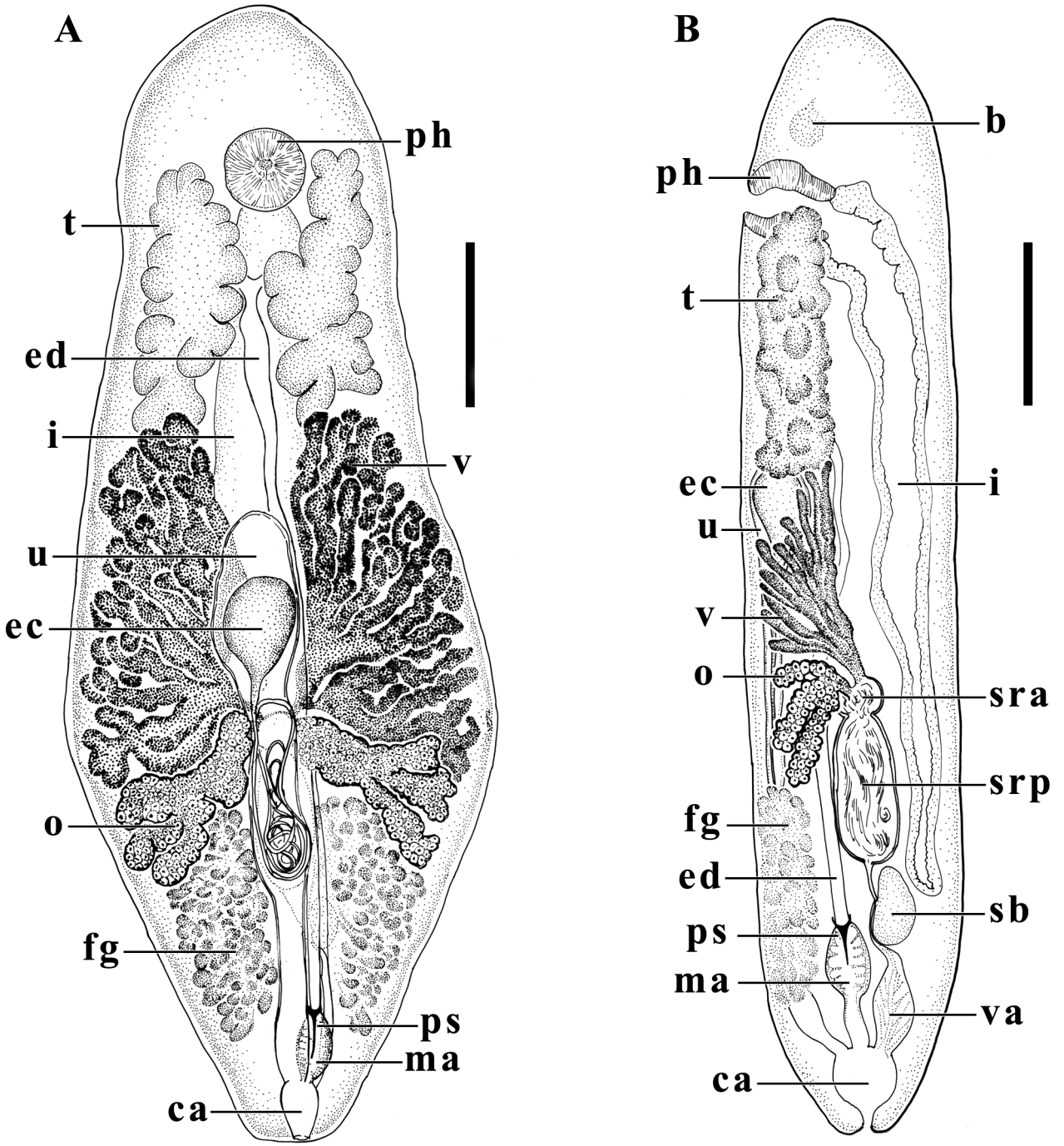

FIGURE 2. *Syndesmis patagonica*, new species. **A.** Entire worm, dorso-ventral view. **B.** Sagittal reconstruction. Scale bars: A and B = 200 µm. Abbreviations: b, brain; ca, common antrum; ec, egg capsule; ed, ejaculatory duct; fg, filament glands; i, intestine; ma, male antrum; o, ovary; sb, seminal bursa; sra, anterior portion of seminal receptacle; srp, posterior portion of seminal receptacle; ph, pharynx; ps, penis stylet; t, testis; u, uterus; v, vitellarium; va, vagina.

Other material: Ten whole-mounted specimens. Two sectioned specimens.

Type host: *Arbacia dufresnii* (Echinodermata: Echinoidea).

Site of infection: Digestive tract.

Etymology: The species is named after the geographic region of the type locality (Patagonia, Argentina).

Prevalence of infection: 9.2% (11 infected hosts out of 120 specimens examined).

Intensity of infection: 1–15 worms per host.

Diagnosis: Pinkish living worms up to 2.3 mm long. Mouth anteroventral, doliiform pharynx, dorsal

intestine, extending posteriorly. Anterior paired testes, slightly lobulated. Short hard penis stylet, 25–50 µm long, beginning at collar like structure and projecting into male antrum. Male antrum opening into common genital atrium. Genital pore at posterior tip of body. Vitellaria posterior to testes, with 3–6 primary branches, each divided once or twice. Paired ovaries posterior to vitellaria. Filament glands in posterior quarter of body. Mature egg capsules ovoid, amber, with long whip-like filament on one pole. This species can be clearly distinguished from all other species in the genus by having the shortest penis stylet ever registered in species of *Syndesmis*.

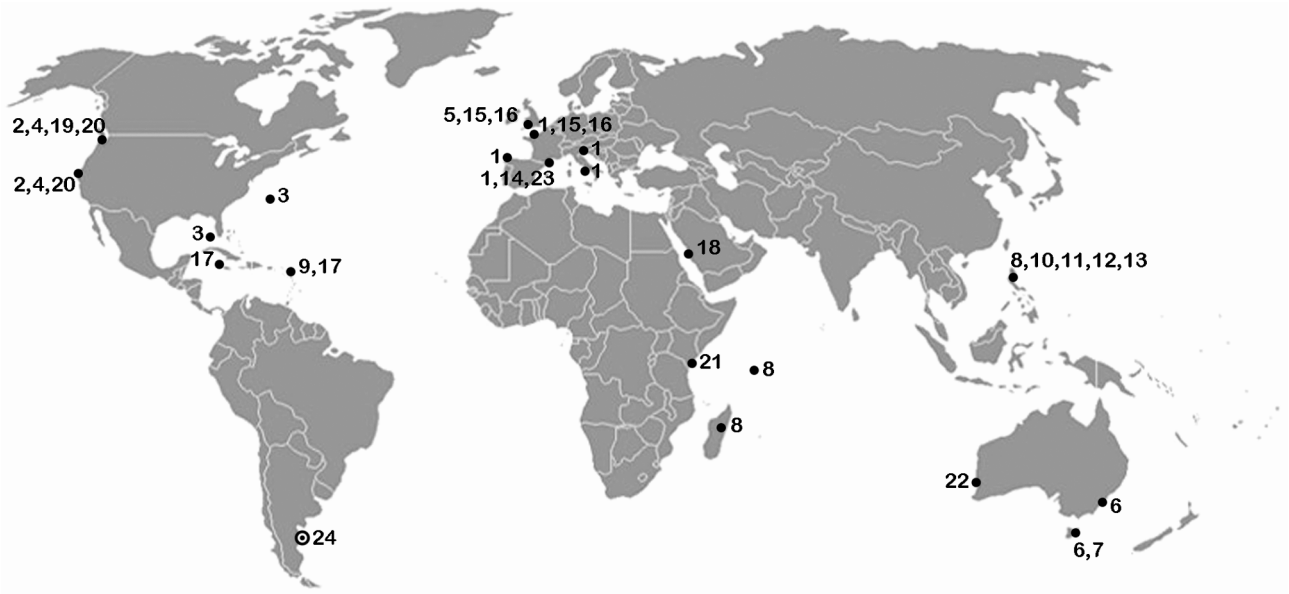

FIGURE 3. Geographical distribution of species of *Syndesmis*. **1.** *Syndesmis echinorum*. **2.** *S. franciscana*. **3.** *S. antillarum*. **4.** *S. dendrastrorum*. **5.** *S. atriovillosa*. **6.** *S. punicea*. **7.** *S. pallida*. **8.** *S. glandulosa*. **9.** *S. evelinae*. **10.** *S. compacta*. **11.** *S. mammilata*. **12.** *S. philippinensis*. **13.** *S. alcalai*. **14.** *S. aethopharynx*. **15.** *S. albida*. **16.** *S. rubida*. **17.** *S. collongistyla*. **18.** *S. obhoriensis*. **19.** *S. inconspicua*. **20.** *S. neglecta*. **21.** *S. longicanalis*. **22.** *S. cannoni*. **23.** *S. echiniacuti*. **24.** *S. patagonica* **n. sp.**

Description: Based on 14 specimens (whole mounts) and histological sections of 4 specimens. Worms 1.32–2.33 mm (1.68±0.30, n = 14) long, 0.40–0.69 mm (0.59±0.08, n = 14) maximum width at level of middle part of body. Living worms pinkish, slightly reddish at level of intestine. Mouth anteroventral, at end of first 1/7 of body length, opening into a doliiform pharynx. Pharynx 77–126 µm (104±14, n = 14) in diameter. Intestine dorsally, extending posteriorly from pharynx to beginning of last 1/6 of body length.

Paired testes on both sides of anterior body midline, 280–690 µm (390±118, n = 14) long, 100–230 µm (154±38, n = 14) wide, slightly lobulated, extending from posterior half of pharynx to posterior first 1/3 of body length, slightly overlapping vitellaria posteriorly. Ejaculatory duct close to midline, without coils or notorious loops, seminal vesicles not observed. Short hard penis stylet, beginning at collar like structure and projecting into male antrum, 25–50 µm (36±10, n = 13) long, stylet length to body length ratio 1:24–73 (1:50±1:15, n = 13). Male antrum opening into common genital atrium. Genital pore at posterior tip of body.

Vitellaria posterior to testes, 320–640 µm (503±85, n = 14) long, 180–300 µm (250±39, n = 14) wide, having 3–6 primary branches, each divided once or twice. Paired ovaries posterior to vitellaria, longest lobe 180–270 µm (219±35, n = 14) long, with 3–5 terminal lobes. Vitellaria and ovaries enter seminal receptacle at its anteriormost portion. Seminal receptacle formed by a spherical anterior portion, becoming elongated posteriorly, lumen with sperm. Seminal bursa posterior to seminal receptacle. Proximal part of vagina joining seminal bursa through bursal valve. Vagina gradually wider distally, reaching common genital atrium. Uterus ventrally, about 2/3 of the body length. Entry of uterus into common genital atrium ventral to entrances of male antrum and vagina. Filament glands occupying almost whole posterior quarter of body, 220–630 µm (368±119, n = 14) long, 100–170 µm (134±23, n = 14) wide. Mature egg capsules ovoid, 111–148 µm (128±14, n = 7) long, 87–98 µm (93±9, n = 7) wide, amber in color, with long whip-like filament on one pole.

Discussion

Including the species herein described, there exists a total of 24 valid species of *Syndesmis* (Beltagi & Mandura 1991; Doignon & Artois 2006) (see Table 1). *Syndesmis patagonica* **n. sp.** can be easily distinguished from 19 species of *Syndesmis* based on the length of the penis stylet. *Syndesmis patagonica* **n. sp.** has the shortest stylet registered for the genus so far (25–50 µm long), being 50 times shorter than the body length. Only 4 other species have been described as possessing penis stylets shorter than 100 µm: *Syndesmis cannoni* Jondelius, 1996, *Syndesmis aethopharynx* Westervelt & Kozloff, 1990, *Syndesmis dendrastrorum* Stunkard & Corliss, 1951, and *Syndesmis obhoriensis* Beltagi & Mandura, 1991. *Syndesmis patagonica* **n. sp.** can be clearly distinguished from these 4 species by the position of the testes. Whereas the testes extend anteriorly to the level of the pharynx in *S. patagonica* (Figs. 1, 2), they are situated closer to the center of the body in *S. cannoni*, *S. aethopharynx*, *S. dendrastorum*, and *S. obhoriensis*.

TABLE 1. Summary of valid species of *Syndesmis*. Measurements are given as the mean followed by the range between brackets. Measurements in italic indicate an estimated value from the original description (originally given as proportions of total body length). Echinoid species in bold indicate irregular sea urchins. References in bold indicate the authority for the original description of the species.

Umagillid species	Body length (mm)	Body width (mm)	Penis stylet length (µm)	Echinoid host(s)	Reference(s)
Syndesmis echinorum	(5.00 largest)	1.20	200	*Paracentrotus lividus*, *Sphaerechinus granularis*, *Psammechinus miliaris*	**François, 1886**; Kozloff & Westervelt, 1987
Syndesmis franciscana	(2.00–3.00); 1.85 (1.56–2.01)	(1.60–2.50); 1.02 (0.95–1.05)	(*666–1,000*)	*Strongylocentrotus franciscanus*, *S. pallidus*, *S. droebachiensis*, *S. purpuratus*, *Lytechinus anamesus*	**Lehman, 1946**; Jennings & Mettrick, 1968
Syndesmis antillarum	(1.00–1.50)		(*333–500*)	*Diadema antillarum*	**Stunkard & Corliss, 1951**
Syndesmis dendrastrorum	(1.00–2.50); (0.52–1.23)	(0.26–0.66)	74	***Dendraster excentricus***	**Stunkard & Corliss, 1951**; Smith, 1973
Syndesmis atriovillosa	2.00		150	***Spatangus purpureus***	**Westblad, 1953**
Syndesmis pallida	(1.30–1.70)	(0.80–1.16)	(134–137)	***Echinocardium cordatum***	**Hickman, 1956**
Syndesmis punicea	(2.00–4.70)	(1.20–2.40)	668	*Heliocidaris erythrogramma*, *Amblypneustes ovum*	**Hickman, 1956**
Syndesmis glandulosa	1.90 (1.43–2.67); 1.40	0.85 (0.62–1.13)	270 (228–305)	*Diadema setosum*, *Echinothrix calamaris*	**Hyman, 1960**; Komschlies & Vande Vusse, 1980a
Syndesmis evelinae	1.60 (0.99–2.43)	0.73 (0.41–1.00)	320 (190–368)	*Echinometra lucunter*	**Marcus, 1968**; Hertel & Duszynski, 1991
Syndesmis compacta	1.02 (0.80–1.16)	0.63 (0.58–0.79)	300 (228–348)	*Echinometra oblonga*	**Komschlies & Vande Vusse, 1980**a
Syndesmis mammilata	1.77 (1.29–2.22)	0.65 (0.57–0.76)	280 (192–360)	*Echinometra oblonga*	**Komschlies & Vande Vusse, 1980**b
Syndesmis philippinensis	2.00 (1.43–3.09)	1.48 (0.98–2.09)	500 (260–600)	*Echinometra oblonga*	**Komschlies & Vande Vusse, 1980**b

continued next page

TABLE 1. (continued)

Umagillid species	Body length (mm)	Body width (mm)	Penis stylet length (µm)	Echinoid host(s)	Reference(s)
Syndesmis alcalai	1.99 (1.65–2.32)	1.14 (0.76–1.50)	309 (252–408)	*Heterocentrotus mammilatus*	**Komschlies & Vande Vusse, 1980**b
Syndesmis aethopharynx	(4.00 largest)	1.20	50	*Paracentrotus lividus*	**Westervelt & Kozloff, 1990**
Syndesmis rubida	3.50	1.30	170–190	*Echinus esculentus*	**Kozloff & Westervelt, 1990**
Syndesmis albida	3.50	1.00	1,000	*Echinus esculentus*	**Kozloff & Westervelt, 1990**
Syndesmis collongistyla	1.80 (1.10–2.80)	1.10 (0.70–1.50)	981 (640–1,350)	*Echinometra lucunter, E. viridis, Lytechinus variegatus, L. williamsi, Tripneustes ventricosus*	**Hertel *et al.*, 1990**
Syndesmis obhoriensis	(3.00–4.00)	(0.70–1.80)	very short	*Echinothrix diadema*	**Beltagi & Mandura, 1991**
Syndesmis inconspicua	(5.00 largest)	2.50	200	*Strongylocentrotus droebachiensis*	**Westervelt & Kozloff, 1992**
Syndesmis neglecta	(3.50 largest)	2.00	(125–160)	*Allocentrotus fragilis*	**Westervelt & Kozloff, 1992**
Syndesmis longicanalis	1.55 (0.91–2.44)	0.86 (0.50–1.32)	478 (296–838)	*Tripneustes gratilla, Toxopneustes pileolus*	**Moens *et al.*, 1994**
Syndesmis cannoni	(0.90–1.20)		47–50	***Ammotrophus arachnoides***	**Jondelius, 1996**
Syndesmis echiniacuti	(3.10 largest)	1.00	180	*Echinus acutus*	**Kozloff, 1997**
Syndesmis patagonica	1.68 (1.32–2.33)	0.59 (0.40–0.69)	36 (25–50)	*Arbacia dufresnii*	Present study

Syndesmis patagonica is smaller than *S. aethopharynx* and *S. obhoriensis* (1.32–2.33 mm vs. 4.00 mm, 3.00–4.00 mm, respectively), and larger than *S. cannoni* and *S. dendrastrorum* (1.32–2.33 mm vs. 0.90–1.20 mm, 0.52–1.23 mm sensu Smith [1973], respectively) (Table 1). In addition, *S. patagonica* lacks the club-shaped pharynx described in *S. aethopharynx* (Westervelt & Kozloff 1990); and it has a pinkish color not mentioned for *S. dendrastrorum* and *S. obhoriensis* (Stunkard & Corliss 1951; Smith 1973; Beltagi & Mandura 1991). Besides the morphological differences among S. *cannoni,* S. *dendrastrorum* and *S. patagonica*, they all have been described from different groups of hosts. Whereas *S. cannoni* and *S. dendrastrorum* have been reported from irregular echinoids (*Ammotrophus arachnoides* [Clark] and *Dendraster excentricus* [Eschscholtz], respectively) (Stunkard & Corliss 1951; Jondelius 1996), *S. patagonica* was found inhabiting a regular echinoid (*A. dufresnii*).

To date, species of *Syndesmis* have been found infecting echinoids in 5 orders, viz., Clypeasteroida, Spatangoida, Diadematoida, Echinoida and Temnopleuroida (Doignon & Artois 2006). The discovery of *S. patagonica* in *A. dufresnii* respresents a new host record and the inclusion of the Arbacioida as hosts for umagillids. The genus *Syndesmis* has been reported from a total of 31 species of echinoids distributed in 20 genera; 87% are regular echinoids (sea urchins) and only 13% are irregular echinoids (Table 1). Umagillids seem to have some degree of specificity for their echinoderm hosts. Most of the species in *Syndesmis* (75% of the species) have only been registered from a single host species. Six species can have a wider range of hosts and are symbionts of at least 5 species of sea urchins in the Echinoida (e.g. *Syndesmis collongistyla* Hertel, Duszynski & Ubelaker, 1990; Table 1). Only 1 species, *Syndesmis punicea* Hickman, 1956, has been found in 2 different hosts, belonging to different orders of echinoids. All species of *Syndesmis* infecting irregular echinoids are host specific and are the only flatworms registered in these hosts. Most infections are monospecific (in 84% of host species), and only *Echinometra oblonga* (Blainville) has been found to be parasitized by up to 3 species of *Syndesmis* (Table 1).

It is worth noting that during the present survey, 120 specimens of *Pseudechinus magellanicus* (Philippi) (Temnopleuroidea), a sympatric species to *A. dufresnii*, were also checked for symbionts. No worms were found in *P. magellanicus*, so *S. patagonica* seems to show strict host specificity for *A. dufresnii*.

All species of *Syndesmis* have a restricted distribution (Fig. 3), with the exception of *S. glandulosa* Hyman, 1960 which has been reported from 2 different hosts in Philippines and Madagascar. *Syndesmis patagonica* also represents the first record of the genus in the South Atlantic (Fig. 3).

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