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Two new species of *Syndesmis* (Platyhelminthes, Rhabdozoa, Umagillidae) from the sea urchin *Pseudechinus magellanicus* (Echinodermata, Echinoidea) in the Southwestern Atlantic Ocean

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ABSTRACT

In this paper, we describe two new species of *Syndesmis* living in *Pseudechinus magellanicus* in the Southwest Atlantic Ocean. The new species have a long stylet in the male reproductive system, which is different from that of the known species of the genus. Specimens of *Syndesmis selknamii* n. sp. have a ~220- μ m-long stylet (~1/3 of the body length, 0.69 mm). This ratio is unique because only four species (*Syndesmis echinorum*, *Syndesmis rubida*, *Syndesmis inconspicua* and *Syndesmis echiniacuti*) have similar stylet lengths but are larger in body sizes (3–5 mm). Specimens of *Syndesmis aonikenki* n. sp. have a ~148- μ m-long stylet (~1/10 of the body length, 1.11 mm). *Syndesmis pallida* has a similar ratio but the uterus is located posteriorly, and the filament glands are very small and located in the posterior region of the body. These are the first flatworms reported parasitizing *Pseudechinus magellanicus*.

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1. Introduction

Platyhelminthes have colonized a wide variety of environments and lifestyles. They include worms with free living mode of life, parasites, and intermediate symbiont forms. Among those that have adapted to a parasitic life, some small groups of non-Neodermata (“Turbellaria” parasites) parasitize different groups of marine invertebrates (mollusks, echinoderms, sipunculids). Among them, the family Umagillidae (Dalytyphloplanida) is well known for parasitizing sea urchins, holothuroids and sipunculids. This family is a natural group (Van Steenkiste et al., 2013) represented by 68 species of parasitic worms. The genus *Syndesmis* presents twenty-four species parasitizing the intestine and

coelomic cavity of sea urchins from different regions of the world (Brogger and Ivanov, 2010).

In the Southwest Atlantic Ocean, there are some records of turbellarian parasites of invertebrates (Brusa et al., 2006, 2011), but *Syndesmis patagonica* is the only known species of the genus that has been recorded parasitizing *Arbacia dufresnii* (Echinoidea, Arbaciidae) in the north Patagonian coast in Argentina (Brogger and Ivanov, 2010).

In this paper, we describe two new species of *Syndesmis* parasitizing *Pseudechinus magellanicus* (Echinoidea, Temnopleuridae) specimens collected during a campaign by the Oceanographic ship Puerto Deseado in the southern Argentinean Sea in January 2011.

2. Material and methods

Specimens of *Pseudechinus magellanicus* were collected with a bottom trawl net in the mouth of the Beagle Channel and north of Bahía Camarones in the Southwest Atlantic. They were fixed in 10% formalin and then dissected in the laboratory for the extraction of *Syndesmis* from the intestine. The whole mount

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specimens were stained in Gill's Hematoxylin, cleared in clove oil, mounted in Canada Balsam, and then observed by optical microscope for the study of the internal morphology. In addition, some specimens were cleared in polyvinyl-lactophenol to study the morphology of the stylet. Other specimens were serially sectioned (4 μm thick) with a microtome, and slides were stained with Masson's trichrome method (Suvarna et al., 2013) for reconstructions of the internal anatomy. The study specimens are deposited in the Invertebrate Collection at Museo de La Plata, La Plata, Argentina.

3. Results

Family Umagillidae Wahl, 1910
Genus *Syndesmis* François, 1886

3.1. *Syndesmis selknami* n. sp.

(Figs. 1–2).

3.1.1. Morphology

Worms 0.54–0.81 mm (0.69 ± 0.07 , $n = 8$) long, 0.35–0.47 mm (0.43 ± 0.02 , $n = 8$) maximum width at level of middle part of body (Figs. 1 and 2). Epidermis ciliated and epithelial cells taller in anterior region of body. In the anterior-dorsal region, there are invaginations of the body wall forming sensory pits (Fig. 2F), internally associated with projections on the brain. Mouth anteroventral, opening into a doliiform pharynx. Pharynx 62.5–75 μm (67.5 ± 6.94 , $n = 8$) in diameter. Vacuolated cells in the transition region between pharynx and intestine (Fig. 2E).

Paired testes on both sides of anterior body midline (Fig. 1), slightly lobulated, extending from posterior half of pharynx to posterior first 1/3 of body length, slightly overlapping vitellaria posteriorly (Fig. 1). The ejaculatory duct (Fig. 2C) connects the testes with a small seminal vesicle connected with the stylet by a narrow duct. Long penis stylet, beginning at funnel-like structure and projecting into male antrum, 190–250 μm (221.6 ± 30.13 , $n = 3$) long (Fig. 2D). Male antrum muscle walls with circularly oriented, opening into a common genital atrium. Genital pore at posterior tip of body.

Massive vitellaria overlapping to posterior region of testes, slightly lobulated, fan-like. Paired ovaries between vitellaria and filament glands, overlapping both. They are lobulated. Filament glands grouped in the last part of the body (Fig. 2).

Vitellaria join ovaries and enter the seminal receptacle at its anterior-most portion. Seminal receptacle (Fig. 2B and C) formed by spherical anterior portion, becoming elongated posteriorly, lumen with sperm. Vagina gradually wider distally, reaching a 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 third of body. Mature egg capsules ovoid, with the opening area forming by small plates (Fig. 2B and C). Eggs 100–132.5 μm (117.5 ± 13.38 , $n = 4$) long, 62.5–85 μm (68.125 ± 11.25 , $n = 4$) wide, brown, with a long filament on one pole; filament long and in distal part rolled on itself (Figs. 1 and 2A); in some specimens, filament straight and thick and with distal region threaded with thickening at tip.

3.1.2. Etymology

This species is named in honor of the Selk'nam or Onas tribe

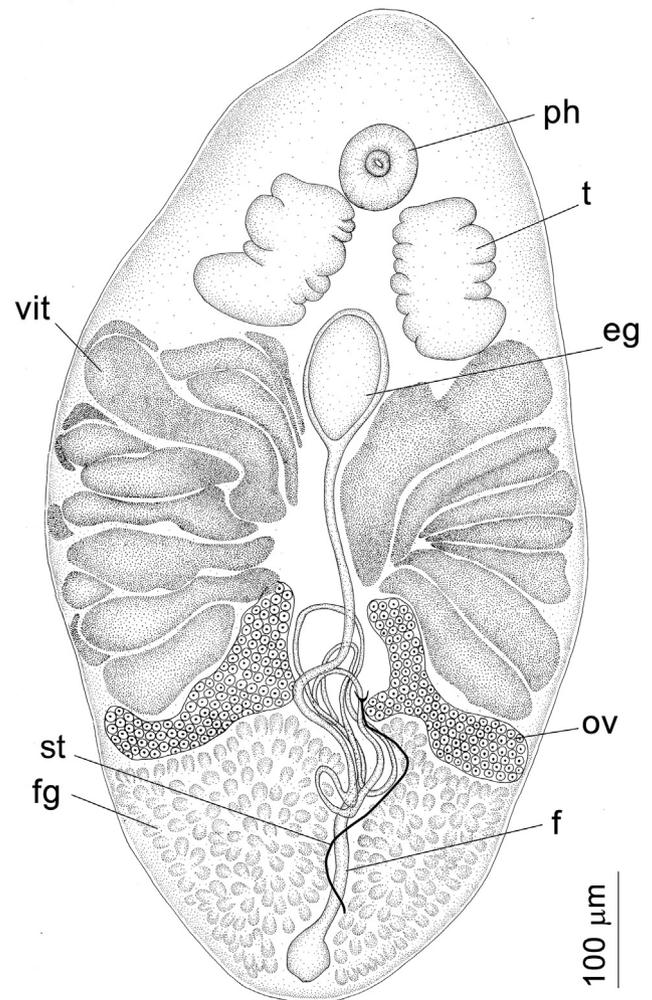


Fig. 1. Schematic reconstruction of *Syndesmis selknami* n. sp. in dorso-ventral view. Abbreviations: eg, egg; f, filament; fg, filament glands; ov, ovary; st, stylet; t, testes; vit, vitellaria.

who lived in the region where this species was found.

3.1.3. Study material

Eight whole mount specimens stained with Gill's Hematoxylin, three specimens cleared in polyvinyl-lactophenol and two specimens serially sectioned at 4- μm thick stained with Masson's trichrome method.

3.1.4. Specimens deposited

The studied specimens have been deposited at the Invertebrate Collection of Museo de La Plata. Holotype MLP-He 7266, whole mount specimen stained with Gill's Hematoxylin. Paratype MLP-He 7268, whole mount specimen stained with Gill's Hematoxylin. MLP-He 7273, sagittal section specimens stained with Masson's trichrome method.

3.1.5. Localities

Bahía Camarones (44° 51'2.09S, 65° 40'52W) and Beagle Channel (54° 10'2.4S, 65° 30' 0.8W).

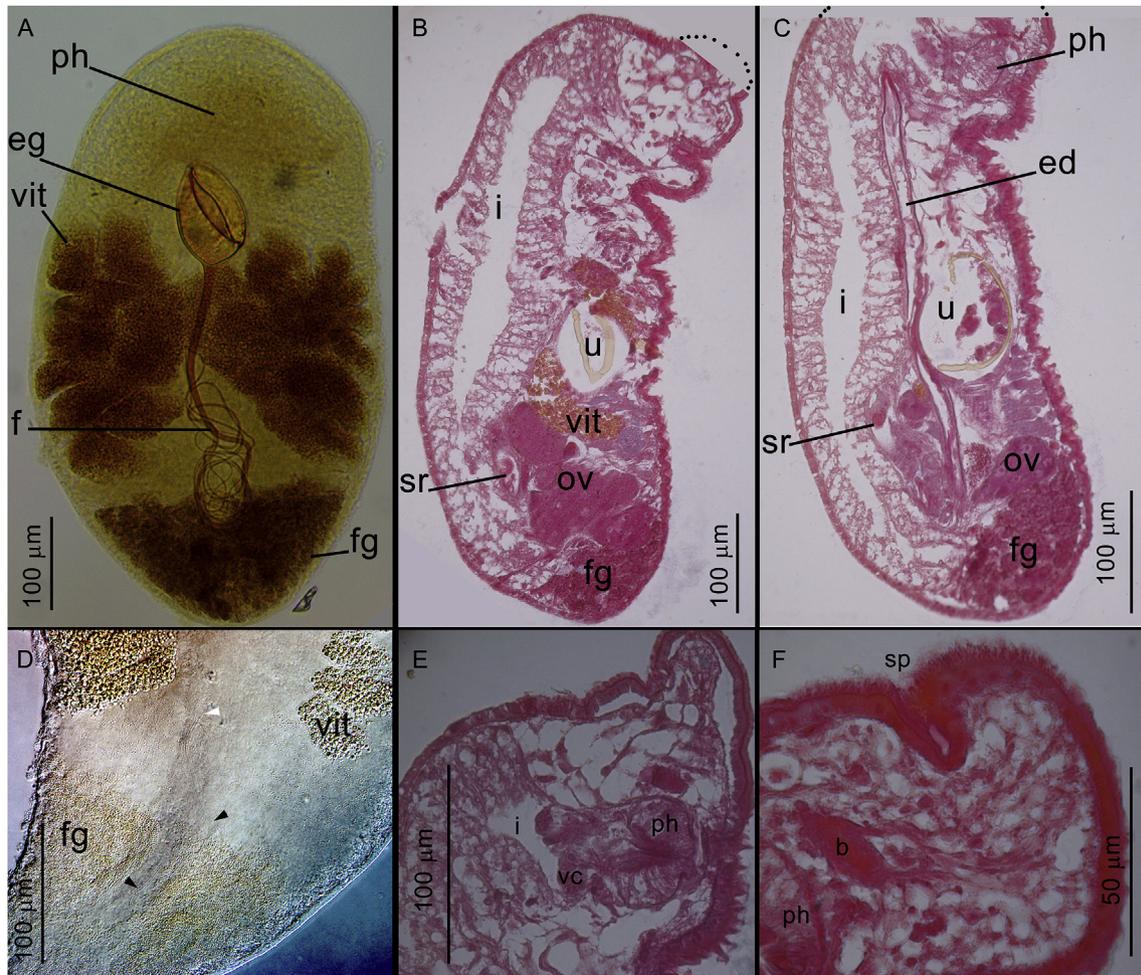


Fig. 2. *Syndesmis selknamii* n. sp. A, D, whole mount preparations. B, C, E, F, sagittal sections of the body. Abbreviations: b, brain; ed, ejaculatory duct; eg, egg; f, filament; fg, filament glands; i, intestine; ov, ovary; sp, sensory pit; sr, seminal receptacle; t, testes; u, uterus; vc, vacuolar cells; vit, vitellaria. The white arrow heads marks the proximal part of the stylet and black arrow heads mark the distal part.

3.1.6. Prevalence of infection

47% (17/36 urchins).

3.2. *Syndesmis aonikenki* n. sp.

(Figs. 3–4).

3.2.1. Morphology

Worms 0.74–1.56 mm (1.11 ± 0.26 , $n = 8$) long, 0.51–0.98 mm (0.75 ± 0.18 , $n = 8$) maximum width at level of middle part of body. Mouth anteroventral, opening into a doliiform pharynx. Pharynx 87.5–130 μm (108.54 ± 15.46 , $n = 12$) in diameter (Figs. 3 and 4).

Paired testes on both sides of anterior body midline, slightly lobulated, extending from anterior region of pharynx overlapping vitellaria posteriorly (Fig. 3). Ejaculatory duct close to midline, runs to the posterior body region, and coils posteriorly to the proximal stylet region (Fig. 4B); seminal vesicles not observed. Long penis stylet, beginning at funnel-like structure and projecting into male antrum, 105–220 μm (148.75 ± 50.22 , $n = 4$) long. Male antrum opening into a common genital atrium. Genital pore at posterior tip of body (Fig. 4A, C).

Vitellaria branched, reaching the pharynx region and

overlapping with testes, fan-like (Fig. 4A). Paired ovaries between vitellaria and filament glands, overlapping posterior vitellaria region. They are lobulated. The bodies of the filament glands are in the latero-posterior part of the body, reaching the posterior vitellaria region. The ducts of the filament glands meet before discharge in the last portion of the uterus.

Vitellaria and ovaries enter a large and wide seminal receptacle at its anterior portion. The lumen of the seminal receptacle narrows posteriorly to form the vagina and connect the common genital atrium (Fig. 4C). Without seminal bursa. 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 third of body, almost lateral. Mature egg capsules ovoid, 90–125 μm (103.57 ± 12.89 , $n = 7$) long, 57.5–100 μm (81.07 ± 16.94 , $n = 7$) wide, brown in color, with a long filament on one pole (Figs. 3 and 4A). This filament is straight and thick and then has its distal region threaded (Fig. 4A) sometimes thickening at tip.

3.2.2. Etymology

This species is named in honor of the Aonikenk or Tehuelche who lived in the region where this species was found.

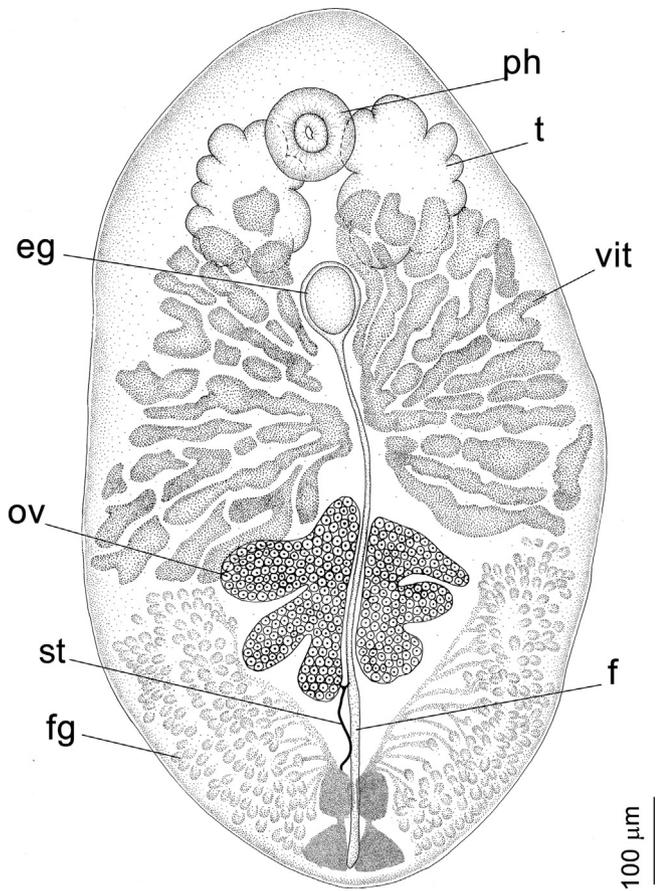


Fig. 3. Schematic reconstruction of *Syndesmis aonikenki* n. sp. in dorso-ventral view. Abbreviations: eg, egg; f, filament; fg, filament glands; ov, ovary; st, stylet; t, testes; vit, vitellaria.

3.2.3. Study material

Eight whole mount specimens stained with Gill's Hematoxylin, three specimens cleared in polyvinyl-lactophenol and one specimen serially sectioned at 4- μ m thick stained with Masson's trichrome method.

3.2.4. Specimens deposited

The studied specimens have been deposited at the Invertebrate Collection of the Museo de La Plata. Holotype MLP-He 7267, whole mount specimen stained with Gill's Hematoxylin. Paratype MLP-He 7269, whole mount specimen stained with Gill's Hematoxylin. MLP-He 7274, sagittal section specimen stained with Masson's trichrome method.

3.2.5. Localities

Bahía Camarones (44° 51'2.09S, 65° 40'52W).

3.2.6. Prevalence of infection

14% (5/36 urchins).

4. Discussion

The species described in this work have a combination of features that allow us to assign them to the genus *Syndesmis*. They are rhabdocoels that have a needle-like copulatory stylet

varying in length, a common gonopore at the rear end of the body, an egg with a long filament that can be rolled up, and filament glands located in the latero-posterior body region (Westblad, 1953).

Syndesmis selkhami n. sp. has a stylet of ~220 μ m in length, which is 1/3 of the body length (690 μ m). This relationship is unique because only four species have similar stylet lengths but are far larger in body sizes (3–5 mm). These species are *Syndesmis echinorum* François, 1886 (5 mm body length, 200 μ m stylet length), *Syndesmis rubida* Kozloff and Westervelt, 1990 (3.5 mm body length, 170–190 μ m stylet length), *Syndesmis inconspicua* Westervelt and Kozloff, 1992 (5 mm body length, 200 μ m stylet length) and *Syndesmis echiniacuti* Kozloff, 1997 (3.1 mm body length, 180 μ m stylet length). *S. echinorum*, *S. inconspicua* and *S. rubida* have a different body shape, with the rear end tapered, the ovaries are larger and more branched, and the filament glands have a lateral position, associated with the different body shape. In *S. echiniacuti*, lobed testes are located more distant from the pharynx and ovaries are larger. In addition, all these species have been recorded in the northern hemisphere (Europe and the US coasts) associated with different species of sea urchins (Brogger and Ivanov, 2010).

Syndesmis aonikenki n. sp. has a stylet ~148 μ m in length, which is slightly more than 1/10 of the body length (1.1 mm). These features can be compared with three species of the genus: *Syndesmis atriovillosa* Westblad, 1953 (2 mm body length, 150 μ m stylet length), *Syndesmis pallida* Hickman, 1956 (1.3–1.7 mm body length, 134–137 μ m stylet length), and *Syndesmis neglecta* Westervelt and Kozloff, 1992 (3.5 mm body length, 125–160 μ m stylet length). In *Syndesmis pallida*, the ratio between the length of the stylet and the size of the body is similar to that of *Syndesmis aonikenki*. However, the uterus in *S. pallida* is located posteriorly and the filament glands are very small and located in the posterior region of the body. *Syndesmis atriovillosa* has the vitellaria located more posteriorly, ovaries are massive, and the filament glands are located differently. *Syndesmis neglecta* has the posterior body end tapered with filament glands occupying the entire posterior region, and, as in *S. atriovillosa*, the vitellaria are further posterior than in the new species. Only one of these three species has been recorded in the southern hemisphere (*S. pallida* in Tasmania), whereas the other two are from Europe and the US (Brogger and Ivanov, 2010 and references therein).

The 24 known species of *Syndesmis* are host specific, parasitizing six orders of regular and irregular echinoids (Doignon and Artois, 2006; Brogger and Ivanov, 2010). Most species are found in the intestine of only one host species. A few echinoids have been reported as being parasitized by more than one species of *Syndesmis* (Komschlies and Vande Vusse, 1980a, b; Kozloff and Westervelt, 1990; Brogger and Ivanov, 2010). This is the case for the new species described here for the first time from *Pseudechinus magellanicus* in the Southwestern Atlantic Ocean. This finding adds a new Order (Temnopleuroida) to the group of host species that have more than one species of *Syndesmis*, since so far only five species of Echinoida were known to host more than one species of *Syndesmis*.

Similar to that recorded by Brogger and Ivanov (2010), who found no Umagillids parasitizing specimens of *Pseudechinus magellanicus* in northern Patagonia, we also examined 22 specimens of *Arbacia dufresnii* (Arbacioida, Arbaciidae) from the south Patagonian coast in Argentina, but found no worms. This leads us to suggest that the low prevalence of these worms masks their distribution and encourages us to continue studying more host

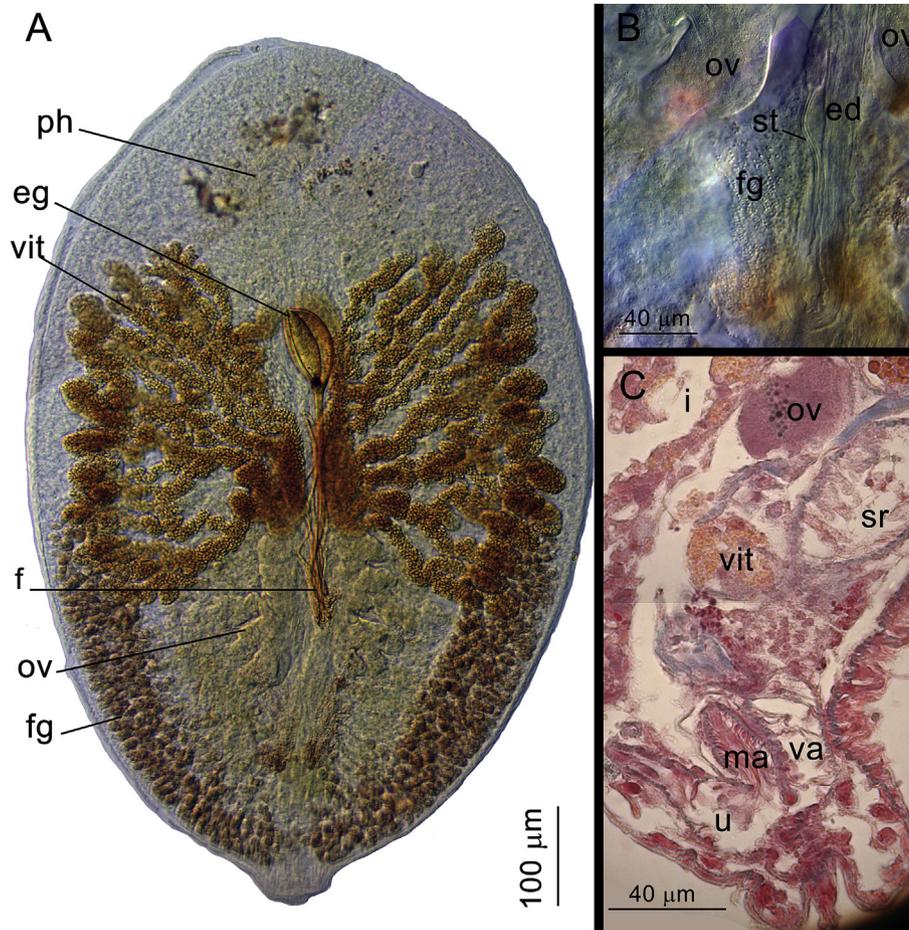


Fig. 4. *Syndesmis aonikenki* n. sp. A, B, whole mount preparations. C, sagittal section of the body. Abbreviations: ed, ejaculatory duct; eg, egg; f, filament; fg, filament glands; i, intestine; ma, male atrium; ov, ovary; sr, seminal receptacle; st, stylet; u, uterus; va, vagina; vit, vitellaria.

species from different regions of the South Atlantic to know their real distribution and be able to use the group in zoogeographic studies.

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