

# The parasite *Monascus filiformis* (Trematoda, Digenea, Fellodistomidae) on *Stromateus brasiliensis* (Pisces, Perciformes, Stromateidae): possible routes of transmission involving jellyfish

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*A new final fish host (Stromateus brasiliensis) for the digenean parasite Monascus filiformis from the continental shelf of Patagonia Argentina in the South-western Atlantic Ocean is reported. This demersal-pelagic fish (commonly denominated pampanito) is exclusively a jellyfish consumer. It is well known that larval stages of Monascus filiformis mostly use medusae as secondary hosts. Therefore, the pampanito likely acquires this parasite when it predate upon some species of parasitized medusae in the area. This work improves the knowledge about the final hosts of this parasite and infers which species of medusa may be involved in their life cycle.*

**Keywords:** Flatworm, digenean, pampanito, medusae, South-western Atlantic Ocean

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## INTRODUCTION

Trematodes (Digenea) have complex life cycles usually involving two invertebrates as intermediate hosts, and one vertebrate (predominantly fish) as the final host. The transfer of these parasites often involves different predator-prey interactions between the hosts (Rohde, 1993; Marcogliese, 1995; Martorelli, 2001).

It is well known that some species of digenean parasites on fish, such as *Monascus filiformis* (Rudolphi 1819) Looss, 1907, use medusae and chaetognaths as secondary hosts (Marcogliese, 1995; Martorelli, 2001; Daponte *et al.*, 2006). In recent years knowledge about the intermediate medusa hosts of this parasite has increased (Martorelli, 2001; Diaz Briz *et al.*, 2012), however, little is known about their complete life cycle and only 11 fish species around the world have been reported to be final hosts (Køie, 1979; Quintero-Alonso *et al.*, 1988; Girola *et al.*, 1992; Martorelli & Cremonte, 1998; Sey *et al.*, 2003; MacKenzie *et al.*, 2004; Oguz & Bray, 2006; Keser *et al.*, 2007; Kohn *et al.*, 2007).

In the South-western Atlantic Ocean, most records of final fish hosts of *Monascus filiformis* correspond to tropical waters (Brazil) (Amato, 1982; Wallet & Kohn, 1987; Pereira *et al.*,

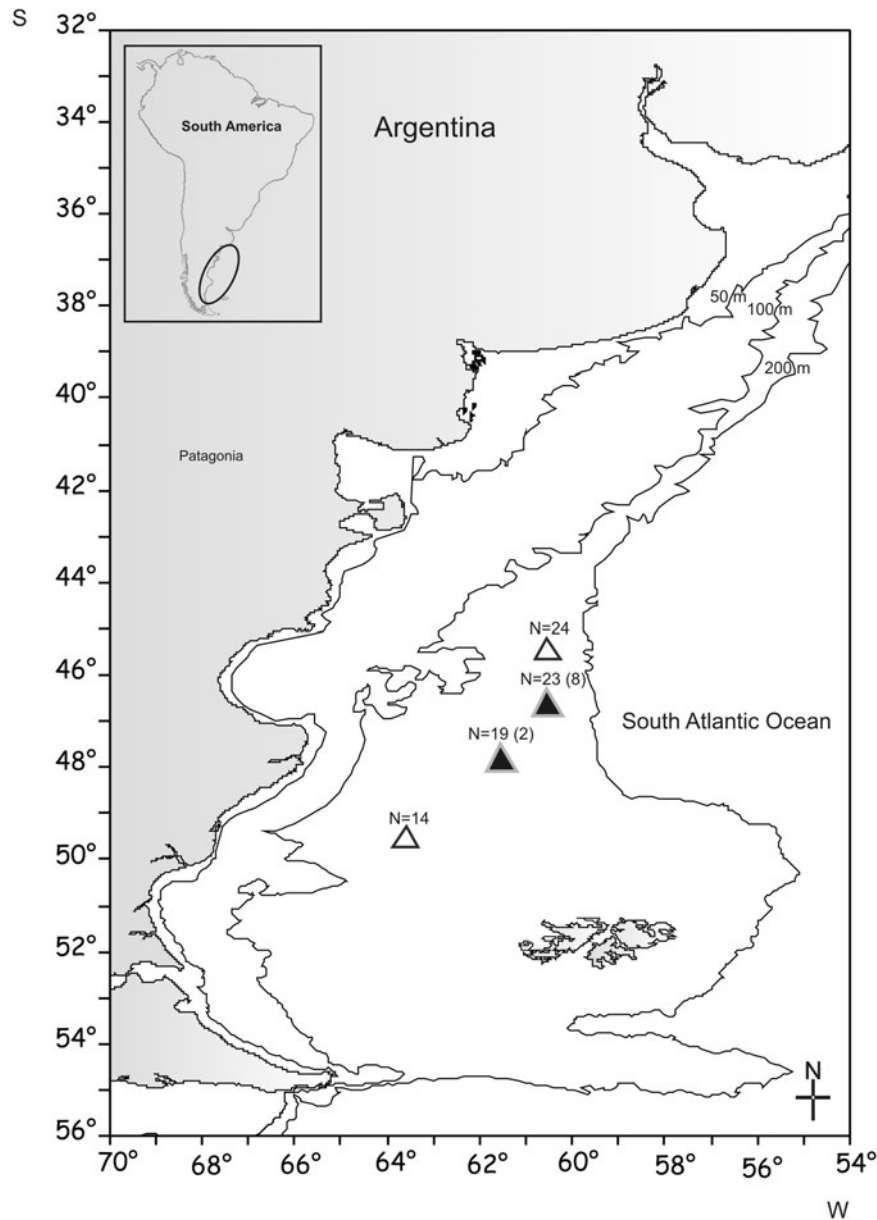
2000). For temperate waters (Argentina), information about fish hosts is scarce, and only one complete life cycle has been described for this parasite, involving the bivalve *Nucula obliqua* Lamarck, 1819 as first intermediate host, the hydromedusa *Liriope tetraphylla* (Chamisso and Eysenhardt, 1821) and the chaetognath *Saggita* sp. as secondary hosts, and the fish *Trachurus lathami* Nichols, 1920 as final host (Girola *et al.*, 1992; Martorelli & Cremonte, 1998).

As part of a project studying the role of gelatinous plankton in food webs, the gut content of many specimens of fish *Stromateus brasiliensis* Fowler 1906, from cold temperate waters of Patagonia (45°–49° S) was analysed. This demersal-pelagic fish (commonly denominated pampanito) is exclusively a jellyfish consumer (see Mianzan *et al.*, 1996; Cousseau & Perrota, 2000; Diaz Briz, 2014). In this work, we report for the first time the occurrence of *Monascus filiformis* on *Stromateus brasiliensis*, expanding the knowledge about the final hosts of this parasite, as well as the role of medusae as intermediate hosts of this parasite. We infer which medusa species of the area may be involved in the life cycle of this digenean.

## MATERIALS AND METHODS

The fish were collected on the Continental Shelf of Patagonia Argentina (45°–49°S 59°–63°W, see Figure 1) in the South-western Atlantic Ocean, by the cruise 'Eduardo

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**Fig. 1.** The study area (Patagonia Argentina continental shelf) with detail of stations sampled. Black triangles represent stations with specimens of *Stromateus brasiliensis* parasitized by *Monascus filiformis*; White triangles represent stations with specimens without parasites. For each station sampled, N represents the total number of specimens analysed and the numbers of parasitized fish are given in parentheses.

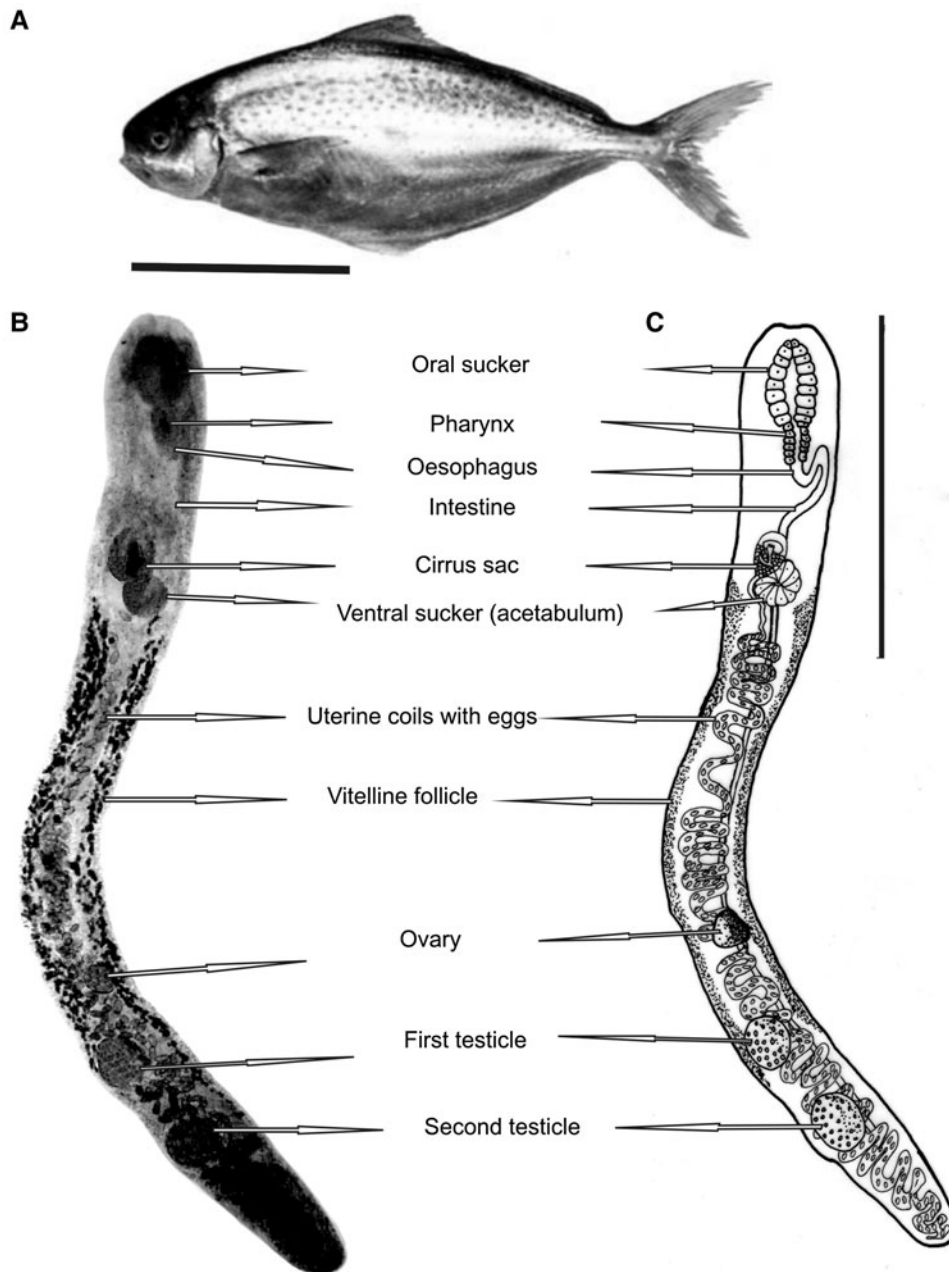
Holmberg' of Instituto Nacional de Investigación y Desarrollo Pesquero (INIDEP) during February 2009, using demersal trawls. They were frozen on board. In the laboratory, all gut contents of pampanito were examined under stereomicroscope to determine the presence of digenean parasites and gelatinous organisms. Digenean parasites were removed with dissection needles, fixed in 10% formalin and stained with Gill's Haematoxylin, dehydrated in an ethanol series, cleared in clove oil and mounted in Canada balsam. All measurements of 10 mature parasite individuals were taken using an ocular micrometer. The morphological features and measurements of these parasites corresponded with those previously reported by Køie (1979), Cribb *et al.* (1999), Sey *et al.* (2003) and Kohn *et al.* (2007). The ecological terminology used to estimate the prevalence followed the criteria of Bush *et al.* (1997) and Rózsa *et al.* (2000). The digeneans were kept in the collection

of the Mar del Plata University (UNMdP – Box PDMo1) and in La Plata Museum Helminthological Collection under the numbers MLP-He 7019.

Nematocysts (stinging organelles typical of cnidarians) found in the stomach contents of the parasitized fish were identified according to Mariscal (1974) and Östman (2000).

## RESULTS

A total of 80 specimens of *Stromateus brasiliensis* were analysed (Figure 2A). Ten of these hosted adult stages of *Monascus filiformis* within their gut contents (total prevalence 12.5%) (Figure 1). A total of 68 parasites were found, with intensities ranging between 1 and 24 parasites per fish.



**Fig. 2.** (A) The new final host *Stromateus brasiliensis*; (B) microscopic view of adult *Monascus filiformis* found in this study; (C) drawing of adult *M. filiformis*. Scale bars: A, 12 cm; B–C, 1.5 mm.

The following description is based on 10 *Monascus filiformis* (fixed and mounted specimens): Body elongated, 1593–4288  $\mu\text{m}$  (mean = 2603; SD = 965) length and 166–319  $\mu\text{m}$  (mean = 209; SD = 45.5) maximum width. Oral sucker subterminal, sub-globular to slightly elongated with a longitudinal aperture and usually larger than the ventral sucker 165–248  $\mu\text{m}$  (mean = 189.7; SD = 24.3)  $\times$  125–178  $\mu\text{m}$  (mean = 151.1; SD = 15.6). Acetabulum anterior, 95–130  $\mu\text{m}$  (mean = 117.6; SD = 14.02)  $\times$  106–120  $\mu\text{m}$  (mean = 112.8; SD = 4.8) Muscular pharynx 67–107  $\mu\text{m}$  (mean = 86.5; SD = 15.1)  $\times$  41–63  $\mu\text{m}$  (mean = 51.3; SD = 8.3), oesophagus with a proximal portion lined with integument and distal portion coated by bulky epithelial cells. Intestine with a blind left small arm and a right arm

that extends to the end of the body. Uroproct not present. Testes rounded in tandem located in the second body part. Cirrus pouch pre-acetabular containing bipartite seminal vesicle, prostate pars and ejaculatory duct. Genital pore located on the acetabular side of cirrus pouch. Ovary, lobed, in the middle third of the body. Uterine coils at the rear end of the body filled with operculated eggs 31–44  $\mu\text{m}$  (mean = 37.6; SD = 5.3)  $\times$  17–24  $\mu\text{m}$  (mean = 20.3; SD = 2.5) and vitelline follicles lateral, extending from near posterior level of acetabulum to mid-level between testes (Figure 2B, C).

The stomachs of parasitized fish presented completely digested contents with thick mucus appearance. Although no visible structures of jellyfish were observed, nematocysts were found in these stomach contents, and corresponded to the



**Fig. 3.** Microscopic view of nematocysts found in stomach contents of parasitized *Stromateus brasiliensis*. (A) spherical isorhizas; (B) oval isorhizas; (C) mastigophores. Scale bar: 15  $\mu\text{m}$ .

type of spherical and oval isorhizas (15–20  $\mu\text{m}$  of length) (Figure 3A, B) and mastigophores (40–50  $\mu\text{m}$  length) (Figure 3C). Other prey items were not found in these stomachs.

## DISCUSSION

In this study, the occurrence of *Monascus filiformis* is reported for the first time in the gut contents of *Stromateus brasiliensis* from cold temperate waters (Patagonia Argentina) of the south-western Atlantic Ocean.

A limited number of fish species in the world are known to be final hosts of this parasite. Prior to this study, *Monascus filiformis* had been reported in only two unnamed species of Pampus (Stromateidae) from India (Sey *et al.*, 2003), on *Cepola rubescens* (Cepolidae) from Italy, on *Selaroides leptolepis* (Carangidae) from Kuwait, on *Mugil ophuyseni* (Mugilidae) from China (Sey *et al.*, 2003), on *Trachurus trachurus* (Carangidae) from Denmark, Iberian Peninsula, Norway and Turkey (Køie, 1979; Lozano *et al.*, 2001; MacKenzie *et al.*, 2004; Oguz & Bray, 2006) and, on *Trachurus lathami* (Carangidae) from Venezuela (Nasir & Gómez, 1977). In the South-western Atlantic Ocean, *Monascus filiformis* has been found only in five species of fish from subtropical waters of Brazil: *Chloroscombrus chrysurus* (Carangidae) and *Trachurus lathami* (Carangidae) (Amato, 1982), *Oligoplites saurus* (Carangidae) (Travassos *et al.*, 1965, 1967), *Peprilus paru* (Stromateidae) (Wallet & Khon, 1987), *Micropogonias furnieri* (Sciaenidae) (Pereira *et al.*, 2000); and from cold temperate waters of Argentina it

was reported infesting only *Trachurus lathami* (Girola *et al.*, 1992).

The pampanito, *Stromateus brasiliensis*, has been considered a consumer of ctenophores (Marí, 1985; Mianzan *et al.*, 1996; Perrota & Cousseau, 2000); but it also predares heavily on medusae in the study area (Mianzan *et al.*, 1996; Diaz Briz, 2014). *Monascus filiformis* was never found in ctenophores. This digenean has been reported only in chaetognaths (Martorelli & Cremonese, 1998; Daponte *et al.*, 2006, 2008) and medusae (Martorelli, 2001; Diaz Briz *et al.*, 2012) in the area; however, chaetognaths are not a known food source of pampanito (Marí, 1985; Mianzan *et al.*, 1996; Cousseau & Perrota, 2000; Diaz Briz, 2014).

In this study different types of nematocysts (Figure 3) were found in the stomach contents of parasitized fish. This fact supports the idea that the transmission of *Monascus filiformis* occurs when parasitized medusae are eaten by pampanito. It is well known that medusae with high values of parasitism prevalence are considered important in the transmission of digenean to final fish hosts (Lauckner, 1980; Marcogliese, 2002; Diaz Briz *et al.*, 2012). The high prevalences (from 27 to 70%) of *Monascus filiformis* reported by Diaz Briz *et al.* (2012) in *Proboscoidactyla mutabilis*, *Aequorea* spp. and *Eucheilota ventricularis* in Patagonian waters, suggest that these hydromedusa species may be involved in the life cycle of this parasite (Figure 4). These medusae species show an overlapping distribution with the examined *Stromateus brasiliensis* (Cousseau & Perrota, 2000; Genzano *et al.*, 2008; Rodríguez, 2013). In addition, the morphological features (size and shape) of the nematocysts found in the stomachs of parasitized fish are consistent with some nematocysts that



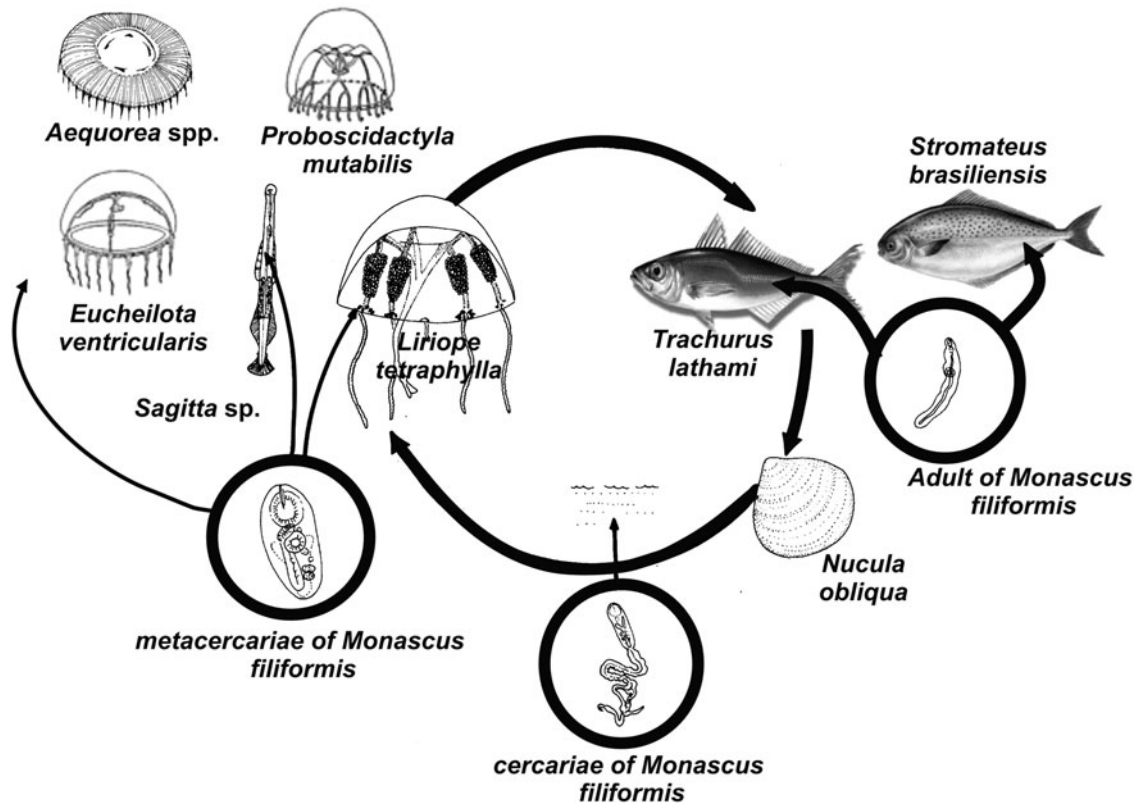


Fig. 4. Life cycle of *Monascus filiformis* and the potential routes of transmission in the area.

constitute the cnidae of these three medusa species (Diaz Briz, personal observation). Therefore, the presence of *Monascus filiformis* and nematocysts in gut contents of *Stromateus brasiliensis* would not be an occasional or isolated event but would be a consequence of their specific trophic habits.

This fish, unlike the other species belonging to suborder Stromateoidei, has anatomical adaptations in its digestive tract that facilitate the consumption of these gelatinous organisms. Among these adaptations are the specialized pharyngeal sacs covered with buds and conical horn-denticles that serve to crush the gelatinous prey and prevent regurgitation, a large stomach to store greater amounts of food and long digestive tracts (Haedrich, 1967; Macpherson, 1983; Harbison, 1993).

It is well known that parasites use predator–prey relationships among their hosts to facilitate their transmission (Marcogliese, 1995). Therefore, their presence within a host population provide information on the host's diet and on the predators of the host, as well as the trophic role of the host in the marine food web (see Marcogliese, 2004, 2005).

Even though predation by fish on jellyfish has not yet been determined through parasitism (Arai, 2005), a high prevalence of digenean parasites in medusae allows us to infer that jelly may have an important role in the transmission of parasites to their final fish hosts (Lauckner, 1980; Marcogliese, 2002; Diaz Briz *et al.*, 2012). Therefore, we hypothesized that the medusa species with high prevalences above mentioned from the area could be important for the transmission of *Monascus filiformis* to pampanito. Hence, we propose that the final host, *Stromateus brasiliensis*, may acquire the parasite by eating these infected medusae in the area (see Figure 4).

Thus, our studies have expanded our knowledge of the final hosts of *Monascus filiformis* as well as the secondary medusa

hosts that may be involved in its life cycle in the area. Future studies about the life cycles of these digeneans, seasonality in medusae hosts, and distribution of their first intermediate and final fish hosts will allow us to achieve a better understanding of the role that gelatinous plankton have in local pelagic food webs.

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