

Ligophorus saladensis n. sp. (Monogenea: Ancyrocephalidae) from *Mugil platanus* Günther in Samborombón Bay, Argentina

Paula S. Marcotegui · Sergio R. Martorelli

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Abstract *Ligophorus saladensis* n. sp. (Monogenea: Dactylogyridae) is described from the gills of the grey mullet *Mugil platanus* Günther collected in Samborombón Bay, Argentina. The new species differs from *L. mugilinus* Euzet & Suriano, 1977, *L. mediterraneus* Sarabeev, Balbuena & Euzet, 2005 and *L. huitermpe* Fernandez, 1987 by the morphology of the accessory piece of the male copulatory organ and mean values derived from measurements of the sclerotised hard-parts. This is the second report of monogeneans on *M. platanus* in the Southwestern Atlantic Ocean region and the first description of a species of *Ligophorus* Euzet & Suriano, 1977 from *M. platanus*. Some aspects of the speciation and host-specificity of *Ligophorus* spp. are discussed.

Introduction

Species of *Ligophorus* Euzet & Suriano, 1977 parasitise only mugilid fishes. Furthermore, each host species is infected by one particular species of this monogenean genus (Zhang et al., 2003).

The Mugilidae is represented by three species along the coast of the Southwest Atlantic Ocean

(Cousseau et al., 2005). In Argentine waters, the only mullet permanently present is the grey mullet *Mugil platanus* Günther (see Cousseau et al., 2005). This species is commercially exploited in Brazil and Argentina by inshore fisheries (250 tonnes per year), but its monogeneans have been poorly studied. According to Abdallah et al. (2009), 29 *Ligophorus* species have previously been reported from coastal mugilids of the North Atlantic and the Northwest and South Pacific Oceans. Recently, four species of the genus were reported on *M. lizae* (see Abdallah et al., 2009) from Brazilians waters and one more species on *M. platanus* from the coast of Uruguay (Failla Siquier & Ostrowski de Núñez, 2009).

We have recently collected specimens of *Ligophorus* from the gills of *M. platanus* in mixohaline Argentine South Atlantic waters. A detailed study of this fresh material indicated the presence of a new species, which is described herein.

Materials and methods

Samborombón Bay is located in the south-western region of the Río de La Plata estuary, between Punta Piedras (32°57'S; 57°08'W) and Punta Rasa (36°18'S; 56°48'W), along the northeast coast of Buenos Aires Province. This area encompasses Argentina's most extensive mixohaline wetland. Mulletts were collected in Samborombón Bay between 2006 to 2007 using cast nets. The identification of the host species is

P. S. Marcotegui (✉) · S. R. Martorelli
CEPAVE (CCT—CONICET—LA PLATA)
(FCNyM-UNLP), 2 No. 584, La Plata,
Buenos Aires CP: 1900, Argentina
e-mail: pmarcotegui@fcnym.unlp.edu.ar

according to Cousseau et al. (2005). Live fish were transported to the laboratory in containers filled with estuarine water and held in oxygenated aquaria prior to their examination. A total of 53 fish, ranging in total length from 2.8 to 25.0 cm, were examined for parasites. Excised gills from freshly killed fishes were examined under a dissecting microscope, and monogeneans were collected, heat-fixed without pressure, preserved in 10% formalin and mounted in glycerine-jelly for study. In order to study details of their internal anatomy, 25 specimens of monogeneans were heat-fixed under press, preserved in 10% formalin, then stained with Van Cleave's haematoxylin, passed through a series of increasing ethanol concentrations between 70 and 100%, cleared in clove oil and mounted in Canada balsam. Other specimens were stained using Gomori's stain for studying the sclerotised hard-parts.

Measurements and drawings were made using a Nikon Optiphot-2 microscope with DIC optics at magnifications of $\times 400$ and $\times 1,000$ and a Wild M20 microscope at a magnification of $\times 1,500$ for the sclerotised hard-parts and internal organs. Figures were prepared with the aid of a drawing apparatus. Microphotographs of the sclerotised structures were taken using DIC optics on an Olympus microscope and with an Olympus digital camera. Measurements are given in micrometres as the mean \pm standard deviation with the range in parentheses.

Sclerotised structures were measured as defined in Sarabeev & Balbuena (2004) and Rubtsova et al. (2006, 2007). The following abbreviations for the characters are used throughout the text: APL, MCO accessory piece total length; APUL, MCO accessory piece distal portion of upper lobe length; APUW, MCO accessory piece distal portion of upper lobe width; APSHL, MCO accessory piece upper lobe shaft length; APLL, MCO accessory piece lower lobe length; BL, body length; BW, body width; DAA, dorsal anchor total length; DAB, dorsal anchor main part length; DAC, dorsal anchor outer root length; DAD, dorsal anchor inner root length; DAE, dorsal anchor point length; DAF, dorsal anchor shaft length; DBL, dorsal bar length; MCO, male copulatory organ; MHTL, marginal hooklets total length; MHHL, marginal hooklet handle length; MCOL, total length of MCO; MHSL, marginal hooklet sickle length; VAA, ventral anchor total length; VAB, ventral anchor main part length; VAC, ventral anchor outer root length;

VAD, ventral anchor inner root length; VAE, ventral anchor point length; VAF, ventral anchor shaft length; VBAP, distance between membranous anterior processes (protuberances) of ventral bar; VBL, ventral bar length; VL, vagina length.

The identification of fish species is according to Cousseau et al. (2005).

Ligophorus saladensis n. sp.

Type-host: Grey mullet *Mugil platanus* Günther (Mugilidae).

Type-locality: Samborombón Bay, Buenos Aires, Argentina, between Punta Piedras ($32^{\circ}57'S$; $57^{\circ}08'W$) and Punta Rasa ($36^{\circ}18'S$; $56^{\circ}48'W$).

Site: Gills.

Type-material: Deposited in the Museo de la Plata, Invertebrates Collection. La Plata, Argentina. Registration numbers: holotype MLP 5933; paratypes MLP 5934.

Etymology: The species is named for the principal site where mullets were collected in Samborombón Bay, the Salado River estuary.

Description (Figs. 1–2; Table 1)

Worms with characters of genus as defined by Euzet & Suriano (1977) and Euzet & Sanfilippo (1983) supplemented by Sarabeev & Balbuena (2004). Body 532 (523–798) long; maximum width 132 (82–120) at level of gonads (Fig. 1A). Pharynx subspherical, 38 (28–32) \times 32 (37–51).

Testis 56 (35–69) \times 27 (24–42). MCO tubular, C-shaped; accessory piece claw-shaped (Fig. 1B), with lower lobe smaller than upper lobe; lower lobe broad with distal tip turned away from and not reaching level of upper lobe; upper lobe longitudinally grooved with straight distal end which gradually tapers, joining lower lobe medially at about level of maximum width of upper lobe. Ovary 105 (80–170) \times 60 (43–93), U-shaped. Vagina a long, thin, sclerotised tube, convoluted to straight, funnel-shaped distally; vaginal pore mid-ventral (Fig. 1C).

Haptor 64 (44–72) \times 113 (81–133). Ventral anchor with inner root longer and stouter than outer root and arched blade curved in distal half; short shaft and roots markedly thicker than blade. Ventral transverse bar connects ventral anchors, slightly

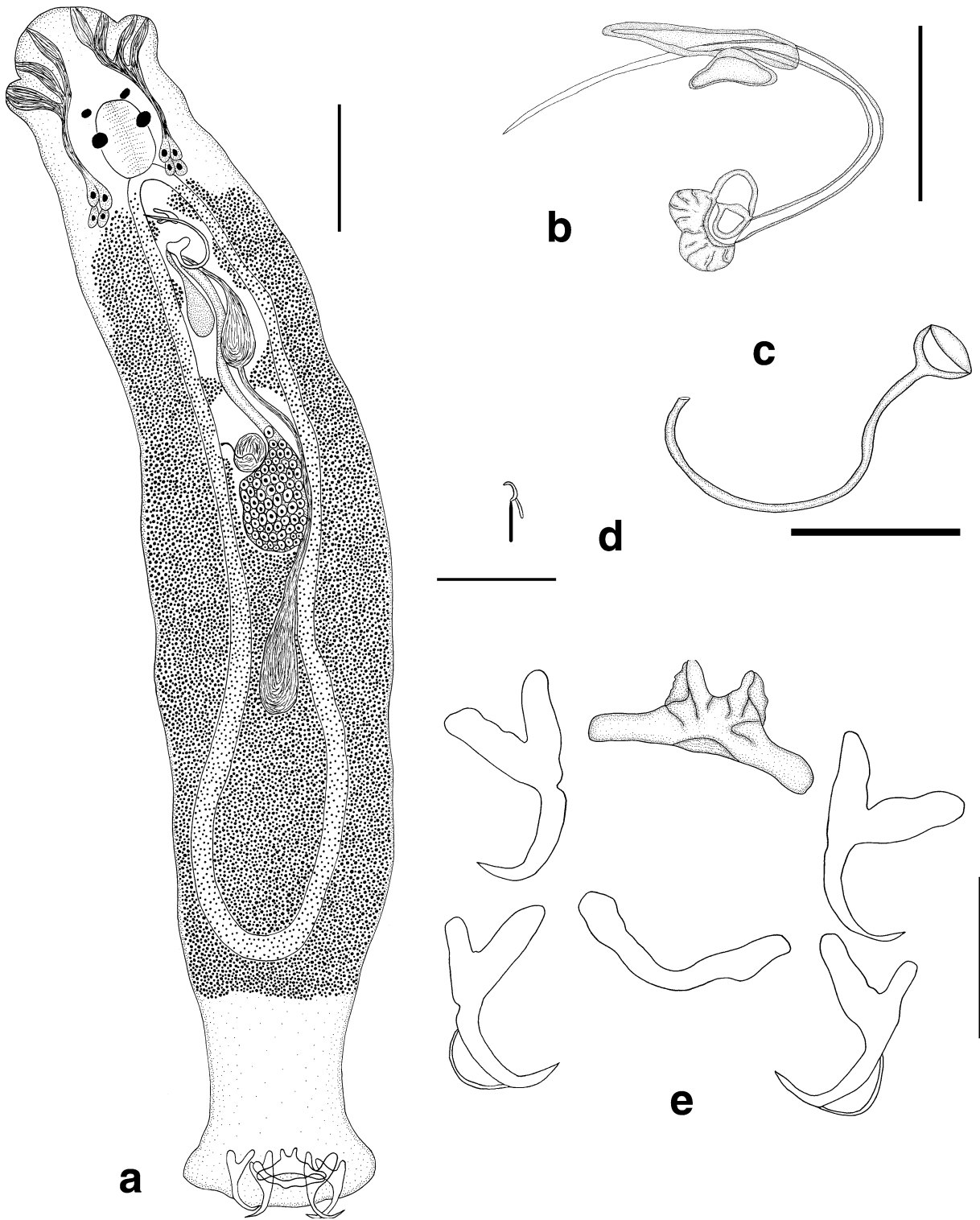


Fig. 1 *Ligophorus saladensis* n. sp.: A. entire worm, ventral view; B. male copulatory organ—tube and accessory piece; C. Sclerotised vagina; D. marginal hook; E. Anchors and bars. Scale-bars: A, 60 μ m; B–D, 25 μ m; E, 30 μ m

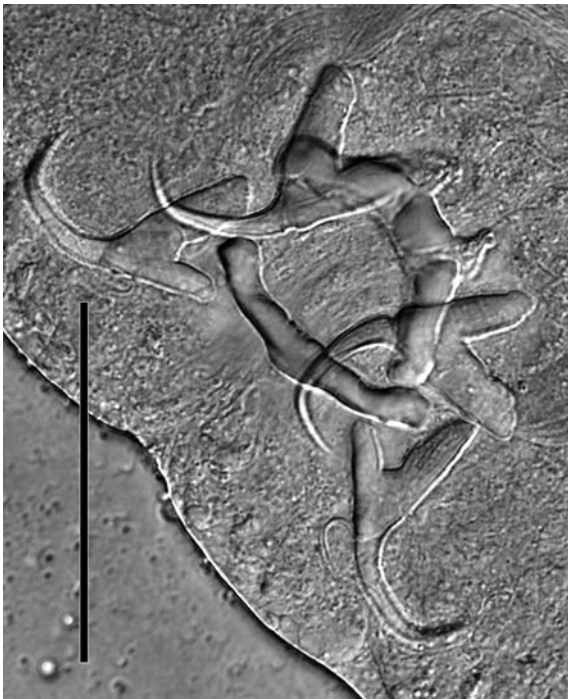


Fig. 2 *Ligophorus saladensis* n. sp.: photomicrograph of anchors and bars. Scale-bar: 50 μ m

bowed, with 2 submedian membranous protuberances contiguous with short median process, latter not reaching level of tip of protuberances. Dorsal anchor similar to ventral, but with slightly greater ratio between inner and outer roots; filament present. Dorsal transverse bar bowed, connects dorsal anchors (Figs. 1E, 2). All 14 marginal hooklets similar in shape and size, with straight handle and sickle (Fig. 1D).

Remarks

Among the *Ligophorus* species parasitising mugilids, *L. saladensis* n. sp. is similar to *L. mugilinus* Euzet & Suriano, 1977, *L. mediterraneus* Sarabeev, Balbuena & Euzet 2005 and *L. huitrempe* Fernandez, 1987. However, the new species can be distinguished from *L. mugilinus* by the shape of the ventral bar, which has a short, wide median process, and a funnel-shaped distal extremity of the vagina. Moreover, the measurements DAD and VBL are slightly smaller than in *L. mugilinus*. It differs from *L. mediterraneus* in the morphology of distal extremity of the accessory piece of the MCO (forwardly directed in the new species but curved backwards in *L. mediterraneus*).

L. saladensis can be also distinguished from *L. mediterraneus* by having smaller measurements VAE, MHTL and APL and longer VBL and VL. Dmitrieva et al. (2009) have recently redescribed *L. mediterraneus*, adding some morphological features, but the overall range of measurements has not been essentially changed. Finally, *L. saladensis* can be differentiated from *L. huitrempe* by the morphology of the accessory piece (U-shaped in *L. huitrempe* versus claw-shaped in the new species).

Recently, five new *Ligophorus* species have been described from South Atlantic waters. Abdallah et al. (2009) reported *L. tainhae* Abdallah, Azevedo & Luque, 2009, *L. brasiliensis* Abdallah, Azevedo & Luque, 2009, *L. guanduensis* Abdallah, Azevedo & Luque, 2009, and *L. lizae* Abdallah, Azevedo & Luque, 2009 on *M. liza* from the Guandu River, Brazil. These species differ mainly from the present new species in the morphology of the accessory piece of the MCO and most morphometric features (Table 1). *L. saladensis* has a smaller accessory piece in relation to the copulatory organ, whereas in *L. tainhae* the accessory piece is larger than the MCO. *L. brasiliensis* has the distal tip of the lower lobe of the accessory piece bifurcate, whereas in *L. saladensis* it is broad and not bifurcate. In *L. guanduensis* the lower lobe is longer than the upper lobe, rather than smaller, as it is in *L. saladensis*. In *L. lizae* the furcae of the terminal bifurcation of the accessory piece are equal in length, whereas in the new species are unequal. Finally, Failla Siquier & Ostrowski de Núñez (2009) reported *L. uruguayensis* Failla Siquier & Ostrowski de Núñez, 2009 (emend.) on *M. platanus* from Uruguayan waters. The new species differs from *L. uruguayensis* in the morphology of the accessory piece of MCO (J-shaped in *L. uruguayensis* versus claw-shaped in the new species), and by the absence of transverse annulations at the distal end of the vaginal tube and a thick process at the distal end of the inner root of ventral anchors. Additionally, the new species differs from *L. uruguayensis* by having a greater VBAP, APL and APLL (Table 1).

Discussion

This is the third report of monogeneans from mullet in the Southwest Atlantic Ocean and the second description of a species of *Ligophorus* from *Mugil*

Table 1 Measurements of the sclerotised features of *Ligophorus saladensis* n. sp., *L. huitrempe* Fernandez, 1987, *L. mugilinus* Euzet & Suriano, 1977, *L. mediterraneus* Sarabeev, Balbuena & Euzet, 2005, *L. uruguayensis* Failla Siquier & Ostrowski de Núñez, 2009, *L. tainhae* Abdallah, Azevedo & Luque, 2009, *L. brasiliensis* Abdallah, Azevedo & Luque, 2009, *L. guanduensis* Abdallah, Azevedo & Luque, 2009 and *L. lizae* Abdallah, Azevedo & Luque, 2009

Species	<i>L. saladensis</i>	<i>L. huitrempe</i>	<i>L. mediterraneus</i>	<i>L. mugilinus</i>	<i>L. uruguayensis</i>	<i>L. tainhae</i>	<i>L. brasiliensis</i>	<i>L. guanduensis</i>	<i>L. lizae</i>
Source	n. sp. Present study	Fernandez (1987)	Dmitrieva et al. (2009)	Sarabeev et al. (2005a, b)	Sarabeev et al. (2005a, b)	Sarabeev et al. (2005a, b)	Failla Siquier & Ostrowski de Núñez (2009)	Abdallah et al. (2009)	Abdallah et al. (2009)
	Range (mean)	Range	Range	Range	Range	Range	Range	Range	Range
VAA	29–38 (34)	35–38	32–39	30–38	28–42	41.2–44.5	44.1–44.8	42.7–46.6	48–49.3
VAB	21–33 (26)	24–27	24–28	22–27	20–31	32.8–37.2	28.7–30.2	33.6–35.2	32.7–35.7
VAC	10–15 (12)	9–11	11–15	8–11	7–14	7.7–11.5	8.7–9.6	10.4–13.3	6.2–8.2
VAD	16–23 (17)	13–15	15–18	16–20	8–20	15.5–19.8	24.7–25.1	16.2–19.1	21.1–22.4
VAE	9–12 (9)	8–10	8–9	9–10	6–11	10.3–10.8	13–13.9	10.3–11.7	13.3–13.6
VAF	17–22 (18)	–	17–20	–	–	24.3–25.8	20.1–22.4	22.1–26.4	21.6–23.1
DAA	31–37 (33)	32–35	30–38	28–41	28–46	42.9–45.6	40.7–41.8	41.4–42.6	27.3–48
DAB	24–28 (26)	25–27	24–28	24–29	19–33	35.2–37.2	31–31.8	30.1–31.7	36.3–38.1
DAC	7–10 (8)	6–8	8–10	7–10	6–15	6.7–7.2	9.5–10.5	10.1–11.1	9.9–11.3
DAD	10–16(15)	9–11	11–17	16–18	7–22	15.2–18.2	16.5–18	15.7–21.2	17.5–19.7
DAE	6–11 (8)	6–8	9–10	8–11	6–12	10–11	12–12.8	9.4–10.7	11.2–11.7
DAF	13–20 (17)	–	16–20	–	–	25.6–27.3	23.5–24.3	21.9–23.7	26.1–28
MHTL	11–15 (12)	12–15	11–12	12–13	8–13	14.7–15.7	12.9–14.5	13.3–14.8	14.2–14.8
MHSHL	6–9 (8)	–	–	–	–	8.9–9.5	7–7.6	8–9.3	7.9–9.8
MHSL	6–8 (7)	–	–	–	–	5.6–6.7	6.3–6.9	5.3–6.1	6–6.3
VBAP	6–10 (8)	4–5	17–21	–	–	4.9–5.3	2.5–2.9	5.3–5.7	5.1–5.7
VBL	53–62 (58)	36–40	36–46	37–57	33–56	50.4–56.2	54.3–56.8	55.2–57.8	53.6–55.2
DBL	31–44 (37)	36–40	37–46	32–51	31–55	53.4–57.7	59.8–60.9	56–63.2	65.9–67.2
APL	19–28 (21)	–	23–34	25–33	15–20	100.7–102.9	54.4–55.2	55.8–63.6	48.2–48.9
APUL	16–23 (19)	–	15–18	–	–	47.7–50	30–31	25.2–27.1	0–0
APUW	3–5 (4)	–	–	–	–	7.3–8.1	4.5–4.8	6.9–7.9	4.2–4.6
APSHL	6–9 (7)	–	–	–	–	52.4–55.7	39.3–40.3	37.7–39.4	0–0
APLL	12–14 (13)	–	4–6	–	8–12	44.9–46.3	20.6–21.6	25.8–28.2	0–0
MCOL	87–117 (105)	–	–	73–92	87–115	126.6–128.3	116–117	125.9–128.8	120.9–122.2
VL	55–65 (57)	–	47–60	29–69	12–71	28.2–30	41.3–41.9	57.2–77.3	51.2–53.9
VADVAC	1.01–1.93 (1.3)	–	–	1.58–2.1	1–2	1.6–2.2	2.6–3	1.3–1.6	2.7–3.6
DAD/DAC	1.08–2.58 (1.81)	–	–	1.44–1.85	0.5–3	2.3–2.7	2.5–2.9	1.5–2.0	1.6–1.9

platanus. The results presented here show that this *Ligophorus* species can be readily distinguished from other species of the genus by morphological features associated with the male copulatory organ and measurements of the sclerotised parts of the haptor. The new species exhibits a similar degree of morphometric variability as other species of *Ligophorus* (see Mariniello et al., 2004). Host size, variation in temperature and other environmental conditions are known to produce variations in the size of the hamuli and other haptor structures (Rohde, 1991), but these parameters were not recorded in the present study. Further detailed studies are needed to determine the effects of temperature and other environmental conditions on *Ligophorus* species.

All studied mugilids have been infected with more than one species of *Ligophorus* (see Dmitrieva et al., 2007), but *L. saladensis* n. sp. was the only monogenean species found during this study. Host-body size has been suggested by several authors as a good predictor of species richness in monogenean communities (Guégan et al., 1992). The fact that we collected specimens only from juveniles of *Mugil platanus* could explain the occurrence of only one species. Previous studies on *Ligophorus* have shown that they display a strict host-specificity in that each host species is infected by a complex of *Ligophorus* species that are not found on other mullets (Mariniello et al., 2004). Esch & Fernández (1993) have suggested that, due to the coastal preference of mugilids, the open ocean has acted as a geographical barrier favouring the speciation of monogeneans within disjunctive mullet populations. *M. platanus* inhabits the southern coast of Brazil through to the northern coast of Argentina, but only *L. uruguayensis* has previously been reported from this host. Despite the fact that Samborombón Bay is very close to the Uruguayan coast, we never found *L. uruguayensis* on *M. platanus*. It is clear that further studies on *M. platanus* over a greater area, with the inclusion of environmental data, are needed in order to better understand the speciation patterns of *Ligophorus*.

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