



## BIOLOGICAL SCIENCES

# ***Dendrapta nasicola* n. sp. (Copepoda: Siphonostomatoida: Lernaepodidae) a parasite from the olfactory sacs of *Bathyraja scaphiops* (Norman, 1937) in the South Western Atlantic**

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**Abstract:** During a parasitological survey of the olfactory sacs of 21 species of Rajiformes (Chondrichthyes) from the Southwestern Atlantic Ocean, copepods referable to *Dendrapta* Kabata (1964) (Siphonostomatoida: Lernaepodidae) were found parasitizing the cuphead skate *Bathyraja scaphiops* (Rajiformes: Arhynchobatidae). Morphological analyses using both light and electron microscopy revealed that they belong to a new species. It can be easily distinguished from its congeners by the ratio between lengths of posterior process and trunk (1:0.8), the large to width ratio of trunk (1:0.7) and the armature of the antennule (1, 1, 5 + 1 aesthete). *Dendrapta cameroni longiclavata* is raised to full specific status, as *Dendrapta longiclavata* n. comb. Kabata & Gusev, 1966.

**Key words:** *Bathyraja scaphiops*, *Dendrapta*, Mar Argentino, South West Atlantic.

## INTRODUCTION

*Dendrapta* Kabata, 1964 is a monotypic genus of lernaepodid copepods parasites of rajid fishes from the Northern Hemisphere. This genus was erected by Kabata (1964) to accommodate *D. cameroni* (Heller 1949), originally described as *Charopinus cameroni* Heller, 1949 from the external surface, near the fin bases, of *Amblyraja radiata* (Donovan, 1808) (as *Rajascabrata* Garman, 1913) from the coasts of Quebec, Canadian Atlantic. Later on, Kabata & Gusev (1966) described the subspecies *D. cameroni longiclavata* Kabata & Gusev, 1966 from the skin of the ocellate spot skate *Okamejei kenojei* (Müller & Henle, 1841), *Bathyraja smirnovi* (Soldatov & Pavlenko, 1915) (as *Raja kenojei* and *R. smirnovi*, respectively) and of an unidentified species of the same genus from the Kamchatkan Peninsula and Sakhalin Island, Russia. This subspecies was successively reported on *Raja inornata* Jordan &

Gilbert, 1880 from British Columbia and in the Canadian Pacific (Kabata 1970). To the best of our knowledge, the last report of a member of this copepod genus was that of *D. cameroni* on its type host, from the Canadian Atlantic (Khan et al. 1980).

During parasitological studies on the parasites of the olfactory sacs of 21 species of Rajiformes from the Argentinian continental shelf, Southwestern Atlantic, parasitic copepods referable to *Dendrapta* were found only on *Bathyraja scaphiops* (Norman, 1937). They were found to be representatives of an undescribed species of *Dendrapta*, which is herein described.

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## MATERIALS AND METHODS

A total of 851 skates belonging to 21 species of Rajiformes (Table I) were examined for parasites. Most fish were obtained from commercial trawlers in waters off the Buenos Aires province, Argentina, between 2013 and 2018. Additional samples of *Sympterygia bonapartii* Müller & Henle, 1841, *Dipturus brevicaudatus* (Marini 1933), *Amblyraja doellojuradoi* (Pozzi, 1935), *Bathyraja magellanica* (Philippi, 1902) and *Atlantoraja castelnaui* (Miranda Ribeiro, 1907) were caught during research cruises of the Instituto Nacional de Investigación y Desarrollo Pesquero (INIDEP) at similar and/or higher latitudes during 2011, 2012 and 2013.

The prevalence and mean intensity were calculated following Bush et al. (1997). Sterne's exact 95% confidence limits (CL) were calculated for prevalence using Quantitative Parasitology 3.0 software (QP3.0) (Reiczigel & Rózsa 2001, Reiczigel 2003).

Skates were examined fresh or kept frozen at  $-20^{\circ}\text{C}$  until examination. Olfactory sacs were excised and examined using a stereo microscope. In order to isolate copepods from host tissues, the entire attachment section was removed and the host remaining tissues, surrounding the holdfast, were degraded by enzymatic digestion with pepsin. Fifteen female copepods were fixed in 4% formalin for storage before being studied and measured. Two specimens were cleared in lactic acid; appendages were dissected and examined using a light microscope. Measurements are indicated in millimetres as mean  $\pm$  standard deviation, with ranges and number of specimens measured in parentheses. Anatomical terminology followed Boxshall & Halsey (2004), terminology of appendages armature and segmentation follows Kabata (1979).

For scanning electron microscopy (SEM), two specimens were dehydrated using a graded series of ethanol washed up to 100%, then dried by evaporation with hexamethyldisilazane, sputter-coated with gold palladium and examined using a JEOL JSM 6460LV SEM (JEOL, Tokyo, Japan).

Type material was deposited in the Carcinological Collection of the Museo de La Plata (MLP-Cr), La Plata, Argentina.

## RESULTS

*Bathyraja scaphiops* was the only rajiform species parasitized by *Dendrapta*. Subclass COPEPODA Milne Edwards, 1840;  
Order SIPHONOSTOMATOIDA Thorell, 1859;  
Family LERNAEOPODIDAE Milne Edwards, 1840;  
Genus *Dendrapta* Kabata, 1964.

### *Dendrapta nasicola* n. sp.

Adult female [based on 15 ovigerous specimens, including holotype, 10 paratypes and four additional specimens used for dissection and SEM]. Total body length (excluding posterior processes)  $11.1 \pm 1$  (9.7–12.8, 15). Cephalothorax heart-shaped,  $2.9 \pm 0.4$  (2.3–3.7, 15) long,  $3.2 \pm 0.3$  (2.9–3.8, 15) maximum width, slightly tilted ventrally to long axis of trunk (Figs. 1a, b; 2a, b), its posterior part fully occupied by maxillary basis (Figs. 2b; 3a), dorsal shield indistinct. Buccal cone situated anteriorly on ventral surface of cephalothorax (Figs. 2b; 3b). Trunk  $8.3 \pm 1.1$  (6.1–9.6, 15) long,  $5.8 \pm 0.5$  (5.2–6.8, 15) maximum width, with short anterior part (neck),  $1.6 \pm 0.2$  (1.4–2.0, 12) long part separated by shallow constriction from roughly pyriform posterior part,  $6.7 \pm 0.9$  (4.7–7.7, 15) long (Figs. 1a, b; 2a). Abdomen small, rather dorsal. Paired posterior processes situated on both sides of abdomen, club-shaped,  $6.7 \pm 1.0$  (5.3–8.9, 27) long, representing 81.0% (62.2–102.4)

**Table I. Composition of samples of 21 skate species in the Argentine Sea and population descriptors of *Dendrapta nasicola* n. sp.**

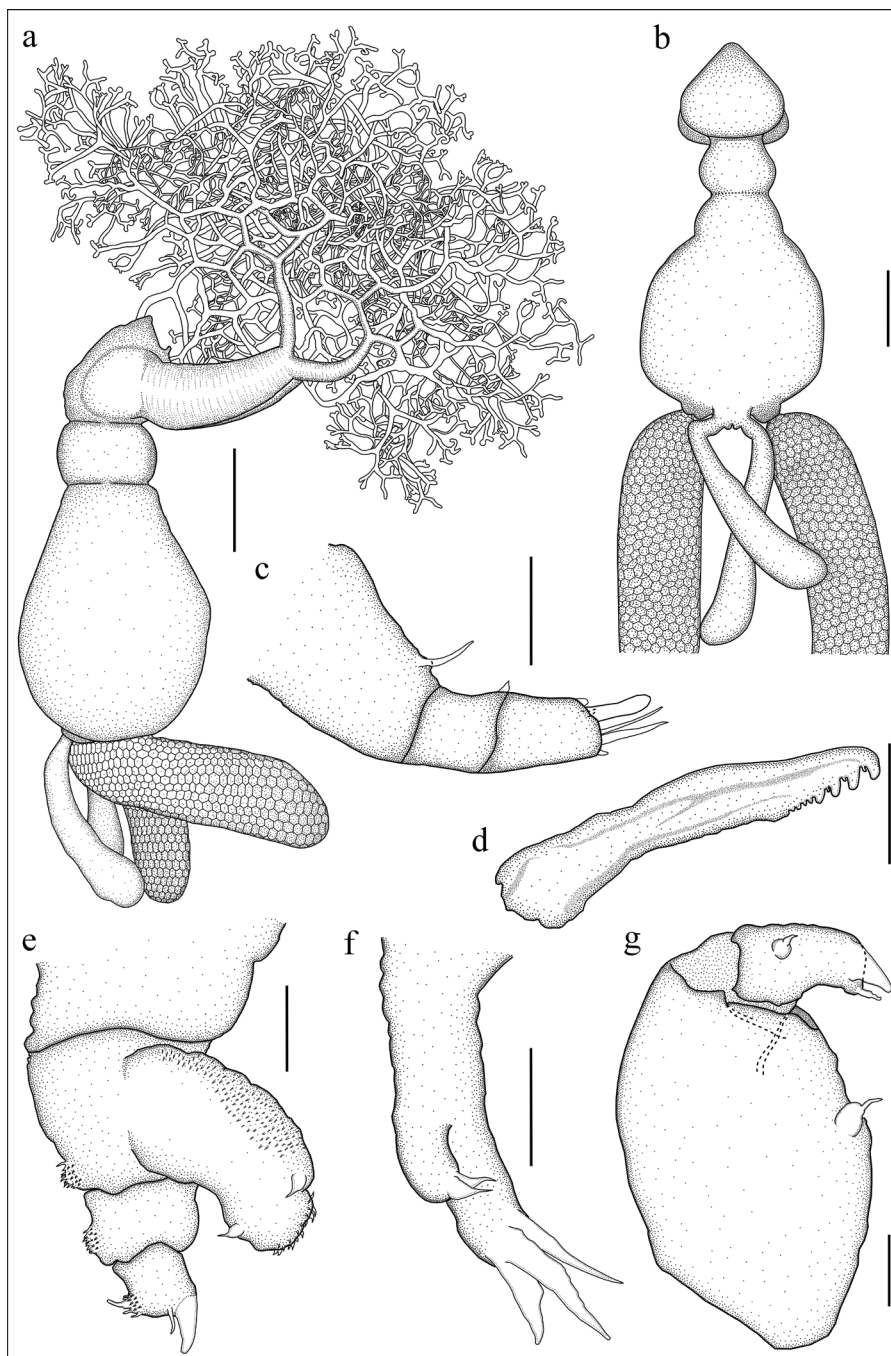
Host species	Common name	N	P	MA
<i>Amblyraja doellojuradoi</i> (Pozzi, 1935)	southern thorny skate	52	0	0
<i>Atlantoraja castelnaui</i> (Miranda Ribeiro, 1907)	spotback skate	31	0	0
<i>Atlantoraja cyclophora</i> (Regan 1903)	eyespot skate	65	0	0
<i>Atlantoraja platana</i> (Günther 1880)	La Plata skate	3	0	0
<i>Bathyraja albomaculata</i> (Norman 1937)	spotted skate	42	0	0
<i>Bathyraja brachyurops</i> (Fowler, 1910)	broadnose skate	31	0	0
<i>Bathyraja griseocauda</i> (Norman 1937)	graytail skate	29	0	0
<i>Bathyraja macloviana</i> (Norman 1937)	Patagonian skate	32	0	0
<i>Bathyraja magellanica</i> (Philippi 1902)	Magellan skate	18	0	0
<i>Bathyraja multispinis</i> (Norman 1937)	multispine skate	1	0	0
<i>Bathyraja scaphiops</i> (Norman 1937)	cuphead skate	19	63.2 (39.2-82.4)	1.6 (0.9-2.6)
<i>Dipturus brevicaudatus</i> (Marini 1933)	yellownose skate	95	0	0
<i>Psammobatis bergi</i> Marini 1932	blotched sand skate	31	0	0
<i>Psammobatis extenta</i> (Garman 1913)	zipper sand skate	36	0	0
<i>Psammobatis lentiginosa</i> McEachran 1983	freckled sand skate	2	0	0
<i>Psammobatis rudis</i> Günther 1870	smallthorn sand skate	41	0	0
<i>Psammobatis rutrum</i> Jordan 1891	spade sand skate	2	0	0
<i>Psammobatis normani</i> McEachran, 1983	shortfin sand skate	35	0	0
<i>Rioraja agassizii</i> (Müller & Henle 1841)	Rio skate	41	0	0
<i>Sympterygia acuta</i> Garman 1877	bignose fanskate	65	0	0
<i>Sympterygia bonapartii</i> Müller & Henle, 1841	smallnose fanskate	192	0	0

**N: number of examined fish; P: prevalence; MA: mean abundance. Sterne's exact 95% confidence limits are given between parentheses after P and MA values.**

of trunk length, dorsal to multiseriate egg sacs,  $8.5 \pm 1.6$  (4.9–10.7, 20) long,  $2.4 \pm 0.3$  (1.8–2.8, 20) wide (Figs. 1a, b; 2a, c).

Antennule (Fig. 1c) three-segmented, first segment carrying short dorso-median whip; second segment short, carrying small distal solus, terminal segment with rounded tip, bearing three subterminal tubercles (processes 1-3), digitiform aesthete (4), and two short setae (5 and 6) (armature formula -base to apex- as follows: 1, 1, 5 + 1 aesthete). Antenna (Figs. 1e; 3b, c, e) biramous, basis with a distoventral patch of spinules, rami subequally long; exopod 1-segmented with spinulose lateral and distal margins, bearing two short setae (one lateral and one medial) near distal end; endopod

two-segmented, first segment with ventral patch of spinules, distal segment armed with robust curved hook 1, slender seta 2, and process 5 located on spinulose process 4 on distoventral margin; process 3 absent. Mouth cone small, labrum and labium fringed by setules (Figs. 3b, c, d); mandible (Fig. 1d) represented by narrow blade with three secondary teeth; dental formula: P1, S1, P1, S1, P1, S1, B5. Maxillule (Figs. 1f; 3f) bilobate, exopod cylindrical ending in two subequal setae; endopod longer, with three terminal papillae and proximal patch of spinules. Maxilla (Figs. 1a; 2a; 3g) developed as a profusely branched holdfast characteristic of the genus, basal part robust (Figs. 2b, c),  $4.1 \pm 0.9$  (2.2–5.4, 26) long,  $1.5 \pm 0.3$  (0.7–2.1, 26), narrowing



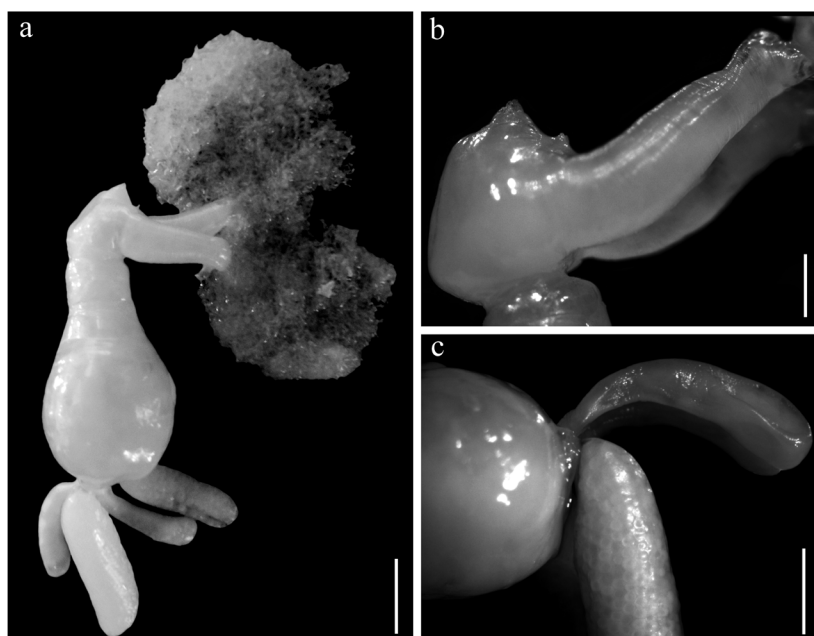
**Figure. 1** *Dendrapta nasicola* n. sp. (adult female) from *Bathyraja scaphiops* (Arhynchobatidae). **a** general habitus (lateral view), composite drawing. **b** general habitus (ventral view) **c** antennule. **d** mandible. **e** antenna. **f** maxillule. **g** maxilliped. Scale bars: **a**, **b** = 2.5 mm; **c–g** = 50  $\mu$ m.

abruptly before branching in a fragile brush of rhizoid branches holdfast. Vestigial bulla present (Fig. 3h). Maxilliped (Figs. 1g, 3a) two-segmented. Corpus robust, myxal area with one

seta on inflated base. Subchela with basal seta. Claw blunt, slightly curved, barb stout, of similar length than claw.

Adult male not found.





**Figure 2** *Dendrapta nasicola* n. sp. (adult female) from *Bathyraja scaphiops* (Arhynchobatidae), stereo microscope photographs. **a** general habitus (lateral view). **b** cephalothorax and proximal portion of maxilla detail. **c** posterior part of body (lateral view). Scale bars: **a** = 2.5 mm; **b** = 1 mm; **c** = 2 mm.

### Taxonomic summary

Type-host: *Bathyraja scaphiops* (Norman, 1937) (Rajiformes: Arhynchobatidae).

Type-locality: Deep waters off Buenos Aires province, Argentina (35° - 41°S).

Site: Olfactory sacs.

Type-specimens: Holotype MLP-Cr coll. No. MLP-Cr 27314 (female). Paratypes MLP-Cr coll. No. MLP-Cr 27315 (10 females).

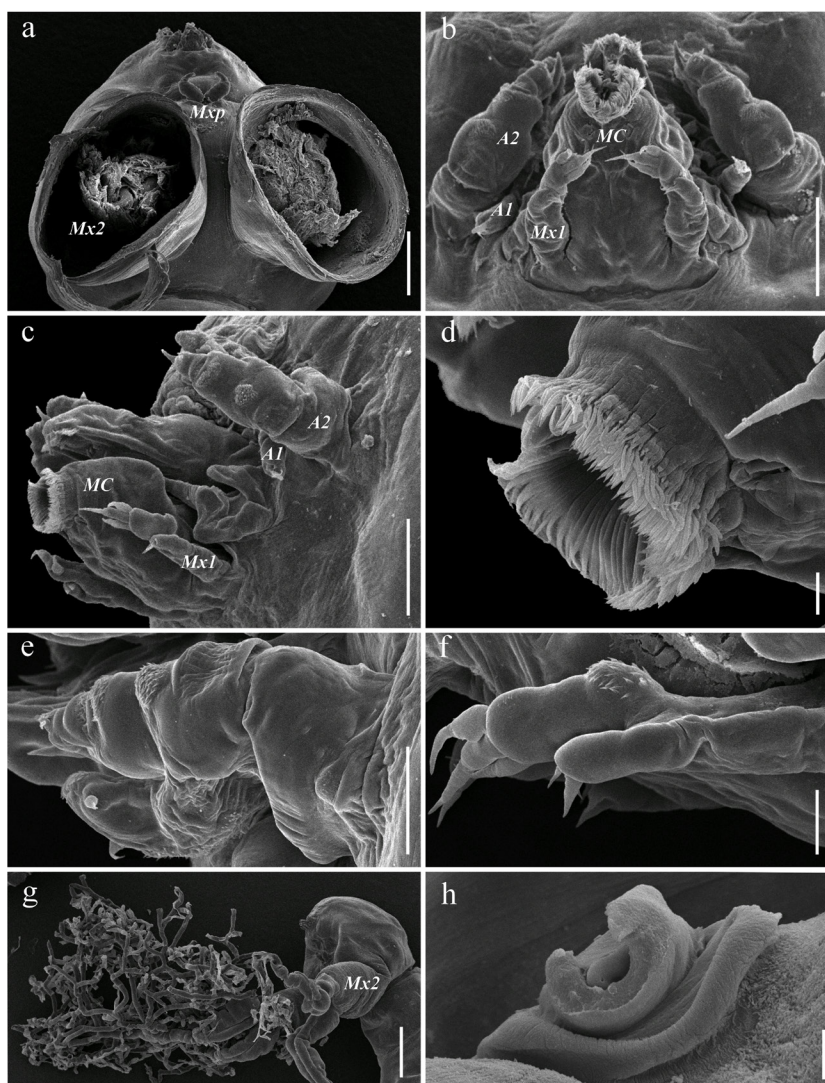
Etymology: The specific name refers to the microhabitat of the parasite, the olfactory sacs in nasal cavities of its hosts.

ZooBank registration: This work and the nomenclatural acts it contains have been registered in ZooBank, the online registration system for the International Commission on Zoological Nomenclature (ICZN). The Life Science Identifier (LSID) for *Dendrapta nasicola* n. sp. is: urn:lsid:zoobank.org:act:E3E43B22-6237-4CB8-8E3C-30957C951ECB.

### Remarks

At present, *D. cameroni*, the only species in the genus, is represented by two subspecies, *D. c.*

*cameroni* and *D. c. longiclavata* (Dippenaar et al. 2004, Walter & Boxshall 2018). They differ in the proportions of the trunk, in the length of the posterior processes and the mode of branching of the attachment organ (Kabata & Gusev 1966). Indeed, based on averaged measurements, the trunk of *D. c. cameroni* is much wider than long, whereas that of *D. c. longiclavata* is only slightly wider than long; the posterior processes of the former are about half length of the trunk, but more than twice as long as the trunk in the latter; additionally, the attachment organ of *D. c. longiclavata* is much more profuse and more finely divided than in *D. c. cameroni* (Kabata & Gusev 1966, Kabata 1988). Despite these differences, normally used as diagnostic specific characters in other species of lernaeopodids (Boxshall & Halsey 2004), Kabata & Gusev (1966) avoided erecting a new species after observing that, in both forms, females become wider and posterior processes increase in length as individuals grow. Because of the low number of specimens measured at that time, the authors considered that the differences between the



**Figure 3** *Dendrapta nasicola* n. sp. (adult female) from *Bathyraja scaphiops* (Arhynchobatidae), scanning electron micrographs (SEM). a cephalothorax (ventral view). b buccal appendices (ventral view). c buccal appendices (lateral view). d mouth cone detail (lateral view). e antenna. f maxillule. g maxilla. h bulla. Abbreviations: A1 Antennule. A2 Antenna. MC Mouth cone. Mx1 Maxillule. Mx2 Maxilla Mxp Maxilliped. Scale bars: a = 500 µm; b, c = 100 µm; d, h = 10 µm; e = 50 µm; f = 20 µm; g = 1 mm.

two forms could be attributed to developmental variation, not justifying the erection of a different species for the Pacific form; suggesting that their formation must have been caused by recent geographical isolation of their closely related hosts of the genus *Raja*.

The specimens from *B. scaphiops* differ from both subspecies of *Dendrapta* in having a longer, but narrower trunk (trunk length:width=1:0.7, vs 1:1.4 and 1:1.1 for *D. c. cameroni* and *D. c. longiclavata*, respectively). The new species also attains a larger size, but its posterior processes are larger than in *D. c. cameroni* and notably shorter than in *D. c. longiclavata* (see

also Dippenaar et al. 2004). These differences in morphometric relationships indicates that they are not due to intraspecific variability as a consequence of allometric growth (the larger the specimens, the larger the posterior processes), but they are actual interspecific differences. Indeed, the relative size of posterior processes is considered as a reliable diagnostic character for species of *Schistobranchia* Kabata, 1964 (Dippenaar 2016), a genus closely related to *Dendrapta* (Dippenaar et al. 2004). Additionally, the armature of the antennule of the new species differs from that of its congeners by having a non-bifid tip of aesthete. Base on the

observed differences, a new species, *Dendrapta nasicola* sp. n. is proposed.

Most lernaeopodids are host- and site-specific (Piasecki et al. 2010), therefore the host species and the microhabitat (olfactory bulbs) of the present material, along with the geographic region or origin (Southwestern Atlantic), support the erection of a new species of *Dendrapta*. For the same reasons, the former subspecies *D. c. longiclavata* is raised to full specific status and should be correctly known as *Dendrapta longiclavata* n. comb. Kabata & Gusev, 1966.

## DISCUSSION

All previous records of the genus *Dendrapta* are restricted to the Northern Hemisphere. This is the first record of a new member of *Dendrapta* from the Southern Ocean, which expands the distribution range for the genus.

Even though 21 skate species were sampled, most of them represented by more than ten individuals, only *B. scaphiops* was found to be parasitized by *Dendrapta nasicola* n. sp., evidencing its high host specificity, a feature shared only with *D. cameroni*, since *D. longiclavata* is known from three host species. The only related lernaeopodid species found in the region, *Brianella corniger*, has been recorded parasitizing seven of the skate species herein examined (Irigoitia et al. 2016).

At present *D. nasicola* n. sp. is the first copepod species recorded parasitizing the cuphead skate *B. scaphiops*. In the study region, only four other copepod species have been found infesting some of the skates species examined in the present work (Irigoitia et al. 2016, 2017), demonstrating the fragmentary nature of the extant information on parasitic copepods in the Southwestern Atlantic. Further studies, including other groups of elasmobranchs, will surely

render new taxonomic and biogeographic data about this group of parasites in a geographical region characterized by a high diversity of elasmobranchs (Menni & Lucifora 2007, Lucifora et al. 2012) and high levels of endemism (Ebert & Compagno 2007, Figueroa et al. 2013).

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#### Author contributions

All authors have contributed significantly to the content of the work, specifically: Dr. MMI -conceptualization, sampling, drawing and writing original draft preparation, writing-reviewing and editing; Dr. VT-sampling, writing original draft preparation, reviewing and editing and Dr. JTT- conceptualization, supervision and writing-reviewing.

