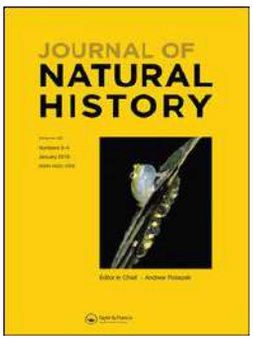

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A new species of *Austrorhynchus* (Platyhelminthes: Kalyptorhynchia) from King George Island (Maritime Antarctic)

Odile Volonterio and Rodrigo Ponce de León

Sección Zoología de Invertebrados, Facultad de Ciencias, Universidad de la República, Montevideo, Uruguay

ABSTRACT

A new species of the turbellarian genus *Austrorhynchus* (Kalyptorhynchia: Polycystididae) was found in King George Island (South Shetland Islands, Maritime Antarctic). The new species has eyes and white to greyish parenchyma. The type II prostate stylet has a funnel and a slightly bent tube with an inner stylet extending throughout its length; a strongly bent hook of about the same size as the tube is present. The type III prostate stylet has a foot and a style connected by a bridge, defining a broad window; the style expands to a comb-bearing plate with large teeth; the foot continues into a narrow flagellum with a distal expansion and a row of fine teeth. The species is oviparous. It can be distinguished from the other known *Austrorhynchus* species by the shape and size of the type II and type III prostate stylets. Out of the five known species of *Austrorhynchus* presenting a window in the type III stylet, the four more similar ones are found in the northern arm of the Scotia Arc and the Weddell Sea area. This is the first report of Kalyptorhynchia from the Antarctic portion of the Scotia Sea, and it confirms previous observations that the true number of *Austrorhynchus* species in the area must be higher than what is currently known.

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Antarctica; *Austrorhynchus*; meiobenthos; Polycystididae; taxonomy; zoogeography

Introduction

Most of our knowledge of Southern Ocean turbellarians (Platyhelminthes) is the result of the collections carried out during the Heroic Age of Antarctic exploration (Böhmig 1902, 1908, 1914; Reisinger 1926; Karling 1952, 1977; Westblad 1952; Volonterio and Brewin 2014). Compared with other zoogeographic regions, this fauna is scarcely known because of the remoteness and the prevailing climatic conditions south of the 60°S parallel. According to the available literature, only about 30 turbellarian species are known from the area, 18 of which are meiobenthic (Böhmig 1914; Reisinger 1926; Prudhoe 1985; Sluys 1989, 1992; Artois et al. 2000; De Broyer and Danis 2011).

Among the meiobenthic turbellarians, only five Kalyptorhynchia (Rhabdocoela) are known to be present in the Antarctic waters of the Southern Ocean, all belonging to the family Polycystididae (Reisinger 1926; Artois et al. 2000). *Austrorhynchus* Karling, 1952

CONTACT Odile Volonterio o.volonterio@outlook.com

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(Polycystididae: Polycystidinae) is the most specious genus, with three species reported from Continental High Antarctic: *Austrorhynchus antarcticus* Artois, Vermin and Schockaert, 2000, *Austrorhynchus biserratus* Artois, Vermin and Schockaert, 2000 and *Austrorhynchus magnificoides* Artois, Vermin and Schockaert, 2000 (Artois et al. 2000). Species of *Austrorhynchus* have also been found in the northern arm of the Scotia Arc (Tierra del Fuego, Falkland Islands and South Georgia), the Mediterranean Sea (Marseille), the North Sea (Skagerrak), the Caribbean Sea (Bermuda), the Pacific Ocean (Australia, Galapagos, Hawaii) and the Indian Ocean (Maldives Islands, Zanzibar and Kerguelen) (Karling 1952, 1977, 1978; Brunet 1965; Artois and Schockaert 1999; Willems et al. 2006, 2007; Artois and Tessens 2008).

As part of a study aimed to describe the biota of turbellarians in King George Island (South Shetland Islands, Maritime Antarctic), several specimens belonging to a new species of *Austrorhynchus* were found. The new species, described herein, represents the first finding of a Kalyptorhynchia in the Antarctic portion of the Scotia Sea.

Material and methods

Fieldwork was carried out for four summer campaigns between the years 2006 and 2011, following recommendations made by the Council of Managers of National Antarctic Programmes and the Scientific Committee on Antarctic Research (COMNAP/SCAR, 2000). Samples of algae and sediment were taken during the low tide in the eulittoral zone of Balvino Point (62.188889ºS, 58.903889ºW) and Pata de Perro Point (62.185278°S, 58.878889° W), Maxwell Bay, King George Island, South Shetland Islands. Turbellarians were recovered from the samples using the $MgCl_2$ method, following Schockaert (1996).

Specimens were studied alive. Following their examination, a few specimens were whole-mounted in Aman's lactophenol and the rest were fixed in warm Bouin's fixative (60°C). The latter were washed, dehydrated, embedded in paraffin and sectioned at intervals of 3 µm. The serial sections were stained with Heidenhain's iron haematoxylin (Langeron 1949) and mounted in Canada balsam.

Drawings and measurements were made with the aid of a drawing tube. Unless stated otherwise, measurements are based on 10 specimens and are given in µm as a range (mean, standard deviation).

Terminology of the male and female atrial organs follows Artois and Schockaert (2003) and Artois and Schockaert (2005), respectively. The biogeographic classification of the coastal and shelf areas follows Spalding et al. (2007).

Abbreviations used in the figures are as follows: bd, bridge; br, brain; bs, bursal stalk; ca, common genital atrium; cm, comb; co, common ovo-vitelloduct; ed, ejaculatory duct; ey, eye; fb, female bursa; fd, female duct type I; fg, flagellum; fo, foot; fu, funnel; gl, glands; ho, hook; is, inner stylet; ma, male atrium; od, oviduct; os, outer stylet; ov, ovary; ph, pharynx; pr, proboscis; pv, prostate vesicle; s2, type II prostate stylet; s3, type III prostate stylet; sd, spermatic duct; sp, sphincter; st, style; sv, seminal vesicle; te, testis; ut, uterus; vd, vitelloduct; vi, vitellarium; wi, window.

Results

Twelve turbellarians belonging to a species of *Austrorhynchus* were found. The study of whole mounts and series of histological sections showed that this species is new to science, so it is described below.

Taxonomy

Suborder **KALYPTORHYNCHIA** Graff, 1905
Infraorder **EUKALYPTORHYNCHIA** Meixner, 1928
Family **POLYCYSTIDIDAE** Graff, 1905
Subfamily **POLYCYSTIDINAE** Schockaert and Karling, 1970
Genus ***Austrorhynchus*** Karling, 1952
Austrorhynchus wennersgaardi Volonterio and Ponce de León, sp. nov.
(Figures 1–4)

Diagnosis

Austrorhynchus species with eyes and white to greyish parenchyma. Type II prostate stylet, double-walled; funnel about 20–25% of total stylet length, with the proximal rim rolled upon itself to a varying degree; tube of the outer stylet slightly bent, with the inner stylet extending throughout its length; a strongly bent hook arises at the level of the junction between the funnel and the tube; hook and tube of about the same size. Type III stylet with a foot and a shorter style connected by a long bridge, defining a broad window; style expands to a thin comb-bearing plate with large teeth, decreasing in size and thickness towards the base of the flagellum; in general, the third to seventh teeth from the free end of the plate are the larger ones, and their bases are frequently placed at a higher level than those of the rest; foot continues into a sinuous to straight, narrow flagellum, bearing a distal expansion; a row of progressively shorter, fine teeth extends from the base of the flagellum to the proximal part of the expansion. Oviparous.

Description

General organization. Preserved specimens are 431–1044 µm (mean 711.0, SD 191.5) long, white to greyish, rather opaque and bear two eyes (Figure 1). Proboscis about 10–20% of body length. Pharynx 68–158 µm (mean 123.7, SD 30.9) in diameter.

Testes paired. Seminal vesicle tapers into an ejaculatory duct opening into proximal end of male genital canal, between bases of type II and III prostate stylets. Prostate vesicle of type II associated with type II stylet. Compact muscle sheet connects wall of prostate vesicle to base of type III stylet.

Paired ovaries and vitellaria. Ovo-vitelloducts of each side join into a common ovo-vitelloduct. Female bursa connected to a female duct type I, which opens into posterior wall of genital atrium. Common ovo-vitelloduct and insemination ducts open into bursal stalk. Uterus opens into anterior wall of distalmost portion of atrium.

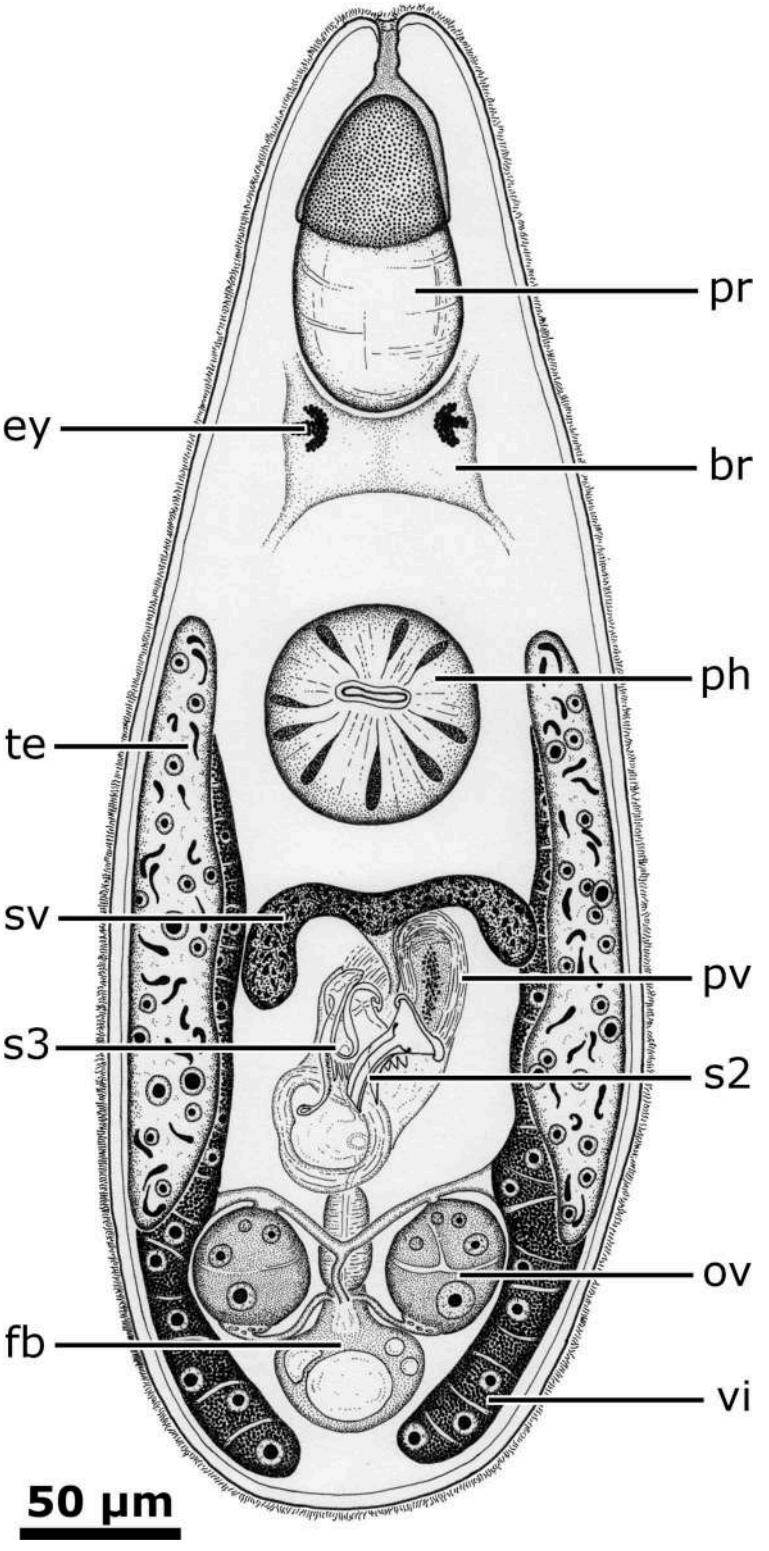

Figure 1. Habitus of an adult specimen of *Austrorhynchus wennersgaardi* sp. nov.

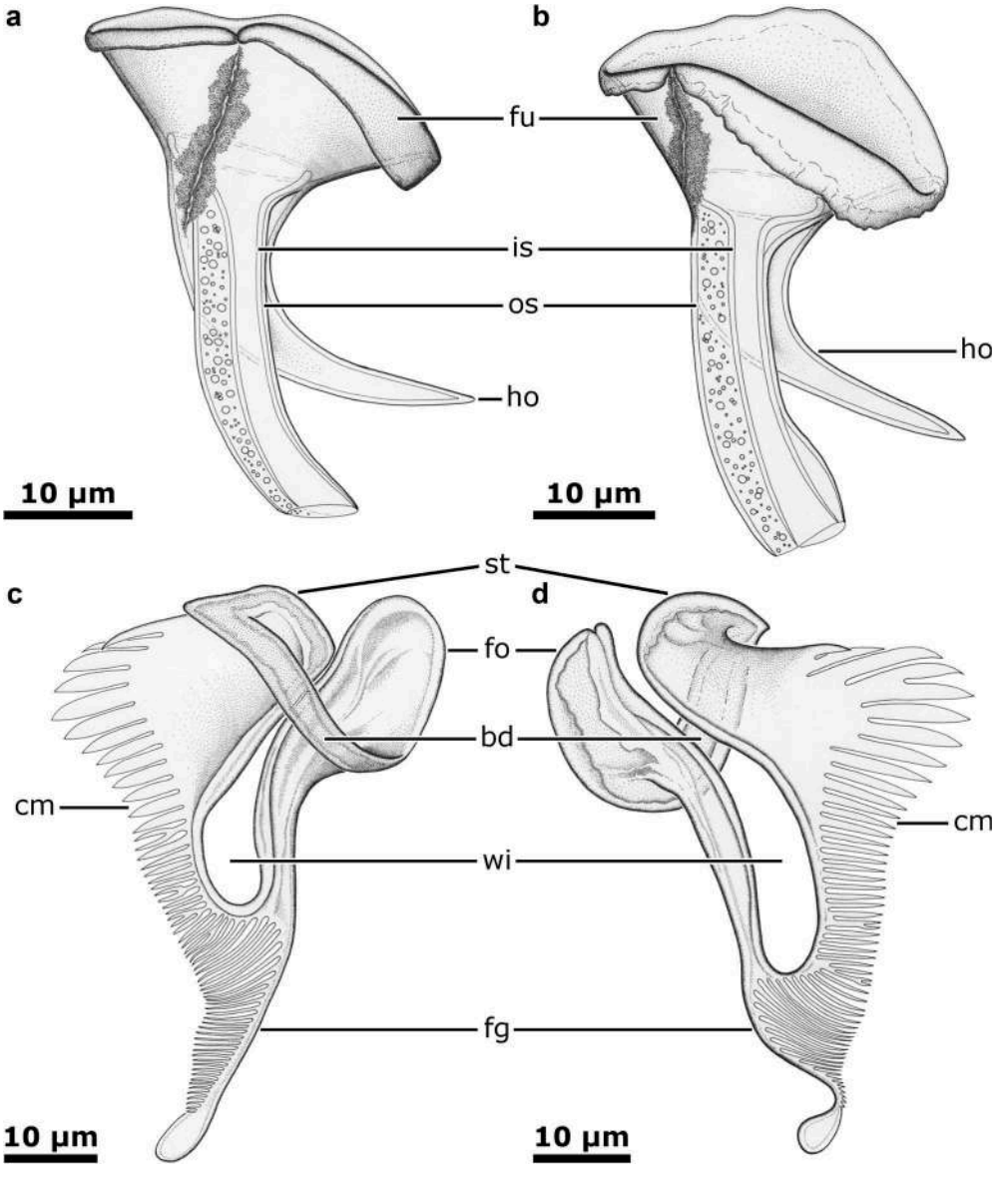

Figure 2. Sclerotized parts of the copulatory organ of *Austrorhynchus wennersgaardi* sp. nov.: (a) typical type II stylet; (b) type II stylet with a distally expanded outer tube; (c) type III stylet, as viewed from the left; (d) type III stylet, as viewed from the right.

Sclerotized parts of copulatory organ. The double-walled type II prostate stylet (Figure 2 (a,b)) is 40–49 µm (mean 44.5, SD 2.2) long and consists of a funnel, a distal tube and a hook. The funnel is 8–14 µm (mean 10.4, SD 1.6) long (about 20–25% of the total stylet length) and 22–33 µm (mean 28.9, SD 2.8) wide proximally; its proximal rim is broad and rolled upon itself to a varying degree. Tube of outer stylet slightly bent, 27–34 µm (mean 31.1, SD 2.0) long, 11–17 µm (mean 13.8, SD 1.6) wide proximally and 5–8 µm (mean 6.4, SD 1.1) wide distally; inner stylet extends throughout its length. In a few specimens, distal portion of tube of outer

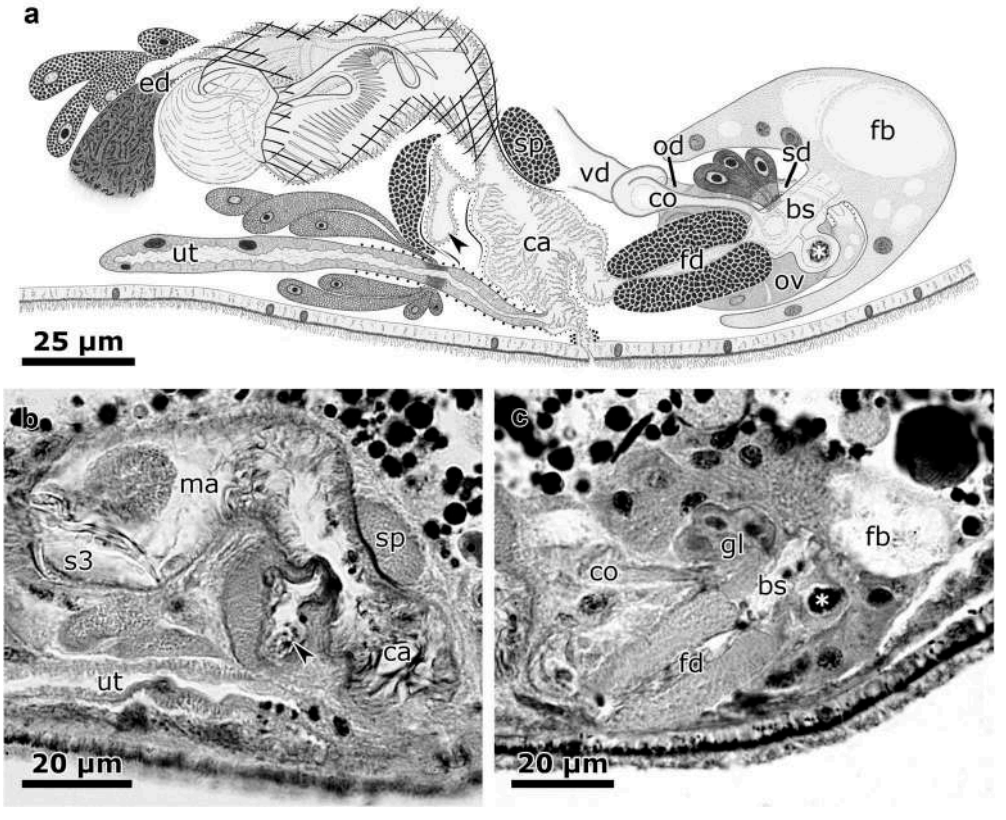

Figure 3. Reproductive organs of *Austrorhynchus wennersgaardi* sp. nov., as viewed from the left: (a) reconstruction based on serial sagittal sections; (b) male reproductive organs; (c) female reproductive organs. Arrowhead: dilation of the anterior wall of the genital canal, forming a pouch. Asterisk: expansion of the ventral wall of the bursal stalk, filled with sperm cells.

stylet is dilated (Figure 2(b)). A large, 28–34 µm (mean 31.0, SD 2.1) long, strongly bent hook arises at the level of the junction between the funnel and the tube.

Type III prostate stylet (Figure 2(c,d)) has a foot and style connected by a long bridge, defining a broad window. Style expands to a thin comb-bearing plate carrying 22–27 µm (mean 24, SD 1.9) large teeth. In general, third to seventh teeth from free end of plate are the larger ones, measuring 10–15 µm (mean 12.1, SD 1.6) in length; their bases are frequently placed at a higher level than those of the rest (Figure 2(d)). Remaining teeth on comb decrease in size and thickness towards base of flagellum. Flagellum, 29–37 µm (mean 32, SD 2.6) in length, is sinuous to straight and has a distal expansion; a row of progressively shorter, fine teeth extends up to proximal part of latter. Distance from proximal end of foot to tip of flagellum is 59–77 µm (mean 71.5, SD 4.7).

Histology. At the histological level, the overall characteristics of the new species are in agreement with the previous histological descriptions of *Austrorhynchus* (Karling 1952; Brunet 1965); the relevant differences are described below.

Figure 4. Egg of *Austrorhynchus wennersgaardi* sp. nov. *in utero*.

The genital canal can be divided into three sections based on the histology of its wall (Figure 3(a)): (i) the proximal portion of the male genital canal, with an epithelium bearing pseudo-cilia surrounded by an internal layer of thin circular muscle fibres and two external layers composed of thick, oblique fibres; (ii) the distal portion of the male genital canal, where the internal oblique fibres adopt a longitudinal direction and the external ones are replaced by a sphincter; (iii) the *atrium inferius sensu* Karling 1952, with an epithelium bearing long pseudo-cilia and a mono-layer of thin circular muscle fibres surrounded by scarce longitudinal fibres. Most of the longitudinal fibres present in the distal portion of the male genital canal leave the wall of the canal immediately below the sphincter and attach to the ventral body wall close to the gonopore.

In a few specimens (for example, NHMUK 2017.11.3.11), the anterior wall of the genital canal is dilated at the level of the sphincter, forming a pouch (Figure 3(a,b), indicated with an arrowhead). Sperm cells seen in the male genital canal were always located in the vicinity or at the level of the sphincter, either in the main cavity of the canal or inside the pouch.

Gland cells open into the dorsal wall of the bursal stalk, just posteriorly to the opening of the common ovo-vitelloduct. In a few specimens, the ventral wall of the bursal stalk presents an expansion filled with sperm cells (Figure 3(a,c), indicated with an asterisk).

Material examined

Holotype. One whole mount of a specimen from Balvino Point, King George Island, South Shetland Islands (62.188889ºS, 58.903889ºW), Antarctica, collected by Odile Volonterio and Rodrigo Ponce de León on 22 January 2009, deposited in the Natural History Museum (NHM), London (accession number: NHMUK 2017.11.3.1).

Paratypes. Eight slides with whole mounts of specimens from Balvino Point, Maxwell Bay, King George Island, South Shetland Islands (62.188889ºS, 58.903889ºW), Antarctica, collected by Odile Volonterio and Rodrigo Ponce de León on 19 December 2006 (two slides), 5 January 2008 (one slide), 6 January 2009 (one slide), 24 January 2009 (two slides) and 6 February 2009 (two slides with gravid specimens); one slide with a whole mount of a specimen from Pata de Perro Point, Maxwell Bay, King George Island, South Shetland

Islands (62.185278°S, 58.878889°W), Antarctica, collected by Odile Volonterio and Rodrigo Ponce de León on 29 January 2010. Deposited in the Natural History Museum (NHM), London (accession numbers: NHMUK 2017.11.3.2–9 and 2017.11.3.10 respectively).

Additional material. Two slides with sagittal sections of two specimens from Balvino Point, King George Island, South Shetland Islands (62.188889ºS, 58.903889ºW), Antarctica, collected by Odile Volonterio and Rodrigo Ponce de León on 22 January 2009, deposited in the Natural History Museum (NHM), London (accession number: NHMUK 2017.11.3.11–12).

Biology

The species is oviparous. In February 2009 two gravid specimens, each carrying a single egg, were found; eggs are oval, 282–299 µm (mean 290.5, SD 12.0, $n = 2$) long, 231–243 µm (mean 237.0, SD 8.5, $n = 2$) wide and present a short adhesive peduncle (Figure 4).

Distribution

King George Island, South Shetland Islands, Maritime Antarctic.

Etymology

Specific name in honour of the Norwegian sailor Ole Wennersgaard, a crew member of the Swedish Antarctic Expedition who died during the extreme Antarctic winter of 1903, when part of the expedition was forced to remain in Poulet Island until rescued by the vessel *Uruguay* (Ekelof 1904).

Discussion

Taxonomy

Besides *Austrorhynchus wennersgaardi* sp. nov., there are only four other *Austrorhynchus* species provided with a window (i.e. a foramen that is the result of the fusion or connection of foot and style) in the type III stylet, namely *Austrorhynchus magnificus* Karling, 1952 from South Georgia Island, *Austrorhynchus calcareus* Karling, 1977 from the Falkland Islands, *Austrorhynchus galapagoensis* Artois and Schockaert, 1999 from Galapagos and *A. magnificoides* from Continental High Antarctic (Weddell Sea). In *A. galapagoensis* the stylet is composed of a ring and a flagellum (Artois and Schockaert 1999), as opposed to the other three species and *A. wennersgaardi* sp. nov., in which the window is in the proximal portion of a wider plate. However, unlike the new species, in *A. magnificus* the comb on this plate is very subtle and the flagellum has neither a distal expansion nor teeth (Karling 1952, 1977); in *A. calcareus* a separate style is lacking and the teeth on the plate are progressively larger towards the flagellum (Karling 1952, 1977), and in *A. magnificoides* the plate has a triangular shape and is broadest proximally (Artois et al. 2000).

Austrorhynchus wennersgaardi sp. nov. also differs from *A. galapagoensis*, *A. magnificus*, *A. calcareus* and *A. magnificoides* in the morphology of the type II stylet. In *A. galapagoensis* the stylet lacks a hook (Artois and Schockaert 1999), and in the other three species the hook is present but is shorter than the tube (Karling 1952, 1977; Artois et al. 2000), whereas in the new species the hook and the tube are of about the same size.

Most of our knowledge of species in the genus *Austrorhynchus* at the histological level derives from the exhaustive description of *Austrorhynchus pectatus pectatus* 'Stachel' Karling 1952 (presently *Austrorhynchus spinosus* Karling, 1977) made by Karling (1952). More recently, sectioned specimens of *Austrorhynchus karlingi* Brunet, 1965 and *Austrorhynchus scoparius* Brunet, 1965 (Brunet 1965), *A. galapagoensis* (Artois and Schockaert 1999), *Austrorhynchus hawaiiensis* Karling, 1977 (Willems et al. 2006) and *Austrorhynchus artoisi* Willems, Sandberg and Jondelius, 2007 (Willems et al. 2007) were also studied, and the internal organization of specimens of each species was found to be comparable to that of *A. spinosus*. In general, the internal organization of *A. wennersgaardi* sp. nov. is also similar to that of the previously studied species, the most striking difference being the presence of a large sphincter in the distal portion of the male genital canal. Strong sphincters, however, have been described in the corresponding position in other representatives of the Polycystidinae, such as *Acrorhynchides robustus* (Karling, 1931) (Karling 1956; Schockaert and Karling 1975), *Alcha evelinae* Marcus, 1949 (Marcus 1949) and *Parachrorhynchus axi* Karling, 1956 (Karling 1956). The presence of this sphincter, therefore, cannot be ruled out in other species of *Austrorhynchus*.

Biogeography

With the description of this new species from the Maritime Antarctic, more than half of the species of *Austrorhynchus* described so far (53%) are found in the Southern Ocean and adjacent areas (Figure 5). Five are distributed in different localities of the northern arm of the Scotia Arc: *A. magnificus* in South Georgia, *Austrorhynchus pectatus* Karling, 1952 and *Austrorhynchus parapectatus* Karling, 1977 in South Georgia and the Falkland Islands, *A. calcareus* in the Falkland Islands and *A. spinosus* in the latter islands and Tierra del Fuego (Karling 1952, 1977). Two have been found at similar latitudes further to the east: *A. magnificoides*, reported from the Spiess seamount, close to the sub-Antarctic Bouvet island, and *Austrorhynchus kerguelensis* Artois and Tessens, 2008, found in Kerguelen (Artois and Tessens 2008), a southern Indian Ocean island that is situated south of the Antarctic Convergence. Only four species are present in Antarctic waters, south of the 60°S parallel: *A. antarcticus*, *A. biserratus*, *A. magnificoides* and *A. wennersgaardi* sp. nov. The three previously known Antarctic species were obtained from deep waters (380 to 509 m) in the eastern side of the Weddell Sea (Continental High Antarctic), and differ from all other *Austrorhynchus* species by having a type III stylet of triangular shape (Artois et al. 2000). *Austrorhynchus wennersgaardi* sp. nov., on the other hand, was found in the intertidal zone.

It is interesting to note that, out of the five presently known species of *Austrorhynchus* that share the presence of a window in the type III stylet, the four in which the window is smaller and is located in the proximal portion of a well-developed plate are found in the Scotia Arc and Weddell Sea area. This likeness could be the result of common ancestry. Considering the tectonic history of this region (Barker 2001; Dalziel et al. 2013), one may speculate that the four species are closely related and that they are the result of vicariant speciation following the events that gave rise to the Scotia Arc. This hypothesis agrees with that of Karling (1977), who advanced the idea that the 'geographic disintegration' of the Scotia Arc favoured local speciation in the genus. If this holds true, we should expect to find more species with this morphological trait in the area.

The high diversity of *Austrorhynchus* in the Scotia Arc, together with the abundance of specimens in the samples (Karling 1977; this work) suggest that other, yet

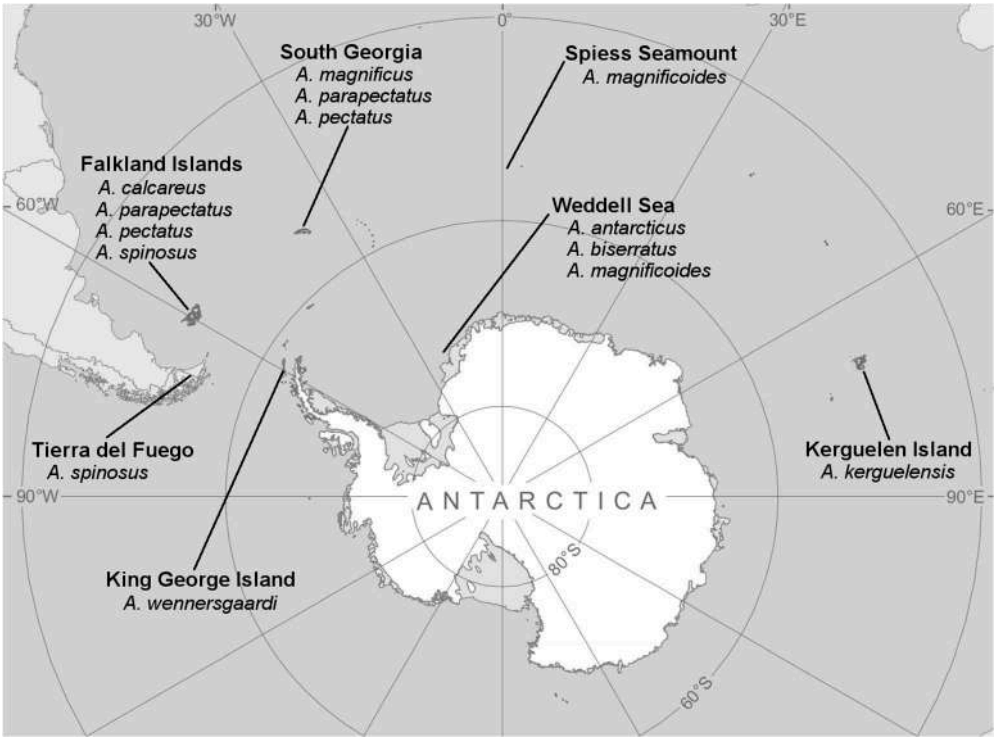

Figure 5. Distribution of *Austrorhynchus* species in the Southern Ocean and adjacent areas. This figure is a derivative of the base map 'Subantarctic islands' (https://data.aad.gov.au/aadc/mapcat/display_map.cfm?map_id=13991) provided by the Australian Antarctic Division, which includes data from the Antarctic Digital Database; © Commonwealth of Australia 2017, used under CC BY 3.0 (http://creativecommons.org/licenses/by/3.0/).

undiscovered, species may be present in the area. Future sampling efforts should therefore be directed towards the southern arm of the Scotia Arc and the Weddell Sea, which have only scarcely been surveyed for the presence of turbellarians.

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Geolocation information

Type locality (point): 62.188889°S, 58.903889°W
Additional locality (point): 62.185278°S, 58.878889°W

Disclosure statement

No potential conflict of interest was reported by the authors.

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ORCID

Odile Volonterio http://orcid.org/0000-0003-4939-9721
Rodrigo Ponce de León http://orcid.org/0000-0003-3730-9805

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