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On the taxonomy of *Apistobranchus* species (Polychaeta: Apistobranchidae) from the Antarctic

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Abstract

The first report of *Apistobranchus* Levinsen, 1883 (Family Apistobranchidae) in Antarctica was presented by Hartman (1967). Two species were later described: *Apistobranchus glacierae* Hartman, 1978 and *Apistobranchus gudrunae* Hartmann-Schröder & Rosenfeldt, 1988, which differed from *A. glacierae* mainly by having compound setae. Subsequently, ecological studies in Antarctica have identified both of these species. On the status of Antarctic *Apistobranchus*, we concluded that there is up to now, only one valid species, *A. glacierae*. The character 'compound-setae' referred for *A. gudrunae* is in fact simple limbate ones eventually splintered as described for *A. glacierae*. Other characters, also previously considered as diagnostics for *A. gudrunae*, did not differ in both species as shown by the observation of several specimens of different sizes and type material of *A. glacierae* and *A. gudrunae*. All the reports on the densities of Antarctic apistobranchids, including ours, show that they have higher values in finer sediments of 20 and 40 m depth. The need of additional work, including the rearing of specimens in the laboratory and plankton analysis, is emphasized.

Key words: Antarctica, Polychaeta, benthos, soft-bottom, macrofauna, *Apistobranchus*, Admiralty Bay

Introduction

Polychaetes are one of the dominant macrofaunal taxon of the Antarctic soft-bottom benthos, both in richness and abundance (Gallardo & Castillo 1969; Gallardo *et al*. 1977; Lowry 1975; Richardson & Hedgpeth 1977; Gambi *et al*. 1997; Mühlenhardt-Siegel 1988, 1989; San Martín *et al*. 2000). In Admiralty Bay the dominant taxa found in macrobenthic assemblages are Polychaeta, Bivalvia and Amphipoda (Jazdzewski *et al*. 1986; Arnaud *et al*. 1986; Wägele & Brito 1990; Sicinski & Janowska 1993), with the polychaetes representing as much as 42% of the total macrofaunal abundance in the nearshore zone of Martel Inlet (Bromberg *et al*. 2000).

Apistobranchus Levinsen, 1883 has been found to be one of the most abundant polychaete genera in shallow soft sediments of Admiralty Bay (Sicinski 1986; Bromberg *et al*. 2000, Sicinski 2000, Petti *et al*. 2006) and in Arthur Harbor (Anvers Island, Palmer Archipelago) (Lowry 1975). Nevertheless, there are still some doubts concerning the taxonomy of *Apistobranchus* species from the Antarctic.

The first report of apistobranchids in Antarctica was by Hartman (1967) from the Antarctic Peninsula, later described as *Apistobranchus glacierae* Hartman, 1978. Richardson and Hedgpeth (1977) identified specimens sampled from the same area as *Apistobranchus typicus* (Webster & Benedict, 1887), a North American species. *Apistobranchus gudrunae* Hartmann-Schröder and Rosenfeldt, 1988 was described from Admiralty Bay, and differed from *A. glacierae*, mainly due to the presence of compound setae and the lack of notopodia on setigers 1 and 8. Benthic ecologists have identified *Apistobranchus* specimens at the genus level (Lowry

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1975; Arnaud *et al.* 1986; Sicinski 1986, 2000, 2004; Knox & Cameron 1998) or have simply opted for *A. gudrunae,* without further comments (Sicinski & Janowska 1993; Bromberg *et al*. 2000). Six species of *Apistobranchus* are known globally (Blake, 1996). This author treated five species in his key for the genus, with only *A. glacierae* reported as an Antarctic species. Sicinski (2000) in a review of the polychaetes of Admiralty Bay refers to the need for clarification of *Apistobranchus* species.

The high densities of *Apistobranchus* in Martel Inlet together with the scant knowledge of the biology and ecology of the family as well as its confused taxonomy (Blake 1996) have provided theme for this paper. The aim of this investigation is, therefore, to clarify the status of species of the genus *Apistobranchus* referred to Antarctica based on specimens collected in Martel Inlet (Admiralty Bay - King George Island), and on the examination of those deposited on the Smithsonian Institution as well as the Zoological Museum of the University of Hamburg, and to provide some information on their ecology.

Study area

The study site (Fig. 1) is located in the nearshore zone of Martel Inlet, in front of the Brazilian Antarctic Station "Comandante Ferraz" (62°05'S, 58°24'W). The bottom topography includes a steep slope down to 30 m. The sediments include gravelly sand at 6 m, becoming muddy sand at 30 m (Nonato *et al*. 2000). Salinity and temperature are almost stable throughout the whole bay. In the austral summer they range at the surface from 32.9‰ to 34.2‰ and from -0.2°C to 3.4°C, respectively, and between 33.4‰ and 33.8‰ and -0.4°C and 0.9°C, respectively, at the bottom (Jazdzewski *et al*. 1986). In winter, under the ice, the water temperature ranges from -2.0°C to -1.6°C (Presler 1980).

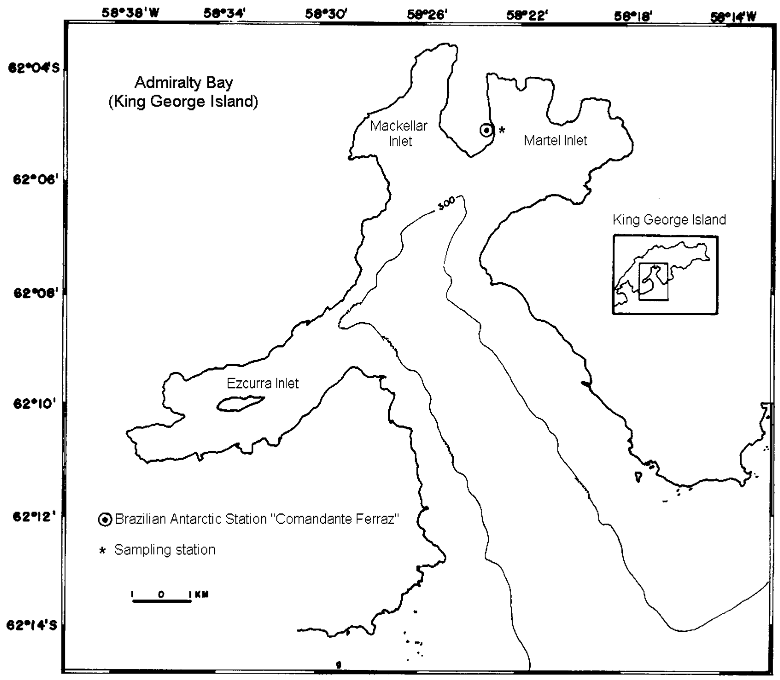

FIGURE 1. Map of the study area.

Material and methods

Sampling was carried out at four stations along a transect ranging from 6 to 25 m depth in front of the Brazilian Antarctic Station "Comandante Ferraz", during two expeditions (Proantar IX - February 1991 and Proantar XIII - December 1994). Replicate samples were taken by SCUBA divers at each station with different diameter corers for the macro- and meiofauna. The examined meiofaunal and macrofaunal apistobranchids are part of the polychaete fauna collected by Skowronski *et al*. (1998) and Bromberg *et al*. (2000), respectively. The samples were washed and sieved through 500, 250, 125 and 62 m mesh sieves in the laboratory in order to separate the fauna into different size categories. All the material retained was preserved in alcohol (70%); the meiofauna was stained with Rose Bengal, and sorted under a stereomicroscope.

The size (length and width) and number of segments were measured for the entire worms, and scanning electron micrographs were taken.

A total of 2151 specimens of *Apistobranchus* were collected by the meio- (n=800) and macrofaunal (n=1351) sampling. While meiofaunal specimens were mostly entire individuals (about 80%), lacking one or two palps, those from the macrofaunal samples were often incomplete or fragmented (ca. 97%). A total of 171 specimens from the macrofaunal and 140 from the meiofaunal samples were examined and analysed in detail for a comparison with the described species of Antarctic Apistobranchidae, *A. glacierae* and *A. gudrunae*.

The largest entire specimen with 52 setigers was 7 mm long and 0.9 mm wide (at the 3rd setiger). The largest palp measured 6 mm long and 0.2 mm wide on a specimen 5 mm long and 0.9 mm wide. Pygidial cirri were frequently lost on the macrofaunal specimens. The smallest specimen was 0.4 mm long and 0.1 mm wide with a palp of 0.7 mm long for 5 setigers. Pygidial cirri were present in most of the meiofaunal individuals.

The type material of *A. glacierae* (holotype USNM 46613 and two paratypes USNM 46614), deposited at the National Museum of Natural History, Smithsonian Institution, Washington, D.C., (USA), and of *A. gudrunae* (holotype HZM: P-19223 and 20 paratypes HZM: P-19223), deposited at the Zoological Institute and Zoological Museum of the University of Hamburg (Germany), were also examined.

Results

Taxonomy. Prostomium and peristomium are fused dorsally and separated ventrally. Prostomium wider than long, broadly rounded anteriorly and densely covered with minute cilia. A ciliated ventral band extends along the body, at least as far as its median portion (Fig. 3A). A pair of very long, strong, usually curved, grooved palps rises from the posterior margin of the prostomium (Figs 2A–B). A pair of ciliated nuchal organs is located at the lateral-posterior bases of the palps (Fig. 3B).

Parapodia are subbiramous, with a reduced achaetous notopodia, ciliated, cirriform and erect, with a single notoacicula. Notopodia are absent from the setiger 1 (Fig. 3B) to the setiger 8 (Fig. 2C) and are present posteriorly to the end of the body. Anteriormost notopodia are bottle-shaped with a short digitated tip (Fig. 3C). The following notopodia are digitiform or finger-shaped. Interramal cirri present on setigers 1 to 7 (Figs 2C; 3B) with noticeable ciliation (Fig. 3D).

Neurosetae on setigers 1 to 7 gold, short, wide and robust forming palisaded rows in dense fascicles (Figs 2C, 3A–B, 3D). The median and posterior segments bear two kinds of setae: 1) limbate setae that are moderately long, with blades often splintered, resembling a compound seta (Figs 2D, 3E–F); 2) capillary setae twice as long as limbate (Fig. 3G), some bearing a hairy tip (Fig. 2E). Neuropodia are supported by two strong aciculae, one acuminate and the other with a rounded or spoon-shaped tip (Fig. 2F). One very strong falciform seta is present on posterior setigers of some specimens (Fig. 2G).

From the setiger 4 to the mid-body setigers the setal lamellae are well developed in the adults, and assume the shape of large flanges bearing pear-shaped lobules at the margin. Number of lobules varying from 2 to 4 on setiger 4 (Figs 2H, 3C) to approximately 25 on the setigers 5 and 6. Post-setal lamellae changes abruptly in form and number of marginal lobules, becoming on the setiger 7 very large and thick with only 7 to 10 large conical or pear-shaped lobules. On the setiger 8 these lobules become minute papillae, increasing in number to approximately 50, then decreasing gradually on the following setigers according to the reduction in the size of the lamellae (Fig. 3H). These lamellae vary in position and number of lobules according to the size of the specimen. In juveniles, they were observed on the setigers 3, 4 or 5 (Fig. 3I). The first setigers may be bulky, especially in the smaller individuals, and the setae are difficult to observe (Fig. 2I).

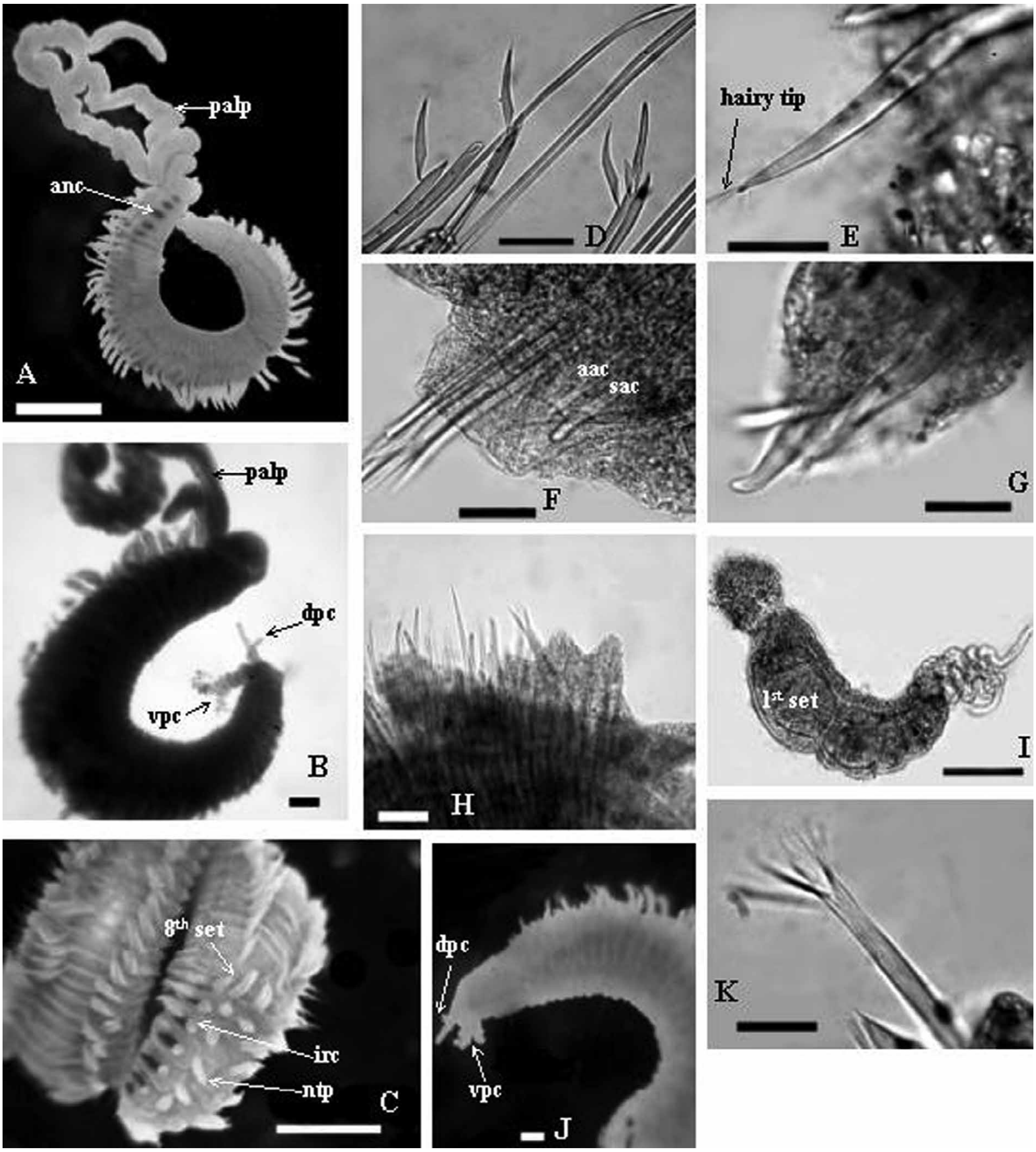

FIGURE 2. *Apistobranchus glacierae* (Martel Inlet). Photomicrographs. Adult (A, C–H, J–K). Juvenile (B, I). A. Lateral view, palps, fascicles of gold setae in the anterior setigers. B. Lateral view, palps, two pairs of pygidial cirri. C. Dorsal view, lack of notopodium in setiger 8, presence of interramal cirri in setigers 1–7. D. Splintered neurosetae of median setigers. E. Neurosetae with hairy tip of median setigers. F. Aciculae supporting neuropodium, one with acuminate, and other with spoon shaped tip of the last setigers. G. Falciform setae of the last setigers. H. Post-setal lamelae from setiger 4. I. Bulky first setiger. J. Pygidial cirri of an adult. K. Smashed setae of setiger of the median region. Abbreviations: **aac**, acuminate acicula; **anc**, anterior neurosetae; **dpc**, dorsal pygidial cirri; **irc**, interramal cirri; **ntp**, notopodium; **palp**, palps; **sac**, spoon-shaped acicula; **vpc**, ventral pygidial cirri. Scales: A, C, 1.0mm; B, F, J, 0.1mm; D, H, 0.05 mm; E, G, I, K, 0.01 mm.

Two pairs of pygidial cirri are present; the dorsal pair is short, straight and digitiform, while the ventral pair is very long, slender and usually curled (Fig. 2B). The long ventral cirri, typically found on juveniles, are often missing on the adults or shorter when present (Fig. 2J).

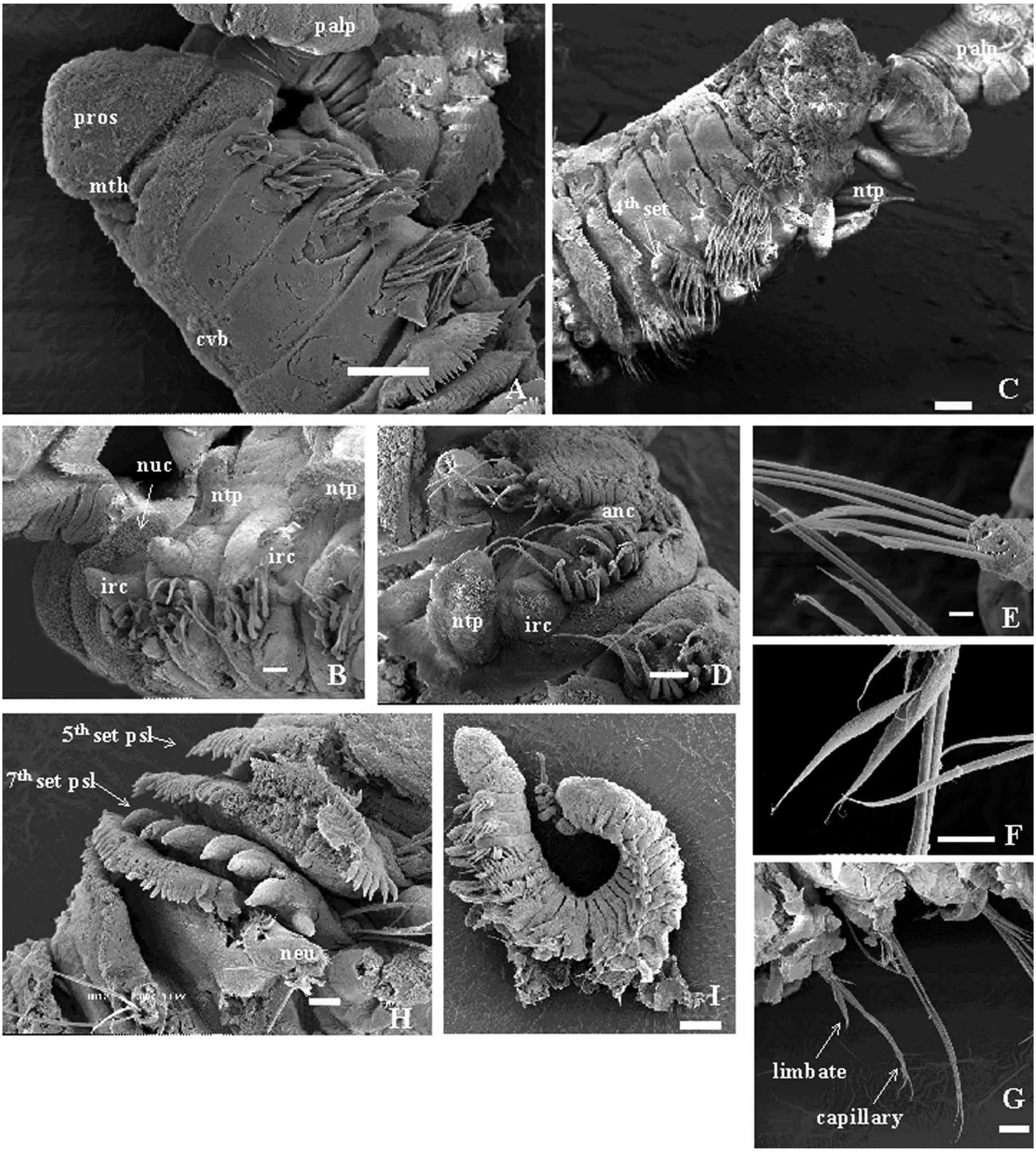

FIGURE 3. *Apistobranchus glacierae* (Martel Inlet). Scanning electron micrographs. Adult (A–H). Juvenile (I). A. Anterior end, ventral view, ciliated prostomium and ventral band, mouth, palps. B. Dorsal view, nuchal organ, only interramal cirri on setiger 1. C. Bottle-shaped notopodium, post-setal lamelae from setiger 4. D. Dorsal view, ciliated interramal cirri and notopodium, anterior neurosetae. E–F. Splintered limbate setae. G. Limbate and capillary setae. H. Dorsal view, post-setal lamelae of setigers 5–8. I. Difference in post-setal lamelae morphology. Abbreviations: **anc**, anterior neurosetae; **cvb**, ciliated ventral band; **irc**, interramal cirri; **mth**, mouth; **neu**, neuropodium; **ntp**, notopodium; **nuc,** nuchal organ; **palp**, palp; **pros**, prostomium; **psl**, post-setal lamellae. Scales: A, C, I, 100 µm; B, D, G, H, 30 µm; E, F, 10 µm.

Discussion

The main diagnostic characters of our specimens collected in Admiralty Bay correspond to those referred to in the original description of the species of the genus *Apistobranchus* in Antarctica (Hartman 1978; Hartmann-Schröder & Rosenfeldt 1988). The descriptions of both Antarctic species were based on incomplete specimens. As we had the opportunity to work on a great number of specimens, many of which are complete, remarks and photographs of some of the characters have been added.

Besides the fact that type material of both *A. glacierae* and *A. gudrunae* are composed of incomplete specimens, all characters observed in both types match the description provided above. Even though Hartman (1978) did not describe the structure of anteriormost notopodia, a careful examination showed that notopodia are not present in the setiger 1 and 8 in all type specimens, a character that could distinguish both *A. gudrunae* and our specimens from *A. glacierae*. On the other hand, the shape and distribution of the post-setal lamellae of our specimens fully agree with those exhibited by *A. gudrunae*, as well as the singularity of the setae with a hairy tip as described and drawn by Hartmann-Schröder & Rosenfeldt (1988).

Another diagnostic character attributed to *A. gudrunae* is the presence of "compound setae". Nevertheless, observation of the type material under optical microscope revealed a structure similar to that shown by our material. The examination of our material under scanning electron microscope indicates that the presumed "compound setae" (Hartman-Schröder & Rosenfeldt 1988) are in fact simple limbate ones eventually splintered as the "splintered setae" of *A. glacierae* Hartman, 1978. Accordingly, Imajima (1974) observed that: "the setae may be broken" and Gathof (1984) stated that for apistobranchids "the setae fracture and splinter easily". The record in this study of these setae in different stages of fracture confirms that they are splintered and not compound. The presence of two acicula on the posterior parapodia, one of them with an expanded apice agree with those shown by Hartman-Schröder & Rosenfeldt (1988). Worn or smashed setae (Fig. 2K), as shown by Blake (1996) and reproduced by Wilson (2000), occur in some specimens.

Pygidial cirri present on most of our specimens from the meiofauna resemble those figured by Orrhage (1962) for *Apistobranchus tenuis* Orrhage, 1962. This structure has not been suitably described for any of the Antarctic apistobranchids, since they are lacking in the holotypes of both *A. glacierae* and *A. gudrunae* with exception of one single pair in paratypes of *A. gudrunae*. Hartman (1978) described one posterior end with a pygidium bearing two pairs of cirri, the dorsal one being slightly longer. As regards our material, the body tends to curl up, with the dorsal part outside and the ventral part inside, which makes it hard to see the tail, and easy to disarray dorsal and ventral cirri. The dorsal pair is short and straight and hard to visualize, while the ventral one is long, curly and very conspicuous. In summary, the observation of holotypes and paratypes of both *A. glacierae* and *A. gudrunae* added by supply material of complete specimens from our collections showed that there is not any character able to distinguish both species. Thus, *A. gudrunae* Hartmann-Schröder & Rosenfeldt, 1988 should be considered a junior synonym of *A. glacierae* Hartman, 1978.

Distribution and ecology. Species of *Apistobranchus* were recorded around the Antarctic Peninsula and the South Shetland Islands, at depths ranging from 6 to 75 m (Hartman 1967, 1978; Richardson & Hedgpeth 1977; Arnaud *et al.* 1986; Sicinski 1986; Sicinski & Janowska 1993; Hartmann-Schröder & Rosenfeldt 1988; Sicinski 2000; Bromberg *et al.* 2000). Knox & Cameron (1998) report *Apistobranchus* sp from the Ross Sea at depths from 104 to 205 m.

High densities of *Apistobranchus glacierae* were found in this study, mainly between 18 and 40 m depth in finer sediments composed of mud and sand. Lowry (1975) obtained 1110 ind/m^2 and Richardson & Hedgpeth (1977) obtained more than 6000 ind/m^2 from 18 to 43 m depth, both samples being sieved in a 1-mm mesh. In samples sieved in 0.5-mm mesh, Sicinski (1986) recorded 226 ind/m^2 from 18 to 43 m depths in Ezcurra Inlet and the maximum density from the shallower sublittoral in Admiralty Bay was of 1020 ind/m^2 (Sicinski 2000). In Martel Inlet, *Apistobranchus glacierae* was dominant in finer sediments at depths of between 18 and 25 m, for both macro- and meiofauna. The highest density of meiofaunal *A. glacierae* was found at 18 m in Dec/94: 135,7 ind/10 cm^2 (135714 ind/m^2), retained mainly between 0.5- and 0.12-mm meshes (Petti *et al*. 2006), while for the macrofaunal *A. glacierae* it was 17800 ind/m^2 at 25-m depth in Dec/94 (Bromberg *et al*. 2000). All the reports on the densities of Antarctic apistobranchids, including ours, show that they are highest in finer sediments around 20 and 40-m depth.

Fauchald (1977) reported that *Apistobranchus* is thought to be tubicolous, but no tubes were observed in the detailed study by Orrhage (1962), or in the present study. It is possible that tubes, if present, are so fragile that they are destroyed or lost during the fixation and sieving processes.

Wilson (2000) pointed out the rarity of biological studies of apistobranchids, and cited Orrhage (1974) who found small eggs and "primitive" sperm in two species: *Apistobranchus tullbergi* (Théel, 1879) and *A. tenuis*. Blake (1996) assigned this finding to a possible external fertilization and planktonic development. Although no apistobranchid larvae or reproduction have ever been observed (Wilson 2000), some individuals of around 5 setigers, which we believe to be post-larvae or juveniles, were found retained by 0.12 and 0.062 mm meshes. This finding suggests that the whole larval development takes place at the bottom.

There are no observations on the feeding by *Apistobranchus* (Rouse & Pleijel 2001). Preliminary results of isotopic analysis done on apistobranchids of Martel Inlet show that their carbon signature is closely related to that of sediment and microphytobenthos and are thus probably deposit feeders (Bromberg 2004). Fauchald & Jumars (1979) suggested that they use their palps for selecting the food on the sediment surface.

Conclusions

The main diagnostic characters of our specimens collected in Admiralty Bay correspond to those referred to in the original description of the species of the genus *Apistobranchus* in Antarctica (Hartman 1978; Hartmann-Schröder & Rosenfeldt 1988).

The examination of our and type material of *A. gudrunae* and *A. glacierae* showed that *A. gudrunae* is a junior synonym of *A. glacierae* Hartman, 1978. A large number of worms of different sizes, many of them complete and well preserved, was fundamental for the observation of most of the details that were indispensable for the characterization of the species, since the "specimens of this family are often incomplete and easily damaged upon fixation" (Gathof 1984). This characterization is important for the further progress of the study of meiofaunal polychaetes, in both taxonomic and ecological terms. Little information is available concerning the development of apistobranchids. Since their larvae have not yet been found, the presence of very young individuals in the sediment may indicate an absence or a very short period of pelagic larval phase.

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