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Paeonocanthus antarcticensis (Hewitt, 1965): a rare copepod parasite of bathypelagic fish, *Bathylagus antarcticus* Günther, from the Antarctic Ocean

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ABSTRACT—*Paeonocanthus antarcticensis* (Hewitt, 1965) is redescribed based on four specimens recovered from a deep-sea smelt, *Bathylagus antarcticus* Günther, collected in the Antarctic Ocean (65°S, 139° 59.6'E). Studies on the morphological variations of these four specimens plus comparison with the three documented specimens yielded that the sphyriid reported as *P. antarcticensis* from the goiter blacksmelt, *Bathylagus euryops* Goode & Bean, taken in the Northwest Atlantic Ocean is a different species. It is renamed *Paeonocanthus hogansi* n. sp.

Key words: parasitic copepod, *Paeonocanthus*, deep-sea smelt, *Bathylagus*, Antarctic Ocean

INTRODUCTION

During a recent survey in the Antarctic Ocean, a research team on board R/V *Hakuho maru* of the Ocean Research Institute, The University of Tokyo, caught a deep-sea smelt, *Bathylagus antarcticus* Günther, infected with four parasitic copepods (Fig. 1). Subsequent study of the parasites revealed that all of them are *Paeonocanthus antarcticensis* (Hewitt, 1965), a rarely known species of the family Sphyriidae (Siphonostomatoida).

In the year when Hewitt (1965) reported a new species of sphyriid, "*Periplexis antarcticensis* n. sp.," from the deep-sea smelt caught at a depth of 390–510 fathoms in the Bellinghausen Basin (at 50°36'S, 130°20'W), Kabata (1965) described also a new sphyriid obtained from the same species of fish collected at Station 31 (66°11'S, 65°10'E; depth 2,669 m) during the B.A.N.Z. Antarctic Research Expedition. Although it was not a complete specimen (lacking anterior part of the neck and cephalothorax), due to the difference in the location of the posterior processes coupled with its occurrence on a teleost (rather than an elasmobranch), Kabata (1965) created a new genus *Paeonocanthus* to accommodate the new species. The species was called "*Paeonocanthus tricornutus* gen. et sp. nov." alluding to the presence of an anchoring device comprising three antlers. However, 14 years later, realizing that he was indeed dealing with the same species of the sphyriid that Hewitt (1965) reported, Kabata (1979) proposed to call the parasite "*Paeonocanthus antarcticensis* (Hewitt, 1965)," because Hewitt's report was published one month prior to Kabata's and the species in question can not be placed in the genus *Periplexis* Wilson, 1919 due to the difference in the structure of the posterior processes.

A year before the publication of Kabata's (1979) amendment of the name of *P. antarcticensis*, Alioshkina (1978) reported the discovery of "*P. antarcticensis* Hewitt, 1965" from an unknown host collected in the South Atlantic. Since the parasite was only briefly mentioned without illustration or photograph, it is impossible to confirm if Alioshkina (1978) had indeed a specimen of *P. antarcticensis*. Another doubtful record of this species of sphyriid was made by Markevitch and Titar (1978). It was reported from an unknown fish collected "in the region of Soviet Far East" without description or illustration. Thus, it is appropriate to

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Fig. 1. A deep-sea smelt, *Bathylagus antarcticus* Günther, from the Antarctic Ocean infected with four sphyriid copepods, *Paeonocanthus antarcticensis* (Hewitt). Upper photo shows the whole fish and lower photo, the infected area (fourth parasite showing only a portion of its neck). Scale bars: upper=10 mm, lower=20 mm.

state that the parasite *P. antarcticensis* has not been seen with certainty since its discovery in 1965 and only three specimens [two in Hewitt's (1965) original description and one in Kabata's (1965) report] of the species are known to science so far.

Although Hogans (1986) reported the occurrence of *P. antarcticensis* on a goiter blacksmelt, *Bathylagus euryops* Goode & Bean, caught at 600 m off the continental slope of the Scotian Shelf in the Northwest Atlantic Ocean, based on our studies on the newly collected specimens from the Antarctic Ocean, the parasites from the two oceans are not identifiable with each other. In this paper we shall redescribe this rarely known parasite in addition to discuss the taxonomic status of Hogan's (1986) "*Paenoncanthus antarcticensis* (Hewitt, 1965)."

MATERIALS AND METHODS

The infected deep-sea smelt, *Bathylagus antarcticensis* Günther (144.2 mm in standard length), was caught by an oblique tow of a RMT-8 net (mesh size 4.5 mm) down to the depth of 807 m. The tow was made on 8 January 2002, during the Leg 2 of the Cruise KH01-3 of R/V *Hakuho maru* at Station 12 (65°S, 139° 59.6'E). Only one deep-sea smelt was collected in that tow.

The photograph shown in Fig. 1 was taken on board R/V *Hakuho maru* immediately after retrieving the infected deep-sea smelt from the RMT-8 net. Then, the fish together with the four attached mesoparasites were preserved in 10% formalin prepared in saltwater. Back to the laboratory in Japan, the parasites were dissected out of the host body under the dissection microscope. The removed parasites were then washed and transferred into 70% ethanol. To study the parasites, the preserved specimens were soaked in 85% lactic acid for 3 days before dissection under a dissection microscope and examination under a compound microscope. All drawings were made with the aid of a *camera lucida*. Specimens of *P. antarcticensis* have been deposited in the National Science Museum in Tokyo and received a catalogue number of NSMT-Cr 14834.

RESULTS

The four parasites exhibit certain differences in the external morphology. Thus, in the following each of them is described separately in order to elucidate intraspecific variations. To facilitate better understanding of these intraspecific differences, the four specimens are coded consecutively according to their position of attachment on the

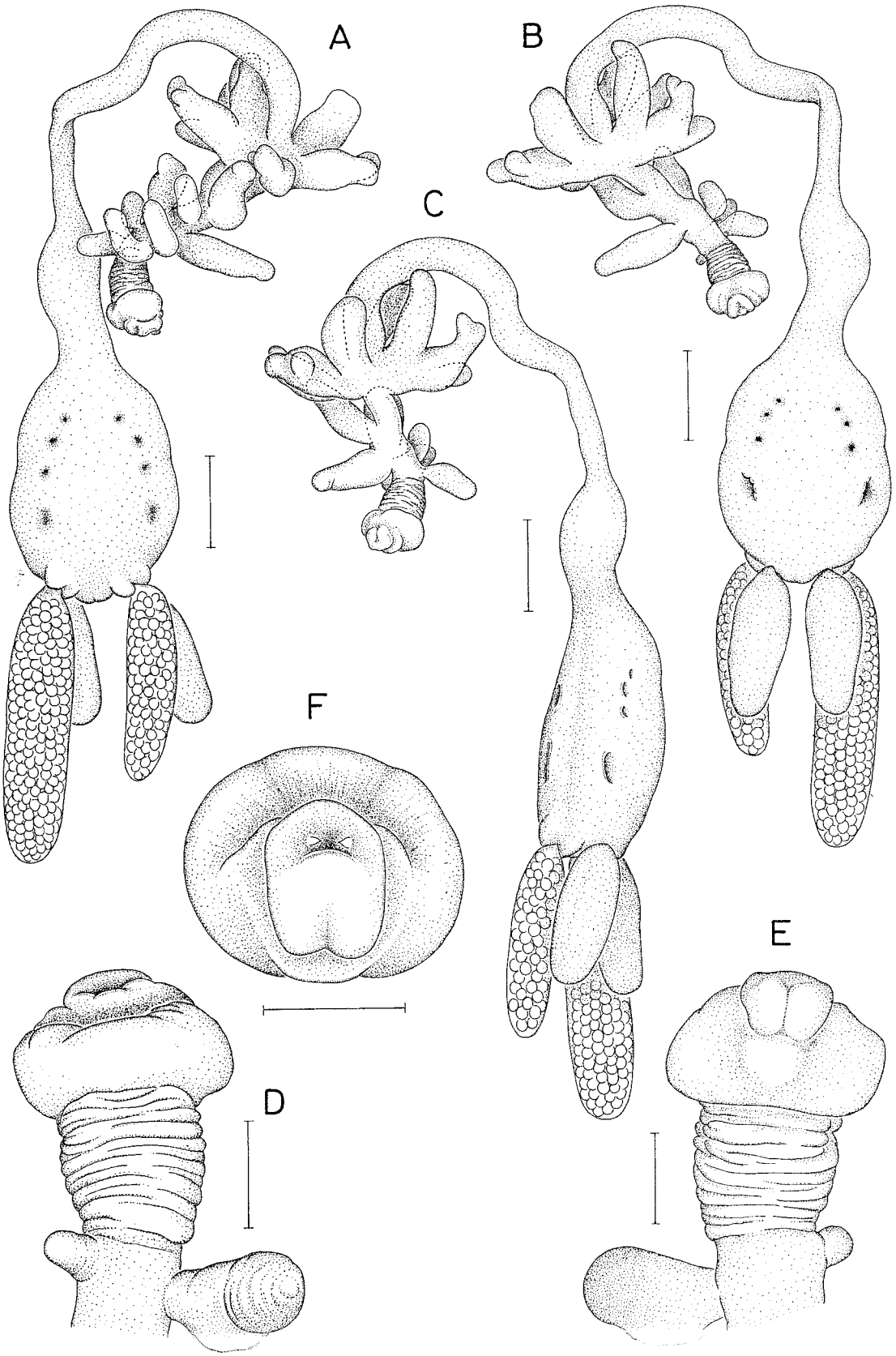

Fig. 2. *Paeonocanthus antarcticensis* (Hewitt, 1965), female, specimen 2. A, habitus, ventral (cephalothorax in lateral view). B, habitus, dorsal (cephalothorax in ventral view). C, habitus, lateral (cephalothorax in dorsal view). D, cephalothorax, ventral; E, cephalothorax, dorsal. F, cephalothorax, frotal (with ventral side up). Scale bars: A–C=3 mm, D–F=1 mm.

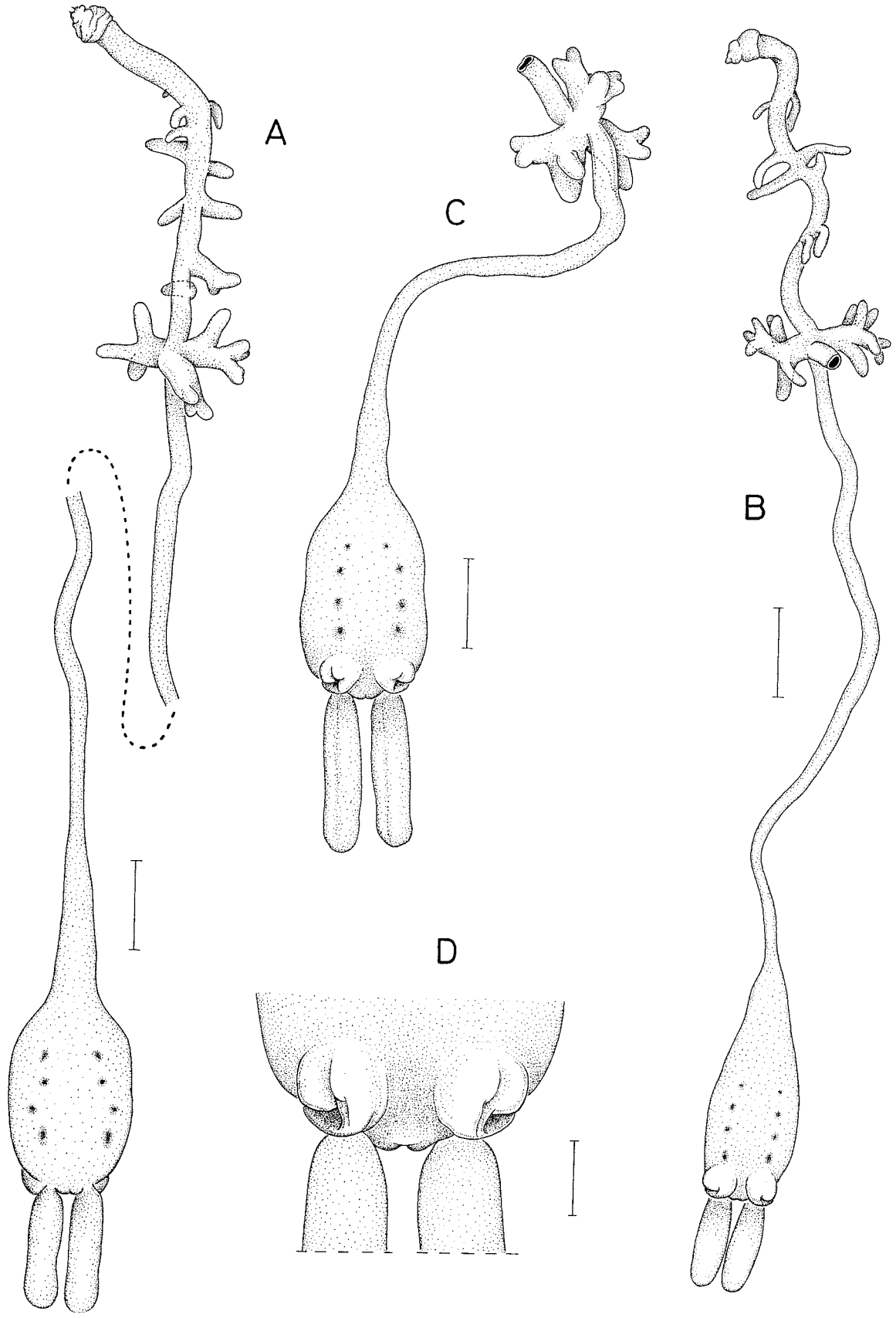

Fig. 3. *Paeonocanthus antarcticensis* (Hewitt, 1965), female. A, specimen 4, dorsal. B, specimen 3, ventral. C, specimen 1, ventral. D. specimen 1, posterior part of trunk, ventral. Scale bars: A–C=3 mm, D=1 mm.

host. The parasite attached to the dorsal-most of the host is coded Specimen 1 and the ventral-most, Specimen 4. As it is discernible in Fig. 1, Specimen 2 is the only ovigerous parasite with the largest trunk and Specimen 3, the youngest one with the smallest trunk. Since the species identity in the parasitic copepods is generally based on the characteristics of the adult, ovigerous female, Specimen 2 is, thus, treated first in the following. As to the other nonovigerous specimens, only the differences from Specimen 2 will be mentioned.

Female *Paeonocanthus antarcticensis* (Hewitt, 1965)

Specimen 2 (Fig. 2A–F)

Description.—Body (Fig. 2A–C) divisible into four parts: cephalothorax, neck (with holdfast), anterior part of trunk, and posterior part of trunk (carrying a pair of posterior processes and egg sacs). Cephalothorax (Fig. 2D, E) longer than wide, inflated anteriorly and corrugated posteriorly; cephalic region with a pair of shallow, dorsal swellings, and a pair of small sclerites at rim of apically located mouth (Fig. 2F). Junction of posterior end of cephalothorax and anterior end of neck marked by a short clavate outgrowth (Fig. 2D, E). Neck long, divisible into a short, horn-bearing anterior part and a long, smooth posterior part; anterior division bearing 7 unequal, clavate processes followed by a set of 3 large, horizontally stretched, antlers, with each antler carrying 3 branches with or without bifid tip. Anterior part of trunk (Fig. 2A, B) small, swollen in middle region but not bilaterally symmetrical. Posterior part of trunk (Fig. 2A, B) large, pyriform, and dorsoventrally compressed; with 4 pairs of depressions on both dorsal and ventral surfaces; posterior processes (Fig. 2B, C) located dorsal to subspherical protuberances to which the egg sacs attach. Anal slit present in posterocentral margin of trunk between two egg sac carrying protuberances (Fig. 2A). Two egg sacs unequal (Fig. 2A, B, C), right one larger than left one.

Measurements.—Total length (from tip of cephalothorax to end of posterior process) 39.7 mm. Cephalothorax 2.57 mm long and 2.00 mm wide; neck 20.83 mm long and 1.25 mm wide; anterior part of trunk 3.50 mm long and 2.17 mm wide; posterior part of trunk 8.01 mm long and 5.60 mm wide; posterior process 4.95 mm long and 1.90 mm wide; and right egg sac 9.05 mm long and 2.19 mm wide.

Specimen 1 (Fig. 3C, D)

Description.—Cephalothorax and anterior part of neck broken. Each antler with 3 short, major branches. Anterior part of trunk not well demarcated from neck and without distinctive central swelling. Egg sac not seen.

Measurements.—Cephalothorax broken; neck longer than 15.60 mm and 0.82 mm wide; anterior part of trunk 3.27 mm long and 1.21 mm wide; posterior part of trunk 7.05 mm long and 4.12 mm wide; and posterior process 5.52 mm long and 1.27 mm wide.

Specimen 3 (Fig. 3B)

Description.—Cephalothorax with smooth posterior part. Anterior division of neck with 8 unequal, clavate processes. Ventral antler broken, each dorso-lateral antler bearing 4 major branches with or without bifid tip. Two parts of trunk not well-demarcated and leaving margins of trunk without constrictions. Egg sac not seen.

Measurements.—Total length (from tip of cephalothorax to end of posterior process) 47.3 mm. Cephalothorax 3.83 mm long and 1.25 mm wide; neck 32.33 mm long and 0.67 mm wide; anterior part of trunk 2.62 mm long and 1.78 mm wide; posterior part of trunk 5.38 mm long and 2.97 mm wide; and posterior process 3.53 mm long and 1.97 mm wide.

Specimen 4 (Fig. 3A)

Description.—Cephalothorax with smooth posterior part. Anterior division of neck with 10 unequal, clavate processes. Posterior end of neck gradually enlarged to become anterior end of trunk without well defined demarcation or central swelling. Egg sac not seen.

Measurements.—Total length (from tip of cephalothorax to end of posterior process) 53.6 mm. Cephalothorax 3.92 mm long and 1.50 mm wide; neck 34.33 mm long and 0.83 mm wide; anterior part of trunk 4.67 mm long and 1.33 mm wide; posterior part of trunk 6.67 mm long and 4.00 mm wide; and posterior process 4.17 mm long and 1.08 mm wide.

DISCUSSION

Intraspecific variations

Based on our current knowledge about the sphyriid copepods, the four specimens attached to *B. antarcticus* collected on board R/V *Hakuho maru* are conspecific. The combination of possessing a pair of cigar-shaped posterior processes dorsal to the egg-sac attachment area and an anchoring device comprising a row of 8 to 10 club-like lateral processes followed by a wreath of triple antlers indicates without doubt that they are *Paeonocanthus antarcticensis* (Hewitt, 1965).

Hewitt's (1965) material of *P. antarcticensis* (two specimens from two hosts) was taken in the Southern Pacific (50°30'S, 130°20'W) at a depth of "390–510 fathoms" on 25 June 1964. But Kabata's (1965) material of the same species (one specimen) was obtained earlier (31 December 1929), from a different sea (Indian Ocean, Antarctic at 66°11'S, 65°10'W), and at deeper water (2,669 m). Since Kabata's specimen was incomplete, without the cephalothorax and anterior part of the neck, it will be excluded in most of the following comparison of the known specimens of the present species. By the same token, Specimen 1 of the present material will also be excluded.

In Hewitt's (1965) original description of *P. antarcticensis*, the lateral processes in the neck region were called "horns" without separating them into "clavate processes"

and "wreath of antlers" like what they were treated above in this report. However, his illustrations of the holotype and paratype of *P. antarcticensis* show that their "horns" are divisible into the same two groups described above. The number of the "horns" was stated to be different between the two type specimens, 15 on the holotype and 12 on the paratype. This difference in the horn number is also found in the present material, there are 10 outgrowths (including the 3 antlers) in Specimen 2, 11 outgrowths (incuding the 3 antlers) in Specimen 3, and 13 outgrowths (including the 3 antlers) in Specimen 4. Thus, in combination with the variations given in the descriptions of the present material, it is appropriate to state that the attachment device of *P. antarcticensis* is composed of two parts, the clavate processes with variable number of horns and triple antlers with variable number of branches.

It is clear from the above descriptions that the wall of the cylindrical, posterior portion of the cephalothorax of this species is variable, it can be either wrinkled (as in Specimen 2) or smooth (as in Specimen 3 and Specimen 4). However, it is smooth in both holotype and paratype (Hweitt, 1965). Another variable appearance is seen in the anterior portion of the trunk. It is well defined in both Hewitts (1965) and Kabata's (1965) materials, but in the present material it is only Specimen 2 that shows a clear separation of the trunk into a small anterior and a large posterior parts. Since both holotype and paratype were ovigerous, it is suspected that the division of the trunk into two parts is probably related to the maturity of the parasite.

One interesting phenomenon was discovered in the process of measuring the different parts of this transformed mesoparasitic copepod. In spite of its maturity evidenced by carrying a pair of egg sacs, the neck of Specimen 2 is distinctively shorter than the two non-ovigerous specimens. It is 20.83 mm in Specimen 2, but 32.33 mm in Specimen 3, and 34.33 mm in Specimen 4. Furthermore, regardless of the maturity, the smooth posterior division of the neck is longer than the anterior horn-bearing division. At this point of time it is impossible to speculate what could be the cause of this difference in the neck length.

Reconsideration of *P. antarcticensis* from the North Atlantic

Paeonocanthus is a monotypic genus of the Sphyriidae and only three specimens of *P. antacrticensis* are known to science prior to the writing of this paper. However, with the present discovery of four more specimens, the intraspecific variations in the morphological features of the present species became better understood. Then, a close comparison with the specimen obtained from the North Atlantic revealed that the latter is not identifiable with *P. antarcticensis*.

When Hogans (1986) reported "*Paeonocanthus antarcticensis* (Hewitt, 1965)" from the goiter blacksmelt, *Bathylagus euryops* Goode & Bean, collected in the North Atlantic, certain morphological differences were detected between his Atlantic specimen and the three Antarctic specimens documented by Hewitt (1965) and Kabata (1965). Among those various differences, the most remarkable ones are the presence of the "first and second maxillae and maxillipeds" in the Atlantic specimen (Hogans, 1986: 306). In general, a transformed adult, female sphyriid seldom carries the oral appendages. A close examination of the oral areas of the three intact specimens of *P. antarcticensis* in our possessions has turned out only one pair of tiny sclerites located at the rim of the oral opening (see Fig. 2F). It is impossible to determine if they are the remnants of oral appendages. No oral appendages were detected by Hewitt (1965) on either holotype or paratype.

As mentioned in the above descriptions, the neck is divisible into a short, horn-bearing anterior part and a long, smooth posterior part, with the wreath of antlers serving as the boundary of these two divisions. We noticed that the length difference between the two parts of the neck is much greater in the North Atlantic specimen. The ratio of the length of the posterior division to that of the anterior division is 8.93 in the North Atlantic specimen, but it is less than 3 in our three specimens from the Antarctic, *viz*. 2.77 in Specimen 2, 2.02 in Specimen 3, and 2.15 in Specimen 4. Furthermore, based on the illustration given by Hewitt (1965), the same ratio for the holotype is 2.14, just like our specimens.

With these qualitative and quantitative morphological distinctions augmented by differences in the host and locality, we consider Hogan's (1986) "*Paeonocanthus antarcticensis* (Hewitt, 1965)" is a different species. It is proposed to be renamed *Paeonocanthus hogansi* sp. nov. In his monumental work on the copepod parasites of British fishes, Kabata (1979: 318) stated "*Paeonocanthus antarcticensis* has been found only in the Antarctic region, with one record from the North Atlantic (62°N, 33°W)." The "record" was Kabata's identification of a specimen sent to him and it was not published (Kabata, personal communication). In his recent communication Kabata stated "Hogans subsequent find confirmed my diagnosis of the parasite." Therefore, we consider, it is another record of *P. hogansi* from the North Atlantic.

It goes without saying that the specimen described as "*Paeonocanthus antarcticensis* (Hewitt, 1965)" by Hogans (1986), deposited in the Atlantic Reference Center of the Biological Station located in St. Andrews, New Brunswick, Canada, and received a catalogue number of 2636 becomes the holotype of the newly proposed *Paeonocanthus hogansi* sp. nov. It was well described by Hogans (1986) and requires no further treatment.

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