AN ULTRASTRUCTURAL STUDY OF THE ANTARCTIC CALANOID COPEPOD METRIDIA GERLACHEI GIESBRECHT, 1902. ADULT FEMALE

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INTRODUCTION

The Antarctic environment is a peculiar ecosystem still greatly unpolluted and constitutes a true natural laboratory. In Antarctic waters low temperatures strongly affect the composition and structure of biocenosis and the occurrence of the Antarctic Convergence separates the Southern Ocean from surrounding waters. These characteristics led to the development of endemisms; therefore, the study of morphology, physiology, genetics and biochemical composition of Antarctic species are the basic elements to know their adaptive strategies and to reconstruct evolutionary events. In 1985 the Italian National Research Program for Antarctica launched extensive researches in the Antarctic region; in this connection, the zooplankton has been the subject of investigation. The calanoid copepod Metridia gerlachei is an Antarctic autochtonous species very abundant southward the Antarctic Circle and also beneath the ice (1). It greatly occurs in the Southern Ocean around the whole continent. The morphology of this Copepod was so far studied by microscopy methods (2-4). Considering that scanning electron microscopy (SEM) is extensively used to study the fine morphology of crustaceans and that ultrastructural descriptions of M.gerlachei are to date unknown, this work aims to describe by SEM the general external anatomy of the adult female and the morphology of some characteristic legs (P2 and P5) and abdomen, with particular reference to the first abdominal joint (genital joint).

MATERIALS AND METHODS

Specimens of M.gerlachei were sampled in Terra Nova Bay (Ross Sea) during the Italian Oceanographic Campaign in Antarctica 1987-88, using a Bioness electronic multinet (5) and fixed in 4% formalin. The classification was performed by means of a Wild M3C stereo-microscope and a Leitz Diaplan microscope (6,7). For SEM observation, specimens were washed in cacodylate buffer at 4°C for 30 min, rinsed twice in the same buffer, rinsed once again in distilled water, dehydrated in ethanol of increasing concentration up to 100% and critical point dried from liquid CO_2 (8). Specimens were mounted on aluminium stubs using small pieces of double-sided adhesive tape, coated with a 20 nm gold layer in an argon atmosphere flow discharge sputter coating-unit (Polaron E 5100) and observed in a ISI SS-40 scanning electron microscope operated at an accelerating voltage of 10-20 Kw.

RESULTS

M.gerlachei female shows a marked convexity of head dorsal surface and of first thoracic joints (fig. 1); the following dorsal thoracic part is downward-curved and the last thoracic joint has rounded margins. These characteristics are well known (9) and peculiar of the species. The second (P2) and the fifth (P5) swimming legs, characteristic of the species, were particularly considered: in the first segment of P2 endopod a concave inner margin provided with two strong curved spines (3) forming the hook process already described (2,9) can be observed (fig 2); the first joint of exopod is provided with series of spines differently prolonged, never previously described. The general (fig. 3) and distal joint (fig. 4) features were extensively observed in P5, showing that three free segments follow the basipod. Figs. 4 and 5 show the marginal seta placed on the outer side of the second free joint whose occurrence was already reported (2,9), however, this joint was considered as the last one (2); and the occurrence of a spine on the inner margin of the distal joint was also reported (3). The abdomen comprised three joints and furca (fig. 1), as described (2,9).

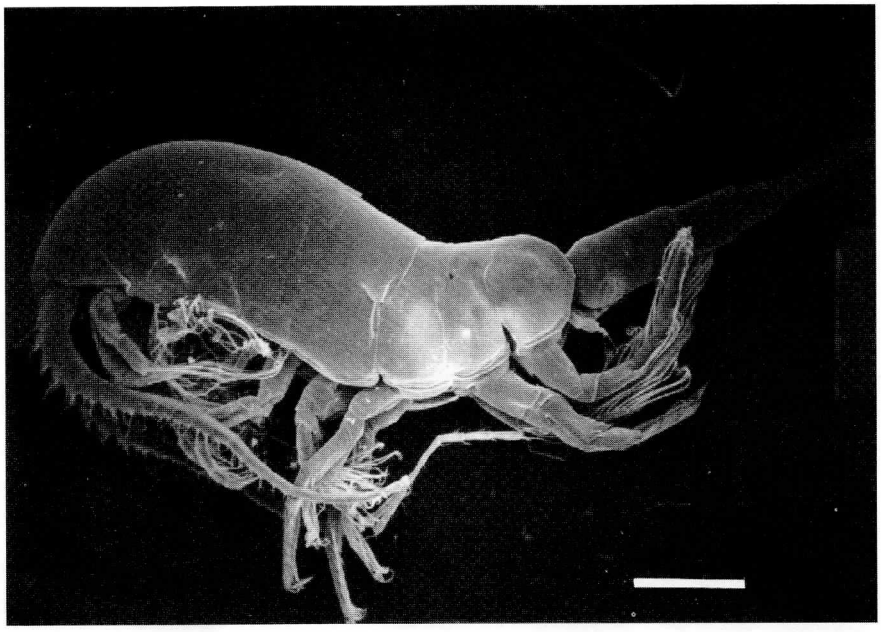

Fig. 1 - Morphology of Metridia gerlachei adult female. Whole animal lateral view. Bar: 500 μm.

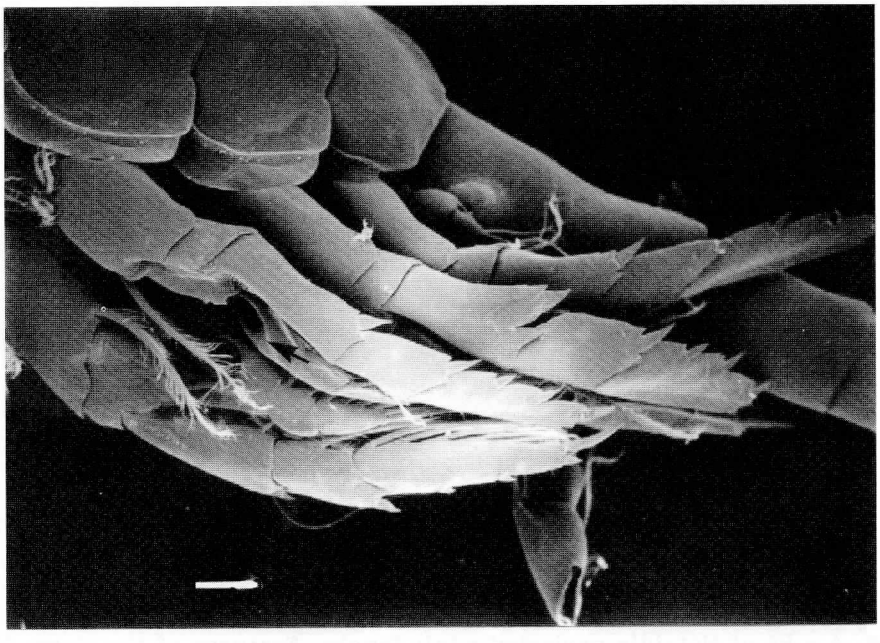

Fig. 2 - Latero-ventral view of P2 of Metridia gerlachei adult female. Hook process on endopod inner margin (arrow). Bar: 100 μm.

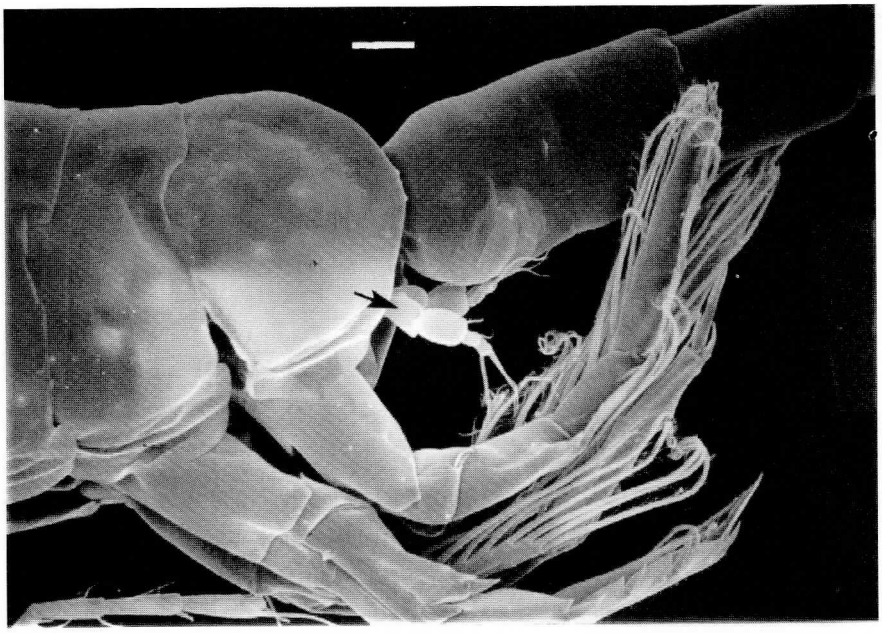

Fig. 3 - Localization of P5 (arrow) of Metridia gerlachei adult female. Bar: 100 μm.

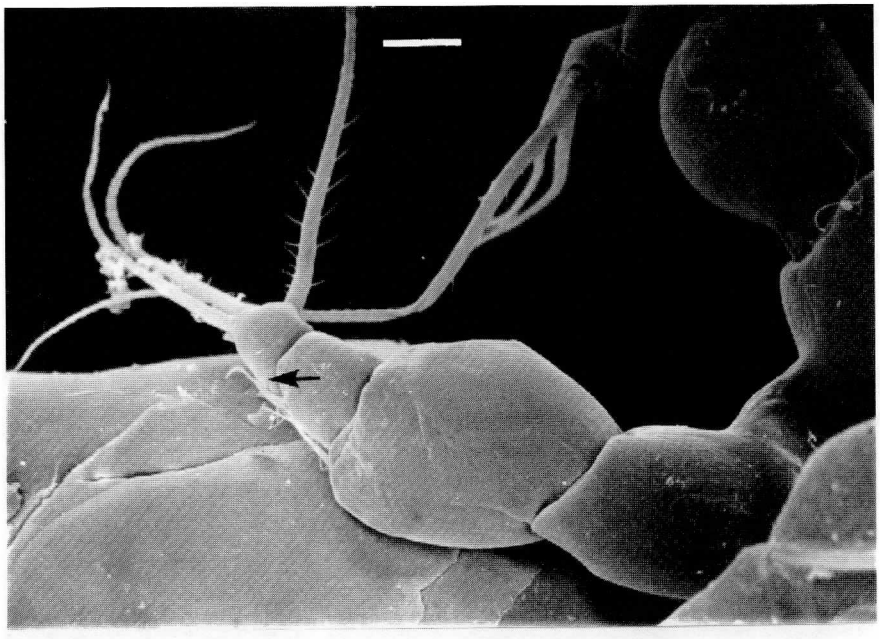

Fig. 4 - P5 of Metridia gerlachei adult female. Features of the three free segments with the seta (arrow) placed on the outer margin of the 2nd free joint. Bar: 30 μm.

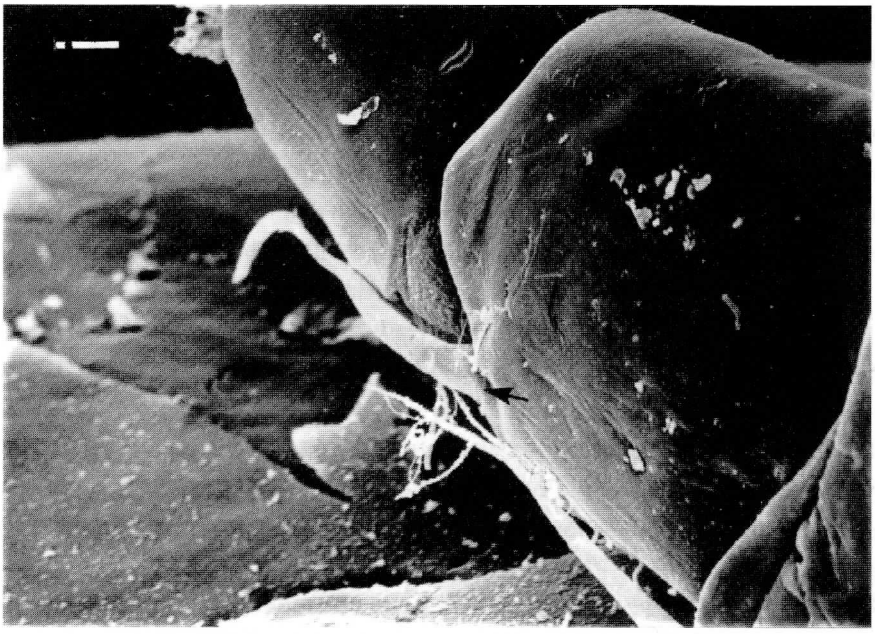

Fig. 5 - P5 of Metridia gerlachei adult female. Detail of the external seta (arrow) placed on the outer margin of the second free joint. Bar: 5 μm.

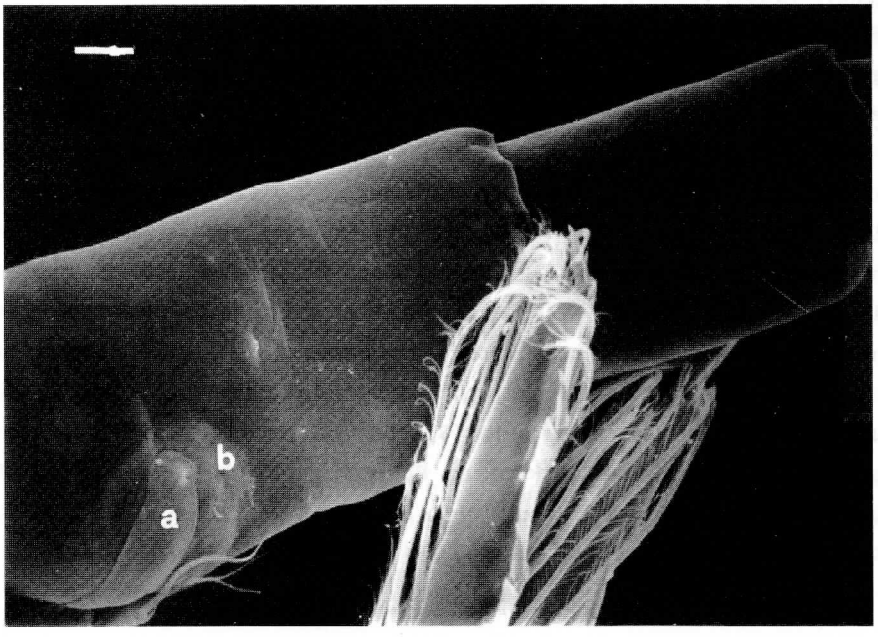

Fig. 6 - Latero-ventral view of the genital joint of Metridia gerlachei adult female; a: genital field; b: surrounding areola. Bar: 50 μm.

The first segment is the largest and the last one is the shortest. All segments are devoid of spines and setae. The genital joint is about 1.7 times longer than the following and has a ventral swelling on its upper part, where a clear areola with longitudinal axis can be noted (fig. 6). The genital field is nearly elliptical, slightly protruding from the swelling, and located in the middle part of the areola; its sides are slightly directed downward. Furthermore, as in other high-latitude species, bulky oil drops (not shown) were observed within tissues.

DISCUSSION

The ultrastructural fine morphology of M.Gerlachei is to date greatly unknown and only recently SEM studies permitted to show the detailed structure of mouthparts (10). SEM observations here reported have improved the anatomical knowledge of this copepod to better characterize the species.

The observation of P2 has confirmed previous descriptions (2,3,9), that pointed out the typical hook process. Several spine-shaped structures located on the first joint of exopod, never described previously though vaguely indicated in some figures (3), have been here emphasized, but their function in ecological or intraspecific relationships is not easily explainable. For P5 it was reported that it is 3-segmented including basipod and the distal joint shows an articulation drawing probably due to the wavy borders of joint margins, a short seta on the outer margin, and three longer distal setae (9). Another study (2) partly agrees with this assumption asserting that "the distal segment is more or less completely divided into two.....the last joint bears one outer marginal bristle in the proximal half, and three distal bristles, of which the innermost is the longest and thickest, the outermost the shortest". It was also stated that P5 is 4-jointed, the distal joint has 3 setae and a small marginal spine in its inner side (3). In the present work a complete segmentation of the distal joint of P5 was verified, as reported (4); therefore P5 seems to have four joints, as asserted (3), but a spine-like seta in the outer margin of the second free joint was here observed. In

this connection intraspecific variations have to be considered; indeed, recent SEM studies on the related species M.lucens reported variations of the number of P5 joints (11). The general aspect of genital segment of female, never completely described in M.gerlachei, was also evidenced, showing a clear areola surrounding the genital field. As concerns the oil drops observed within tissues, it was stated that at high latitudes the development of oil sacs in copepods and the storage of oil by euphausiids may be a food reserve for winter (12). This could also demonstrate that M.gerlachei can bear starvation or food lacking also for a long time (6).

Scanning electron microscopy (SEM) techniques can highly contribute to the knowledge of body structures in order to differentiate between different species or between varieties within the same species. This is particularly important in extreme environments, such as in Antarctic waters, where the evolution efforts have promoted the development of endemisms. In this work the external anatomy of Metridia gerlachei (Copepoda, Calanoida) adult females, sampled during the Italian Oceanographic Campaign in Antarctica 1987-88, was described by SEM, particularly considering some swimming legs and the genital abdominal joint. The descriptions already reported have been verified and some morphological details have been better emphasized. As concerns the P2, the hook process of the first segment of endopod and a series of spines vaguely indicated, but not defined, in previous descriptions have been clearly evidenced. In the P5 the occurrence of three well separated free segments and the location of a marginal seta have been shown. The ultrastructure of the genital segment showed that a clear areola surrounds the genital field.

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1) FARRAN G.P., Nat. Hist. Rep. Zool., 1929, 8, 203-306.
2) WOLFENDEN R.N., Nat. Hist. Zool., 1908, 4, 1-46.
3) TANAKA O., Pelagic Copepoda, p. 1-95 in: Biological results of the Japanese Antarctic Research Expedition, 1960.

4) PIÑERO DE VERDINELLI M.E., Thesis Doutor em Ciencias, Inst. Oceanografico da Universidade de Sao Paulo, 1981.
5) GUGLIELMO L., COSTANZO G., MANGANARO A., ZAGAMI G., Nat. Sc. Com. Ant. Ocean. Camp. 1987-88 Data Rep., 1990, 2, 257-398.
6) CARLI A. MARIOTTINI G.L., PANE L., Nat. Sc. Com. Ant. Ocean. Camp. 1987-88 Data Rep., 1990, 2, 129-159.
7) CARLI A., FELETTI M., MARIOTTINI G.L., PANE L., Atti 9° Congr A.I.O.L., S.Margherita Ligure, 20-23 November 1990, 1992b, 623-633.
8) COHEN A.L., Scanning Electron Microsc., 1979, 2, 303-322.
9) GIESBRECHT W., Copepoden, p. 1-49 in: Expedition Antarctique Belge, Resultats du Voyage du S.Y. Belgica en 1897-1898-1899. Buschmann Anvers, 1902.
10) ROMANO P., FELETTI M., MARIOTTINI G.L., CARLI A., Polar Biol., 1999, 22, 7-12.
11) MAZZOCCHI M.G. et al., Copepods, p. 1-280 In: Atlas of Marine Zooplankton Straits of Magellan. Guglielmo-Ianora Eds., Springer Verlag, Berlin-Heidelberg, 1995.
12) NEMOTO T., HARRISON G., High latitude ecosystèms, p. 95-126 in: Analysis of marine ecosystems, Longhurst A.R. Ed., Academic Press, London, 1988.

KEY WORDS: Metridia gerlachei, SEM, Antarctica.

This work was supported by a research grant from ENEA-PNRA.

Lectured at the meeting held in Genova on July 4, 2000.
Received: July 18, 2000; accepted: October 6, 2000.

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