

A new species of *Ophryotrocha* (Polychaeta: Dorvilleidae) commensal in *Geryon longipes* (Crustacea: Brachyura) from the Western Mediterranean Sea

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A new species of Dorvilleidae, *Ophryotrocha mediterranea*, commensal in the branchial chambers of the deep-water crab *Geryon longipes*, is fully described and illustrated. It is characterized by the presence of seven pairs of denticulate maxillary plates in the jaw apparatus, and especially the 7th plate, which is more elongate, markedly bidentate and situated at a different level. The setae are always spinulate. The gut is annular. The hosts were captured in the Balearic Sea bathyal basin (Western Mediterranean), between 600 m and 1800 m deep. The prevalence of the infestation was 18.87% in male and nil in female hosts. No polychaetes were found in crabs smaller than 41 mm carapace length (49 mm carapace width). No differences were found in the degree of infestation of the right and left branchial chambers. The infestation intensity followed a contagious distribution model. The mean infestation intensity was 4-16 polychaetes per crab. The relative density of the infestation was 0-83 polychaetes per male crab examined and 0-71 per total crabs examined.

KEYWORDS: Infestation, *Ophryotrocha mediterranea* sp. nov., Polychaeta, *Geryon longipes*, Brachyura, Mediterranean Sea.

Introduction

The deep ocean constitutes an ecosystem with strong characteristics of ecological maturity and high rates of internal recycling, where strong and stable interspecific relationships have been established. Such relationships are little known on the Mediterranean bathyal bottoms, since from the faunistic point of view this ecosystem is not well known (Fredj and Laubier, 1985; Perk, 1985). One of the possible mechanisms of speciation in the benthos inhabiting the Western Mediterranean bathyal basin is the relative isolation of the deep water mass, which is characterized by its strong hydrographical stability (Hopkins, 1985; Per&, 1985).

The occurrence of a polychaete of the genus *Ophryotrocha* in the branchial chambers of the deep-water crab *Geryon longipes* A. Milne Edwards, 1881, was previously reported in the Mediterranean (Desportes et al., 1977; Mori and Belloni, 1985). In both cases the polychaetes were attributed to the species *O. geryoncola* (Esmark, 1874), whose known geographic distribution included the eastern and western North Atlantic (Gaston and Benner, 1981; Pfannenstiel et al., 1982; George and Hartmann-Schroder, 1985). *Ophryotrocha geryoncola* has been reported from the branchial chambers of several species of deep-water crabs of the genus *Geryon* (viz. *G. tridens* Kroyer, *G. longipes*, *G. quinquedens* Smith), and also from *Cancer borealis* Stimpson (Gaston and Benner, 1981; Mori and Belloni, 1985). The differences in morphological characters (especially those of the jaw apparatus and the setae) present in the specimens we have studied are sufficient to differentiate them as a new species.

This new species can be considered as a commensal of the host crab, since it lives freely in the branchial chambers of its host. Apparently it does not affect the branchiae adversely, as happens in other polychaete species with similar life-habits (Pilger, 1971; Abello et al., 1988 a; Comely and Ansell, 1989).

In the study area the host species lives on muddy bottoms at depths between 400 m and 1800 m (Abelló et al., 1989b; Abelló and Valladares, 1988).

Material and methods

The host crabs (*G. longipes*) examined were caught by R/S Garcia del Cid between June and October 1988 and between July and October 1989 in the bathyal basin lying between the Catalan coasts and the Balearic islands (north-west Mediterranean Sea). A deep-water trawl of 6 mm cod end mesh size was used at depths between 600 m and 1800 m.

Sex and size (carapace length –CL- (in mm) measured between the rostral notch and the posterior edge of the carapace, and carapace width-CW, measured between the bases of the third anterolateral spines) were taken in all the crabs caught (265 males and 42 females). Crabs were preserved in 70% ethanol.

Both right and left branchial chambers were later examined to detect the possible occurrence of the polychaete. The number and length of all the polychaetes occurring in each branchial chamber was also noted. Infestation intensity was only noted for 248 male crabs. Polychaetes were preserved in 10% formalin.

The terms used throughout the paper follow the recommendations of Margolis et al. (1982). Thus, infestation prevalence is defined as the ratio between the number of individuals of the host species, *G. longipes*, infested by *O. mediterranea* sp. nov. and the total number of hosts examined; infestation intensity, as the number of *O. mediterranea* sp. nov. present in each infested host; mean intensity, as the mean number of individuals of *O. mediterranea* sp. nov. present in each infested host; mean intensity, as the mean number of individuals of *O. mediterranea* sp. nov. per infested host in a sample; abundance or relative density, as the mean number of individuals of *O. mediterranea* sp. nov. per host of the total examined.

Type specimens of *O. mediterranea* sp. nov. are deposited in the zoological collection of the 'Museo Nacional de Ciencias Naturales' of Madrid, MNCNM (Spain) and with the 'Centre d'Estudis Avançats de Blanes', CEAB, (CSIC), (Girona, Spain).

Systematics

Family DORVILLEIDAE Chamberlin, 1919

Genus *OPHRYOTROCHA* Claparède and Meczников, 1869

Ophryotrocha mediterranea sp. nov.

Ophryotrocha geryonjcola Desportes et al., 1977; Mori and Belloni, 1985

(Figs. 1-6)

Host. Brachyura: Geryonidae: *Geryon longipes* A. Milne Edwards 188 1.

Site on host. Branchial chambers.

Type specimens. HOLOTYPE: MNCNM

MNCNM, No. 16-01-761; PARATYPES: (ten specimens), nos. 16-01-761 to 765; CEAB (ten specimens), nos. AP/023/002-0012.

Type locality. Western Mediterranean (40°52.6'N 02'03.1'E, 1246-1284 m deep).

Additional material. One hundred and sixty specimens in collection of senior author.

Etymology. The specific epithet refers to the known geographic distribution of the species.

Description

Specimens range from 6 to 135 mm in length (following preservation in alcohol), and 20 to several hundreds of segments. The colour of the body varied from white to orange in preserved specimens. The pharyngeal region and the gut rings were sometimes darker. There are no sensory hairs visible throughout the body.

Prostomium oval, twice as wide as long (Fig. 1a, b). Two digitiform dorsolateral antennae (approx. 110 μm) (Fig. 1a: AN) and two ovoid ventrolateral palps of about similar size (Fig. 1b: PA). No eyes or ocular spots. Two apodous and achaetous segments follow the prostomium (Fig. 1a, b).

The mouth opens between the prostomium and the first segment on the ventral side (Fig. 1b). The muscular pharynx with the jaw apparatus is located within the first 3 or 4 segments (Fig. 1a, b). There is an annular gut, corresponding to the body segments, giving the appearance of lateral pouches occurring in each segment (Fig. 2).

The jaw apparatus is composed of a pair of mandibles, a pair of maxillae with maxillary carriers, and 7 pairs of maxillary plates together with some additional lateral plates. The mandible is X-shaped (Fig. 3a) with a long posterior end (Fig. 3a), a shorter expanded anterior end with a striated surface, and toothed anterior margins (Fig. 3a, e). The teeth of the anterior margin can be reduced in size (Fig. 3 e), apparently due to abrasion. Both external sides of the mandibles show thin hyaline striated enlargement (Fig. 3a). Maxillae an inverted Y-shape (Fig. 3b: MX), not fused to the mandibles, with the free anterior ends forming a pincer-like structure (Fig. 3b: MX). Posterior ends more massive from lateral view, straight with rounded ends (Fig. 3b: MX). Viewed dorsoventrally the maxillary carriers appear dark, thin and translucent. They are approximately 7-10 μm wide (Fig. 3 d: MC) and 50-60 μm long, with concave striations when viewed laterally (Fig. 3b: MC). Maxillary carriers fused medially to each other (Fig. 3d: MC) and to one of the maxillae posterior ends (Fig. 3b, d: MC). Free maxillae posterior end aileron-shaped (Fig. 3b: AI). Maxillary plates more or less long and concave, with strong denticulate inner margin (Fig. 3c: μMXI to μMXVII), showing up a darker 7th plate which is placed over the others, and bears two long teeth (Fig.

3c: μ MXVII). Square additional plates (0-4) on both external sides of the maxillary plates, sometimes with enlarged margins (Fig. 3b, c, cl: AP).

Parapodia uniramous, those from the anterior end of the body being shorter and bearing fewer setae than those more posterior (Fig. 4a, b). The dorsal and ventral cirri are of similar size. Typically the parapodia from the middle of the body are longer (Fig. 4c, d) with long (about 450 μ m) conical dorsal cirrus (Fig. 4c, d: DC) and shorter (about 330 μ m) ovoid ventral cirrus (Fig. 4c, d: VC); short bilobulate postsetal lobe (Fig. 4c, d: PO); presetal lobe of similar length, conical (Fig. 4d: PR), with pear-shaped distal lobe of about 100 μ m (Fig. 4 c, d: DL).

Parapodium with setae of three kinds (Fig. 4): (1) 4-8 simple notosetae of about 8 μ m wide, subdistally spinulated, with pointed hooked end (Fig. 5b, c); (2) 3-10 dorsal composite falciger neurosetae of similar width, with spinulate handle end, and short (225 μ m) pointed hooked blades with spinulate inner margin (Fig. 5a); (3) 1-4 ventral simple slender (35 μ m) neurosetae, with folded rounded end and one spinulate subdistal enlargement (Fig. 5d). A straight yellowish pointed aciculum bisects each parapodium (Fig. 4c: AC).

The prostomium and the anterior body segments are relatively narrow, whereas midbody segments are rather broad. Posterior segments gradually taper to the pygidium (Fig. 1c). There are up to five more or less undifferentiated segments without parapodia, or at least without setae, in front of the pygidium (Fig. 1c). The pygidium is oval, 1-3 times wider than long (Fig. 1c: P). Anus on dorsal side (Fig. 1c) bearing two dorsolateral pear-shaped anal cirri of about 90 μ m (Fig. 1c: AC) and ventrally one middle anal cirrus of similar form and size (Fig. 1c: MC).

Discussion

There are a number of characters to distinguish present specimens from those of *O. geryoncola*. The thick bidentate 7th pair of maxillary plates present in all the specimens of *O. mediterranea* sp. nov. is lacking in *O. geryoncola*, whose intermediate specimens (*sensu* Gaston and Benner, 1981) bear only six pairs.

Fraying of denticulation or variations in size of some parts of jaw apparatus are the sole changes related to body size that we have observed in *O. mediterranea* sp. nov. Changes in form or number of any part of jaw apparatus have never been observed. On the contrary, maxillary plates of *O. geryoncola* show variations in number ranging from 3 to 14 (Gaston

and Benner, 1981) or from 3 (adults) to 13 (George and Hartmann-Schroder, 1985). According to Pfannenstiel *et al.* (1982), a larger number of jaw components in small worms can be due to the presence of a new jaw apparatus replacing the old jaws, and smaller numbers in bigger worms can be due to loss during usage. Both jaw configurations must, however, be considered as atypical situations.

Maxillae of *O. mediterranea* sp. nov. show one thick aileron-shaped posterior end which is not mentioned in the descriptions of *O. geryoncola* (Gaston and Benner, 1981; Wesenweg-Lund, 1938 in George and Hartmann-Schroder, 1985; Pfannenstiel *et al.*, 1982). The same is true for the different shapes shown by the maxillary carriers, oblong and wide (Fig. 3b) or typical long thin (Fig. 3d).

Although *O. mediterranea* sp. nov. and *O. geryoncola* have similar kinds of setae, we found that *O. mediterranea* sp. nov. has strong spinulate setae while *O. geryoncola* always have smooth setae (Gaston and Benner, 1981, Fig. 2D,E,F; George and Hartmann-Schroder, 1985).

There are a number of differences in the shape of dorsal and ventral cirri of our specimens and those described by Gaston and Benner (1981), Pfannenstiel *et al.* (1982) and George and Hartmann-Schroder (1985) (Table 1, Fig. 6). In addition, Pfannenstiel *et al.* did not mention the presence of any distal lobe.

Available descriptions of the parapodia of *O. geryoncola* are so different that they could be easily attributed to separate species (Fig. 6) but the parapodia of *O. mediterranea* sp. nov. appear distinctive.

Ophryotrocha mediterranea sp. nov. bears one middle anal cirrus similar in size to the lateral anal ones. Pfannenstiel *et al.* (1982) also described one in *O. geryoncola* (median stylus), but this is shorter than the lateral anal cirri.

Ophryotrocha mediterranea sp. nov. has an annular gut with one ring per segment, while *O. geryoncola* shows two laterally extended branches of the gut in each segment (Pfannenstiel *et al.*, 1982). However, we think that this difference could be attributed to different methods of observation: it is difficult to distinguish if the structure of the gut is annular or branched through the body wall. Its observation by dissection is essential.

Infestation characteristics

Infestation in relation to host sex and size

Male *G. longipes* reach much larger sizes than females (Fig. 7) and the population sex ratio is strongly biased towards males (Relini-Orsi and Mori, 1981; present results).

The occurrence of the polychaete *O. mediterranea* sp. nov. was detected in the branchial chamber of a total of 50 males of the 265 examined (Table 2). Thus, the prevalence is 18.87%. This polychaete was not detected in any of the 42 females examined.

The difference between the prevalence in the two sexes is highly significant (chi-squared=8-1330, $P < 0.01$). The polychaete seems to be restricted to adult hosts (Fig. 7). It has not been detected in hosts smaller than 41 mm CL (49mm CW).

Number of polychaetes per host and branchial chamber

No significant differences were detected between the infestation degree of the two branchial chambers, right and left (chi-squared =0-8032, $P > 0.30$).

A maximum of 16 polychaetes per branchial chamber was detected. The most frequent values, however, were 1-3 polychaetes per chamber (Table 3). A maximum of 20 polychaetes per host (16 in the left chamber and 4 in the right) was found in a male crab measuring 61 mm CL). The modal value was 3 polychaetes per crab (Table 4). The mean infestation intensity was 4-16 polychaetes per host. The dispersion index ($DI = \text{variance}/\text{mean}$) of the distribution of the number of polychaetes per host is much higher than one ($DI = 6.774$), suggesting that infestation intensity follows a contagious distribution, there being a high degree of aggregation between infesting individuals. The infestation abundance or relative density was 0-83 individuals of *O. mediterranea* sp. nov. per male crab examined, or 0-71 per crab (males +females) examined.

The sizes of the polychaetes ranged between 6 and 135 mm. No significant correlation was detected between host size and maximum length of the commensal ($P > 0.45$).

Infestation in relation to depth of capture of the host

The smallest prevalence values occurred between 800 m and 1200 m deep (Table 5). There does not seem to be a relationship between depth of capture of the host and infestation prevalence.

Comparison of infestation rates between the Balearic and Ligurian Seas

The proportion of infested crabs in the Ligurian Sea (Mori and Belloni, 1985) and in the Balearic Sea (this study), did not show a significant difference in the overall infestation prevalence (chi-squared =0-0012, $P < 0.9$).

Discussion

We may regard the relationship between *O. mediterranea* sp. nov. and its host crab *G. longipes* as a commensalism (Overstreet, 1983), since the presence of the polychaete does not seem to negatively affect the form and structure of the gills of the host crab, as happens in other polychaete species of similar life-habits (Pilger, 1971; Abello *et al.*, 1988 a; Comely and Ansell, 1989). *Ophryotrocha mediterranea* sp. nov. benefits from its host by apparently feeding on material captured or attracted by the crab, whereas the host is apparently neither harmed nor benefited, as happens in other polychaetes of similar life-habits (Hartnoll, 1962; Gaston and Benner, 1981; Abelló *et al.*, 1988 a).

The minimum host size at which occurrence of *O. mediterranea* sp. nov. was detected (49mm CW) is close to the minimum size at which it was detected in the Ligurian Sea (52mm CW) (Mori and Belloni, 1985).

In this study the overall infestation rate or prevalence was 18-1 1% of the male hosts examined, and is not significantly different from that found in the Ligurian Sea (Mori and Belloni, 1985). The similar size-structure of the Balearic and Ligurian populations, together with the hydrographic homogeneity and stability of the Western Mediter- ranean deep water mass (Hopkins, 1985; Salat and Font, 1985) may contribute to an explanation of the similar infestation rates in the two populations studied to date.

The differences in the infestation rates between male and female *G. longipes* can be attributed to the sexual dimorphism occurring in the sizes of the host species. There are practically no females in the population of sizes larger than the minimum size of infested males (Fig. 7). Furthermore, *O. geryoncola* has been detected in female *Geryon* species that reach larger sizes than those shown by female *G. longipes* (Gaston and Benner, 1981; Pfannenstiel *et al.*, 1982). Apparently the polychaete needs a minimum vital space, which the branchial chambers of female or juvenile *G. longipes* do not satisfy.

The sizes of the polychaetes found in this study ranged between 6 and 135 mm. Mori and Belloni (1985) found infesting polychaetes ranging in sizes between 4 and 100 mm. The maximum infestation intensity (20 individuals per host) is higher than the values detected in the shallower waters of the Ligurian Sea (Mori and Belloni, 1985), with maximum values of 8 individuals per host.

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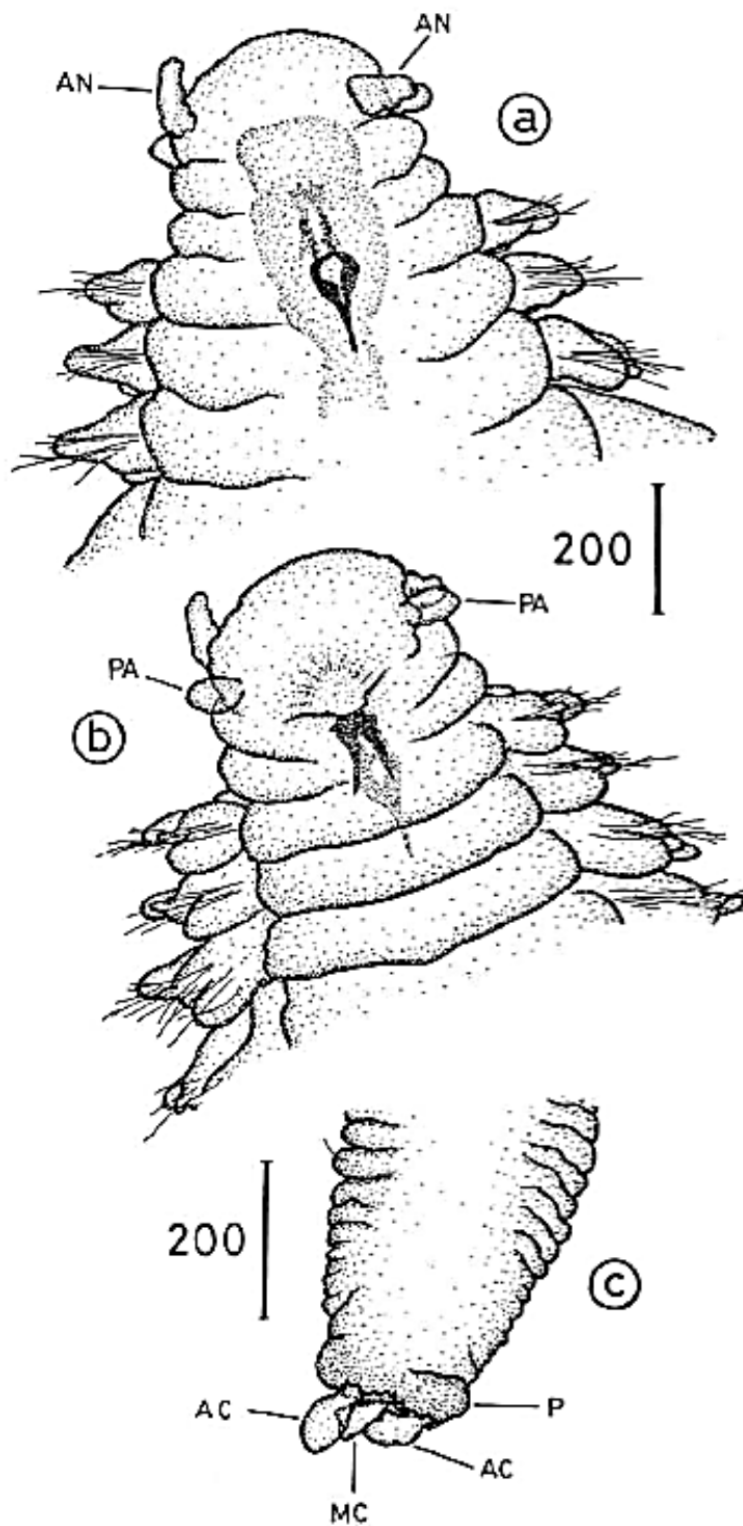


FIG. 1. *Ophryotrocha mediterranea* sp. nov. Body: (a) Dorsal view of anterior end; (b) ventral view of anterior end; (c) dorsal view of posterior end. AN =Antenna; AC =dorsolateral anal cirrus; MC =middle anal cirrus; P =pygidium; PA =palp. Scale bars in micrometres.

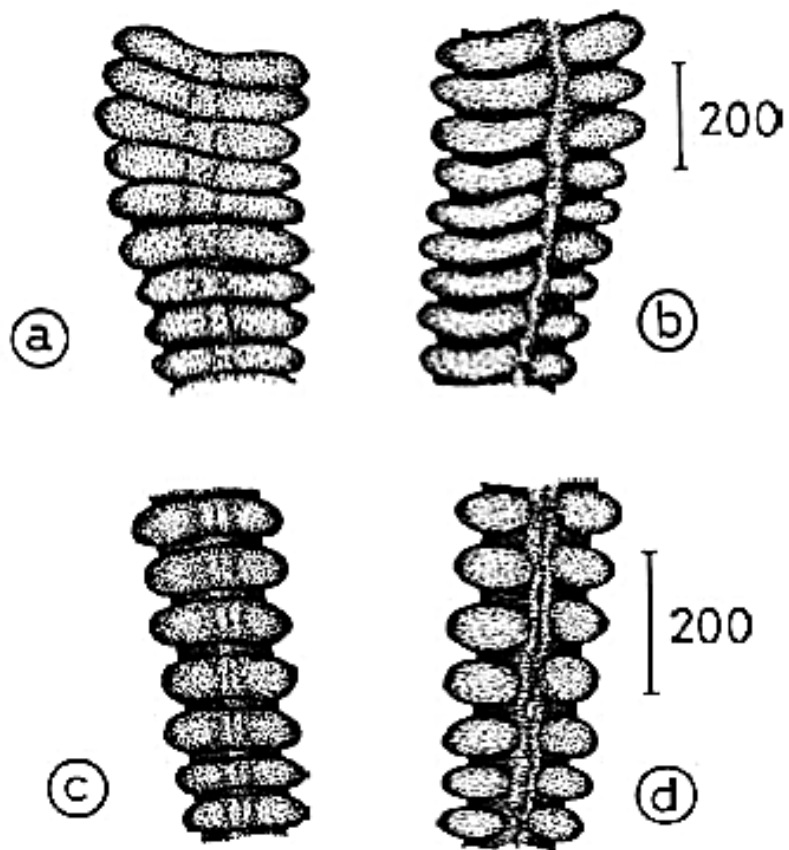


FIG. 2. *Ophryotrocha mediterranea* sp. nov. Dorsal view of middle (a) and posterior (c) gut. Ventral view of middle (b) and posterior (d) gut. Scale bars in micrometers.

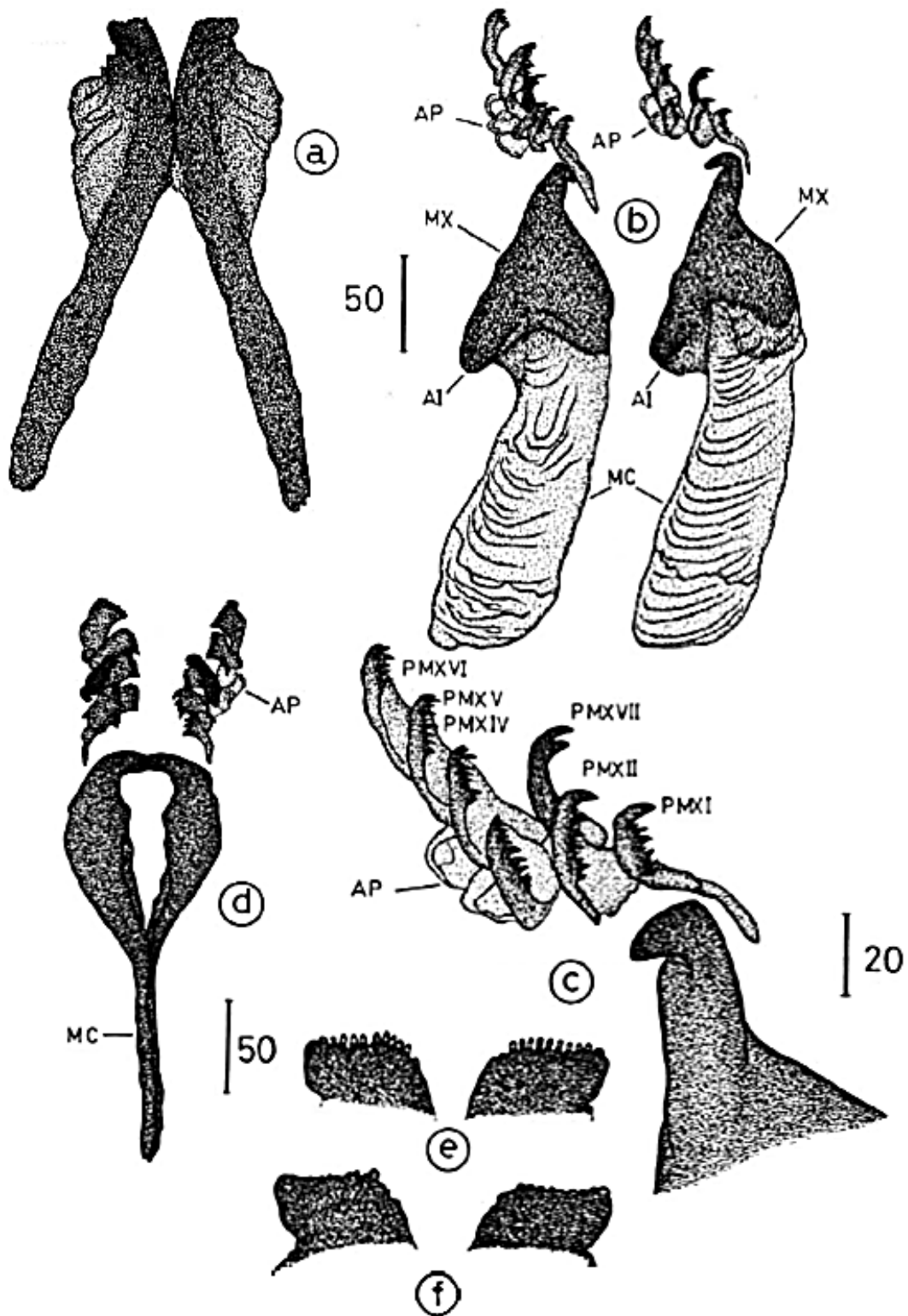


FIG. 3. *Ophryotrocha mediterranea* sp. nov. Jaw apparatus. (a) Mandibles; (b) general lateral view of maxillae group; (c) detail of maxillae; (d) general view of maxillae groups, ventrally; (e) anterior end of mandible, young specimen; (f) anterior end of mandible, old specimen. AI =Aileron; AP =additional plates; MC =maxillary carriers; MX =maxillae; μ MX =maxillary plates. Scale bars in micrometres.

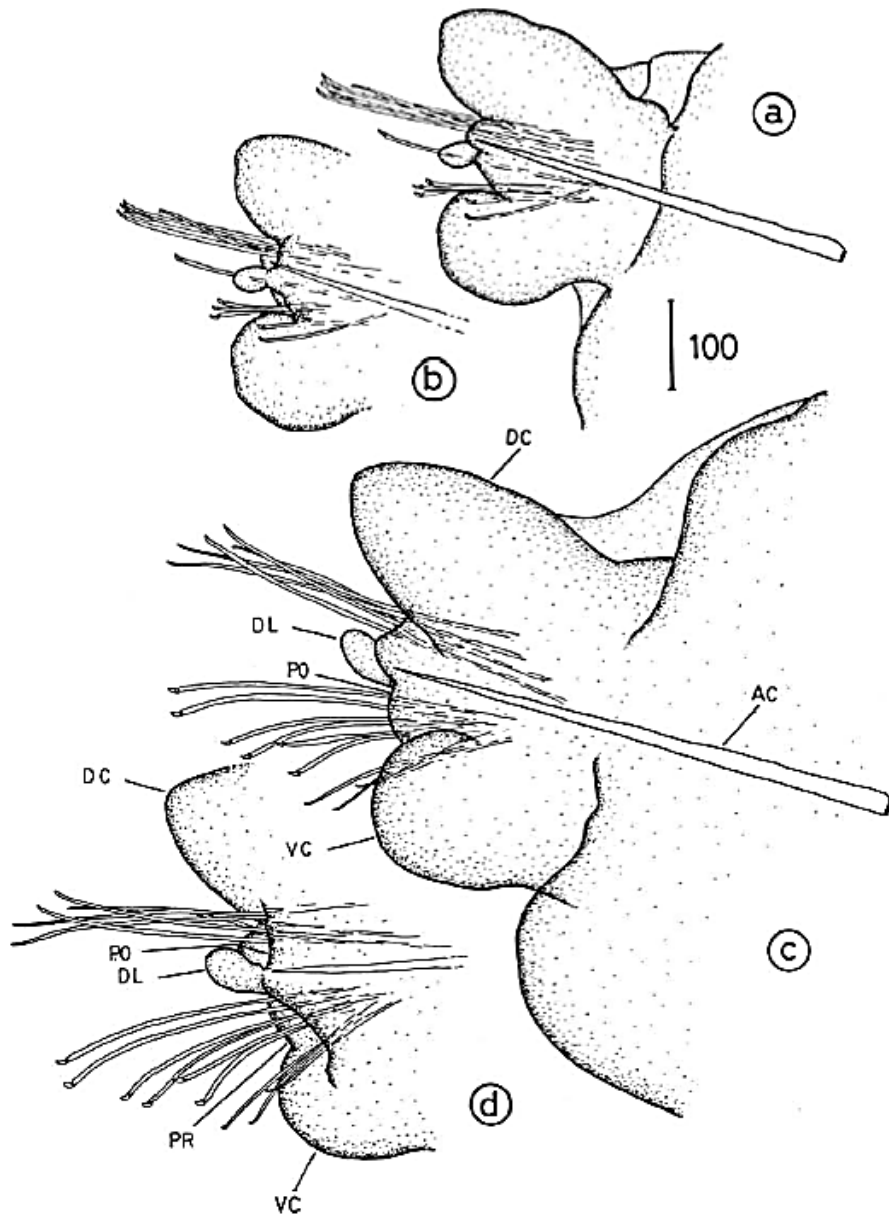


FIG.4. *Ophryotrocha mediterranea* sp. nov. Anterior parapodium, postsetal (a) and presetal (b) views; middle parapodium, postsetal (c) and presetal (d) views. AC=Aciculum; DC =dorsal cirrus; DL =distal lobe, P0=postsetal lobe; PR =presetal lobe, VC =ventral cirrus. Scale bars in micrometres.

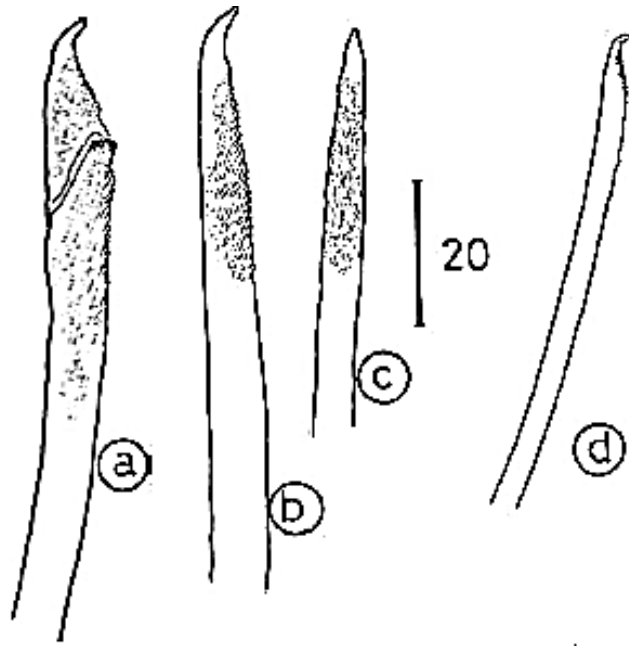


FIG.5. *Ophryotrocha mediterranea* sp. nov. (a) Composite neurosetae from middle parapodium. Simple notosetae from middle parapodium, lateral (b) and frontal (c) views. (d) Simple neurosetae from middle parapodium. Scale bars in micrometres.

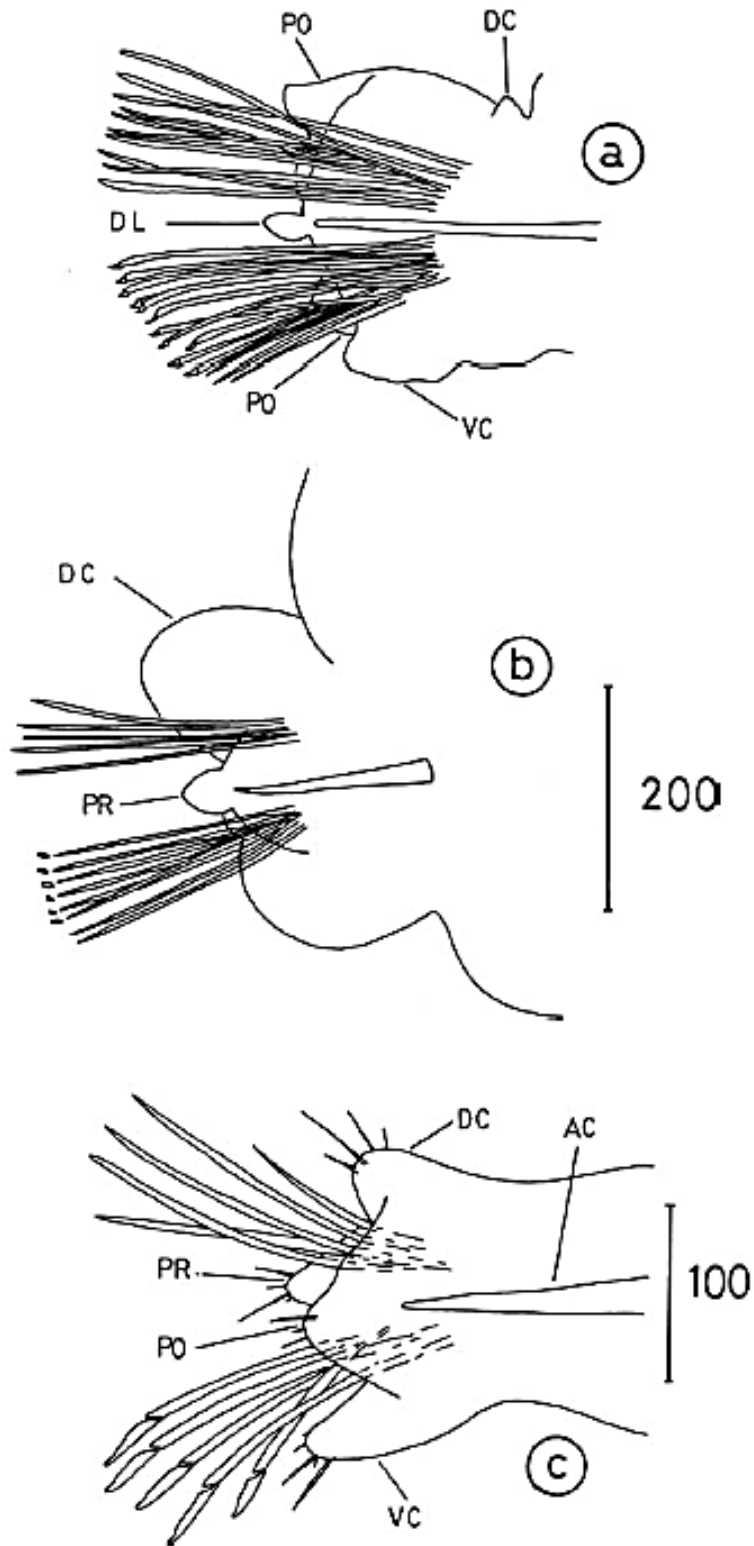


FIG.6. *Ophryotrocha geryoncola*. Parapodia. (a) From George and Hartmann-Schroder, 1985; (b) from Gaston and Benner, 1981; (c) from Pfannenstiel *et al.*, 1982. AC= Aciculum; DC =dorsal cirrus; DL =distal lok, PO =postsetal lok, PR =presetal lobe. Scale bars in micrometres.

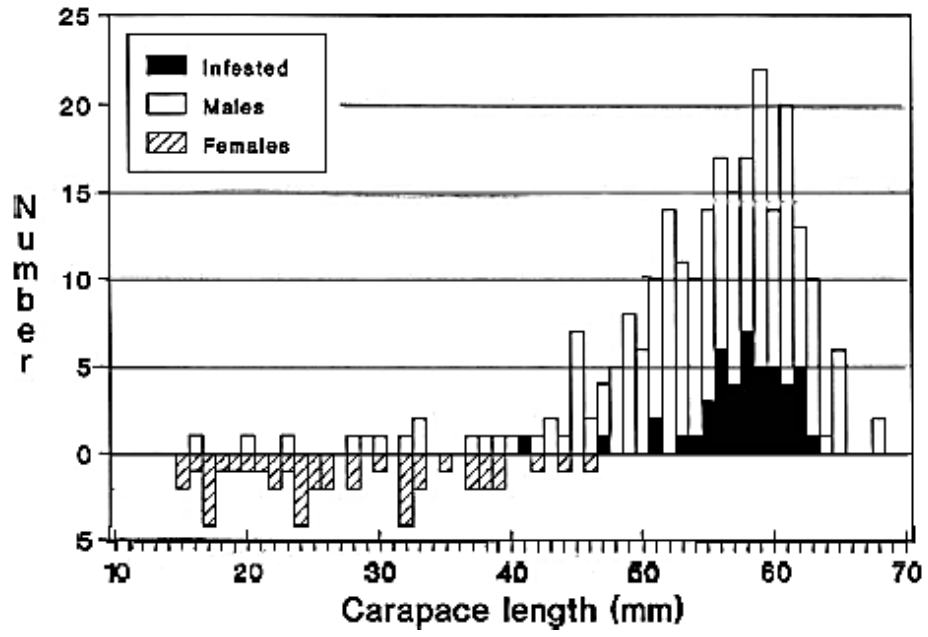


FIG.7. Size frequency distribution (carapace length, in mm) of *Geryon longipes* by sex, showing the occurrence of infested crabs by the polychaete *Ophryotrocha mediterranea* sp. nov.

Table 1. Differences between parapodia of *Ophryotrocha mediterranea* sp. nov. and *Ophryotrocha geryonicola*.

	<i>O. mediterranea</i>	<i>O. geryonicola</i>
Dorsal cirr	Conical, longer than ventral, surpassing the parapodial lobes in length	Conical (G&H-S). Ovoid (G&B, Pf). Shorter than ventrals (Pf)
Ventral cirri	Ovoid, shorter than dorsals	Ovoid, longer than dorsal (H). Conical (G&H-S). Absent

G&B=Gaston and Benner, 1981; H=Pfannenstiel *et al.*, 1982; G&H-S=George and Hartmann-Schroder, 1985.

Table 2. Infestation of the branchial chambers of the crab *Geryon longipes* by the polychaete *Ophryotrocha mediterranea* sp. nov. in males and females of the host species.

SEX	R	L	R+L	Total	Total no.	Prevalence(X)
Males	23	16	11	50	265	18-87
Females	0	0	0	0	42	0-00

R =right branchial chamber, L =left branchial chamber.

Table 3. Frequency distribution of the number of *Ophryotrocha mediterranea* sp. nov. per branchial chamber in *Geryon longipes*.

No.	Frequency
1	14
2	13
3	13
4	5
5	3
6	4
7	2
8	3
9	1
16	1

Table 4. Infestation intensity of *Ophryotrocha mediterranea* sp. nov. (number of polychaetes found in each host) in male *Geryon longipes*. No. of polychaetes No. of hosts

No. of polychaetes	No. of hosts
0	200
1	9
2	7
3	10
4	5
5	6
6	4
7	1
8	3
12	1
17	1
20	1

Table 5. Relationship between depth of capture of *Geryon longipes* and the prevalence of the infestation by *Ophryotrocha mediterranea* sp. nov.

Depth (m)	No. of males	No. infested	Percentage infested
600-800	97	32	33.0
800-1000	51	3	5.9
1000-1200	85	6	7.1
1200-1400	23	6	26.1
1400-1600	2	1	50.0
1600-1800	7	2	28.6