



The occurrence in the Chafarinas Islands (S.E. Alboran Sea, western Mediterranean) of four species of Phoronida (Lophophorata) and their distribution in the north-eastern Atlantic and Mediterranean areas

Christian C. EMIG¹, Antonio M. GARCÍA CARRASCOSA², Carmen ROLDÁN³ and José Manuel VIÉITEZ⁴

¹ CNRS UMR 6540, Centre d'Océanologie, Rue de la Batterie-des-Lions, 13007 Marseille, France;

Fax : (33) 4 91 52 13 30 - e-mail : emig@com.univ-mrs.fr

² Departamento de Biología Animal, Facultad de Ciencias Biológicas, Universidad de Valencia, 46100 Burjasot, Spain;

³ Departamento de Biología Animal I, Facultad de Biología, Universidad Complutense, 28040 Madrid, Spain;

⁴ Departamento de Biología Animal, Facultad de Ciencias, Universidad de Alcalá de Henares, 28871 Alcalá de Henares, Spain.

Abstract: The phoronids *Phoronis australis*, *P. psammophila*, *Phoronopsis albomaculata* and *Phoronopsis harmeri* have been collected from the Chafarinas Islands (Spain), off the Mediterranean Moroccan coast. The two latter species are recorded for the first time in the Mediterranean waters. The biocenoses in which those species occur are briefly described. A diagnosis is given for each species and their distribution in the Atlanto-Mediterranean area is detailed.

Résumé : Présence de quatre espèces de Phoronida (Lophophorata) dans les Iles Zaffarines (S.E. mer d'Alboran, mer Méditerranée occidentale) et leur distribution dans le N.E. de l'océan Atlantique et en mer Méditerranée. Les espèces *Phoronis australis*, *P. psammophila*, *Phoronopsis albomaculata* et *Phoronopsis harmeri*, ont été récoltées autour des îles Zaffarines (Espagne), au large de la côte marocaine. Les deux dernières espèces sont mentionnées pour la première fois en mer Méditerranée. Les biocénoses dans lesquelles ces espèces ont été signalées sont brièvement décrites. Une diagnose est fournie pour chacune des espèces et leur distribution géographique dans la zone atlanto-méditerranéenne est analysée.

Keywords : Phoronida, Chafarinas, SW Mediterranean, biodiversity

Introduction

Of the ten known species of Phoronida, nine have representative populations in the North-eastern Atlantic Ocean and the Mediterranean Sea (Emig et al., 1999). During the recent benthic surveys of the Chafarinas Islands, four phoronid species have been recorded, two of which, *Phoronopsis albomaculata* Gilchrist and *Phoronopsis harmeri* Pixell, are cited for the first time in the

Mediterranean. The new material is listed below, together with details on the collecting stations (Fig. 1) and the occurrence of all four species is discussed below. The diagnoses summarize the most recent data, some unpublished, on these recorded species in the Atlantic-Mediterranean area. The data are taken from previous works (see references in part Distribution) and from observations on the specimens from the Chafarinas Islands, including additional unpublished data. The taxonomic characters are identified on histological slides. The longitudinal muscle formulae have been established on several specimens (Table 1) according to the conventional formula of Selys-Longchamps (1907), that is the arrangement of the

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longitudinal muscle bundles relative to the four subdivisions of the metacoelom formed by the mesenteries (i.e. clockwise left oral, right oral, and, right anal, left anal subdivisions). The data of Table 1 have been included in the formulae given in the diagnosis of each species.

Table 1. Longitudinal muscle formulae of phoronid specimens recorded in the Chafarinas Islands (see Figure 1 for locations). n = number of specimens examined.

Tableau 1. Formule de la musculature longitudinale des spécimens de Phoronidiens des Îles Zaffarines (voir la Figure 1 pour les localités). N = nombre de spécimens examinés.

Species	Stations	n	Formulae	General Formulae
<i>Phoronis australis</i>	R	1	68 = $\frac{22 \mid 24}{10 \mid 12}$	
<i>Phoronis psammophila</i>	H 16	2	37 = $\frac{12 \mid 12}{6 \mid 7}$	41 = $\frac{12 \mid 14}{7 \mid 8}$
<i>Phoronopsis albomaculata</i>	A6, B5, B6, A6	8	67 = $\frac{21 \mid 21}{12 \mid 13}$	[61 - 72] $\frac{19-24 \mid 19-25}{10-13 \mid 11-14}$
<i>Phoronopsis harmeri</i>	H 12	1	130 = $\frac{38 \mid 42}{26 \mid 24}$	

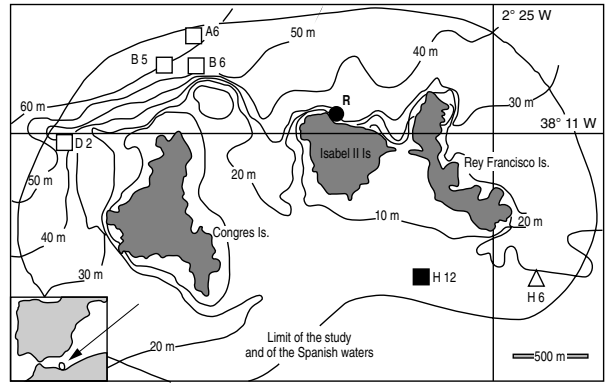
Phoronis australis Haswell, 1883

Biocenosis

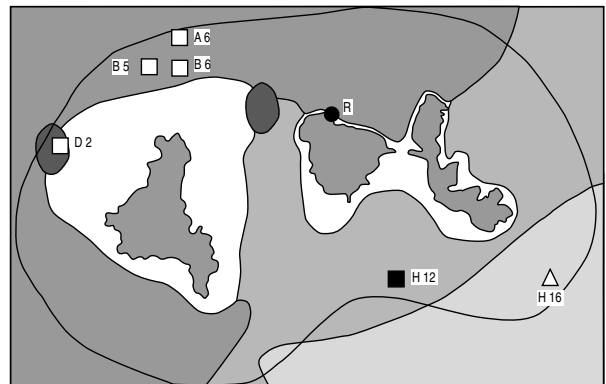
Phoronis australis has been collected in the northern part of Isabel II Island (Fig. 1; station R), at 15 m depth at the base of a cliff, in the tube-wall of the cerianthid *Cerianthus membranaceus* (Spallanzani), that is the characteristic burrowing habits of *P. australis* (see Emig et al., 1972). The depth range of these species is from the intertidal zone to 36 m. The sparse associated fauna and flora is referred to the community of the Sciaphilic infralittoral algae in sheltered environments (Tena Medialdea, 1996), with a scarce cover of *Halopteris filicina* (Grateloup) Kützing, some colonies of the gorgonarian *Eunicella singularis* (Esper) and of the bryozoan *Sertella septentrionalis* Hamer.

Distribution

In the North-eastern Atlantic, *P. australis* was recorded in Senegal (Emig & Marche-Marchad, 1969; Emig et al., 1972), in the Canary Islands (Ocaña et al., 1991), along the



- *Phoronis australis*
- △ *Phoronis psammophila*
- *Phoronopsis albomaculata*
- *Phoronopsis harmeri*



- Well-sorted fine sand biocenosis
- Muddy sand biocenosis
- Terrigenous shelf-mud biocenosis
- Muddy detritic biocenosis

Figure 1. Occurrence of *Phoronis australis*, *P. psammophila*, *Phoronopsis albomaculata* and *Phoronopsis harmeri* in the Chafarinas Islands.

Figure 1. Distribution de *Phoronis australis*, *P. psammophila*, *Phoronopsis albomaculata* et *Phoronopsis harmeri* dans les îles Zaffarines.

Spanish Mediterranean coast (Sanchez-Tocino et al., 1997, Emig et al., 1999) and in Greece (Stanjek & Wägele, 1981) (Fig. 2). *P. australis* is largely known in the Pacific and Indian Oceans (see Emig 1982; Emig & Roldán, 1992).

Diagnosis of *Phoronis australis*.

Synonym: *Phoronis buskii* McIntosh, 1888.

Length in extension up to 200 mm, 2-5 mm in diameter. Colour on live : body pink, anterior body part and lophophore transparent or purple to black. Lophophore spiral with 2.5 to 5 coils on each side, 5-16 mm in length, 600 to more than 1000 tentacles. Nephridia with two funnels (anal large, oral small), only an ascendant branch, nephridiopore opening on nephridial ridge at level of anus. Two giant nerve fibres (left one 5-13 µm in diameter; right

one 3-13 μm in diameter). Longitudinal muscle bundles of bushy type; the general formula is:

$$[43-87] \frac{17-35}{4-17} \frac{14-27}{5-19} \text{ and the mean formula is: } 66 = \frac{23}{12} \frac{22}{9}$$

Sexual reproduction hermaphroditic; embryos brooded in lophophoral cavity on a mucous cord secreted by nidamental glands of type B (i.e. restricted to the floor of the lophophoral concavity with an extension along the coils of the lophophore on the inner surface of the tentacles and associated with the two embryo masses); lophophoral organs small. Asexual reproduction by transverse fission.

Larva: unknown.

Phoronis psammophila Cori, 1889

Biocenosis

The infralittoral biocenosis of the Well-sorted fine sands in which *P. psammophila* is one of the characteristic species occurs from the beach of Ras el Ma (coast of Morocco, located at 2-3 nautical miles from the Chafarinas Islands), until the south-eastern area of these islands, down between 15 to 21 m depth (Fig. 1). *P. psammophila* is embedded vertically in the soft substratum. The depth range of the species is from the intertidal zone down to 52 m depth. The sediments are mainly composed of fine and very fine sand fractions (58 to 93%), with a moderate muddy fraction (8 to 41 %) (Villora Moreno, 1993). The data for the associated fauna are preliminary; the characteristic species are 6 mollusc species (*Spisula subtruncata* (Da Costa), *Tellina pulchella* Lamarck, *Phaxas pellucidus* (Pennant), *Nuculana pella* (Linnaeus), *Nassarius mutabilis* (Linnaeus), *Maetra corallina* (Linnaeus) (see Aparici Seguer & García

Carrascosa, 1996), the ophiurid *Ophiura texturata* Lamarck, the polychaete *Sigalion mathildae* (Aud. & Milne Edw.), *Glycera alba* (Müller) and *G. unicornis* Savigny, the crustacean decapod *Liocarcinus vernalis* (Risso) and the amphipods which are the main group with an average of 62% of Ampeliscidae, the fish *Arnoglossus laterna* Walb. and *Buglossidium luteum* (Risso).

Only two specimens of *Phoronis psammophila* have been recorded in H16, at 20 m depth in a fine sand (92 %) with 8% of silt (Fig. 1; Table 1). The sample was performed with Holme's double anchor dredge for a volume of 20 l. In general, the maximum density of this species in the given biocenosis occurs at a lower depth (Emig, 1973) than here, in the Moroccan waters.

Distribution

Phoronis psammophila is a cosmopolitan species with a world-wide distribution. The nearest record areas from the Chafarinas Islands are the Portuguese coast, the Spanish Atlantic and Mediterranean waters, and the Algerian waters (see Emig, 1982; Emig et al., 1999) (Fig. 2).

Diagnosis of *Phoronis psammophila*

Synonyms: *Phoronis sabatieri* Roule, 1889; *Phoronis architecta* Andrews, 1890.

Length in extension up to 190 mm, diameter 0.5-2 mm. Colour on live: body pink, lophophore transparent with white (occasionally yellow, green or red) pigment spots. Lophophore horseshoe-shaped with ends turned medially. Tentacles up to 190, length 1.5-2.5 mm. Nephridia with a single funnel, descending and ascending branch, nephridiopore on anal papilla opening below anus. Single giant nerve fibre, on the left side, 7-27 μm in diameter, very thin nerve fibre rarely present on right side. Longitudinal muscle bundles of feathery type; general formula is:

$$[24-53] \frac{7-19}{4-11} \frac{7-18}{4-11} \text{ mean formula is: } 34 = \frac{11}{6} \frac{11}{6}$$

Sexual reproduction dioecious; females brooding embryos in a single mass in lophophoral cavity through nidamental glands of type C (i.e. formed by the fusion of the inner row of lophophore tentacles); males with large, glandular lophophoral organs.

Asexual reproduction by transverse fission.

Larva: *Actinotrocha sabatieri* Roule, 1896. Possible synonyms: *Actinotrocha metschnikoffi* Selys-Longchamps, 1907; *Actinotrocha wilsoni* Selys-Longchamps, 1907; *Actinotrocha hatscheki* Selys-Longchamps, 1907; *Actinotrocha ashworthi* Selys-Longchamps, 1907.

Phoronopsis albomaculata Gilchrist, 1907

Biocenoses

Phoronopsis albomaculata which is embedded vertically in the sediments, occurs in two circalittoral biocenoses: that of

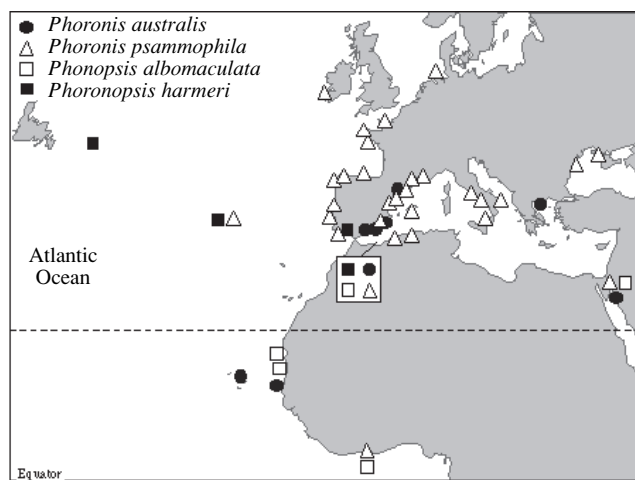


Figure 2. Distribution of *Phoronis australis*, *P. psammophila*, *Phoronopsis albomaculata* and *Phoronopsis harmeri* in the North-eastern Atlantic Ocean and in the Mediterranean Sea.

Figure 2. Répartition géographique de *Phoronis australis*, *P. psammophila*, *Phoronopsis albomaculata* et *Phoronopsis harmeri* dans le nord-est de l'Océan Atlantique et en Mer Méditerranée.

the Terrigenous mud-shelf (A6, 60 m; B5, 59 m; B6, 52 m) and the Muddy-detritic one (D2, 41 m) (Fig. 1). Each of these stations was sampled with Holme's double anchor dredge for a volume of 50 l. The occurrence in the station A6 is presently the deepest record for *Phoronopsis albomaculata*, which depth range extends now from 0 to 60 m. In the sediments of the Terrigenous mud-shelf biocoenosis, the different fractions are gravel (4.9-50.3%), coarse sand (2.9-57.4%), medium to fine sands (7-27.3%), mud (4.7-68.5%); these sediments even with a high mud fraction are compact. In the Muddy-detritic biocoenosis, the grain-size fractions, i.e. gravel, sands, and mud, are mixed in variable proportions, but mud is the dominant fraction (37.4-82.2%). Such sediments differ rather from those, coarse to fine sands with a very low silty fraction, in which *Phoronopsis albomaculata* has been recorded in tropical and subtropical areas (Thomassin & Emig, 1983; Emig & Roldán, 1992). However, this species occurs in waters with high levels of suspended materials and under moderate to strong bottom currents.

According to the preliminary data in the four cited stations, the polychaetes are the dominant group (10-33 species, 21-111 individuals), mainly represented by *Terebellides stroemi* Sars and *Lumbrineris latreilli* (Aud. & Milne Edw.), the echinoderms (2-7 species; 7-62 individuals) by *Amphiura filiformis* O. F. Müller and *A. chiajei* Forbes, the molluscs (5-6 species, 7-34 individuals) by *Nucula nitidosa* Winckworth, as an Atlantic vicariant species of the Mediterranean *N. nucleus* (Linnaeus), and *Venus casina* Linnaeus (see Aparici Seguer & García Carrascosa, 1996), the decapods (4-9 species).

Distribution

Phoronopsis albomaculata is recorded for the first time in the Mediterranean Sea. The currently known nearest records are South of Cape Timiris, on the Mauritanian continental shelf (Emig et al., 1999; Fig. 2). The distribution of this species has been recently discussed in Indian and Pacific Oceans by Thomassin & Emig (1983), Emig & Golikov (1990), Emig & Roldán (1992).

Diagnosis of *Phoronopsis albomaculata*.

Length in extension up to 150 mm, diameter 0.5-2 mm. Colour on live : body pink, lophophore transparent with pigment spots. Lophophore horseshoe-shaped with ends turned medially, up to one coil. Tentacles up to 160, length 2-3 mm. Presence of a generally weakly marked epidermal collar-fold below the lophophore. Nephridia with a single funnel, descending and ascending branch, nephridiopore on anal papilla opening below anus on collar fold within invagination. Giant nerve fibre paired, left fibre only present below the nephridial level on the left side (15-35 µm in

diameter). Longitudinal muscle bundles of feathery type; general formula is:

$$[44-102] \frac{14-33}{7-20} \left| \frac{13-34}{6-20} \right., \text{ mean formula is: } 67 = \frac{22}{13} \left| \frac{21}{11} \right.$$

Sexual reproduction dioecious; females probably having brooding pattern; males with large glandular lophophoral organs.

Asexual reproduction by transverse fission.

Larva: unknown.

Phoronopsis harmeri Pixell, 1912

Biocenosis

Phoronopsis harmeri has been recorded in the station H12 (Fig. 1; Table 1) at 14 m depth within the infralittoral Muddy sand biocenosis, dominated by the polychaete *Nephtys hombergii* Aud. & Milne-Edwards. The sample was performed with Holme's double anchor dredge for a volume of 20 l. The biocenosis is located in the south-eastern part of the Chafarinas Islands, between 14 to 35 m (Fig. 1), while the depth range of the species is from 0 to 104 m.

The species is embedded vertically in the sediment which is formed by muddy sand to sandy mud (36-81%), fine sands (17-57%), and a coarse fraction (until 7%); in H12, these fractions are respectively 72.5%, 27%, and 0.5%.

The preliminary data of the associated fauna in the H12 are: polychaetes (33 species, 206 individuals), particularly *Euclymene oerstedii* (Quatref.), *Notomastus latericeus* Sars, *Laonice cirrata* (Sars); echinoderms (10 species, 198 ind.), dominated by *Amphiura chiajei*; decapods (4 species) by *Atelecyclus rotundatus* (Olivi) and *Goneplax rhomboïdes* (Linnaeus); molluscs (12 species, 19 ind.) by the bivalves *Acanthocardia paucicostata* (Sowerby G.B. II), *Abra alba* (Wood), *Azorinus chamasolen* (Da Costa), *Nucula nitidosa* Winckworth, *Nuculana pella* (Linnaeus), and the scaphopod *Antalis inaequicostatum* (Dautzenberg) (Aparici Seguer & García Carrascosa, 1996).

Distribution

The first occurrence of *Phoronopsis harmeri* in the Eastern Atlantic has been cited at Punta Umbría (Huelva, Spain) by Rodríguez & Viéitez (1992) (Fig. 2). Other records in the Atlantic Ocean (North American coasts, Azores Islands) are given by Emig & Golikov (1990) who have also summarized the Indian and Pacific distributions.

Diagnosis of *Phoronopsis harmeri*

Synonyms: *Phoronis pacifica* Torrey, 1901, *Phoronopsis viridis* Hilton, 1930, *Phoronopsis striata* Hilton, 1930.

Length in extension up to 220 mm, diameter 0.6-4 mm.

Colour on live: body pink to greenish, lophophore transparent sometimes white pigmented. Lophophore spiral with 1 to 2.5 coils on each side, 2-5 mm in length, up to 400 tentacles.

Presence of a well-marked epidermal collar-fold below the lophophore. Nephridia with two pseudo-funnels (anal smaller, oral larger), descending and ascending branch, nephridiopore on anal papilla opening below anus on collar fold within invagination. Giant nerve fibre paired, left fibre only present below the nephridial level on the left side (20-60 μm in diameter). Longitudinal muscle bundles of feathery type; general formula is:

$$[75-166] \frac{22-58}{12-28} \left| \frac{21-55}{11-26} \right., \text{mean formula is: } 108 = \frac{35}{20} \left| \frac{35}{18} \right.$$

Sexual reproduction dioecious; females shed the ova directly in the sea-water; males with large membranous lophophoral organs.

Asexual reproduction by transverse fission.

Larva: *Actinotrocha harmeri* Zimmer, 1964. Synonyms: *Actinotrocha ikedai* A Selys-Longchamps, 1907.

Conclusions

Phoronis psammophila is really a cosmopolitan species occurring in sandy sediments of the infralittoral zone. *Phoronopsis albomaculata* is confirmed here as a tropical-temperate species according to its life conditions in New-Zealand (Emig & Roldán, 1992) and at present in the Chafarinas Archipelago. In the latter location this species occurs rather in types of muddy bottoms similar to those of *Phoronis muelleri* Selys-Longchamps, in deep environments of the continental shelf, but probably under the influence of stronger near-bottom currents. *Phoronopsis harmeri* is living in a large range of bottoms and depths. Both *Phoronopsis* species are recorded for the first time in the Mediterranean. *Phoronis australis* is rather well-known along the Mediterranean Spanish coast, so its record on the North African coast is not surprising.

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