



Phoronida from the Eastern Mediterranean and Black Sea

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Abstract: Faunistic analysis of benthic materials collected in various habitats at different depths in the eastern Mediterranean and the Black Sea revealed two phoronid species, *Phoronis muelleri* and *P. psammophila*, which were also known in many localities in the western Mediterranean. The Black Sea material comprised only *Phoronis psammophila* whereas the Aegean Sea and Levant Sea materials contained both *P. psammophila* and *P. muelleri*. The diagnosis and the ecological and reproductive features of these species as well as their associated polychaete fauna are provided. Our present knowledge of the biodiversity and geographic distribution of the three phoronid species occurring in the studied area, the third being *P. australis*, is developed including unpublished data.

Résumé : *Phoronida de la Mer Méditerranée orientale et de la Mer Noire.* Lors des tris de la faune récoltée dans différents habitats et à diverses profondeurs en Mer Méditerranéenne orientale et en Mer Noire, deux espèces de Phoronida ont été identifiées : *Phoronis muelleri* et *P. psammophila*. Elles sont déjà signalées dans de nombreuses localités du bassin méditerranéen occidental. Le matériel de la Mer Noire n'a révélé qu'une seule espèce, *Phoronis psammophila*, alors que *P. psammophila* et *P. muelleri* sont présents dans les stations en Mer Egée et en Mer Lévantine. Une diagnose avec des remarques sur les conditions écologiques, ainsi que sur la faune de polychètes associée, est donnée pour chacune des espèces étudiées. Nos connaissances sur la biodiversité et la répartition géographique des trois espèces *Phoronis muelleri*, *P. psammophila* et *P. australis*, actuellement signalées dans la zone étudiée, sont présentées en incluant des données non publiées.

Keywords: Phoronida, Polychaeta, distribution, ecology, Eastern Mediterranean, Black Sea

Introduction

Of the ten known species of Phoronida, three have been hitherto identified in the eastern Mediterranean and probably only one in the Black Sea, compared to the nine species recorded in the western Mediterranean (Emig et al.,

2000). During recent benthic surveys in several areas along the Turkish and Cypriot coasts, only two phoronid species were encountered, *Phoronis muelleri* Selys-Longchamps, 1903 and *Phoronis psammophila* Cori, 1889, which have been previously recorded in many locations in the Mediterranean Sea (Emig, 1983).

This paper treats the recent data on these two purportedly cosmopolitan species and also includes some additional notes on *Phoronis hippocrepia* Wright, 1856, the identification of which probably remains doubtful in the

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Black Sea, and on *P. australis* Haswell, 1883, which has been reported from the eastern Mediterranean.

Material and methods

A total of 12 benthic samples containing phoronid specimens taken from different parts of the eastern Mediterranean and the Black Sea were examined (Fig. 1). The samples (Table 1) from station 1 and the stations located in Izmir Bay were collected by using a van Veen Grab, with a capacity of 10 dm³ sediment; those taken from the stations along the Turkish Levant coast were collected by scuba diving, and all the removable fauna collected within a quadrat of 20 x 20 cm. Those recorded from the Cypriot coast were collected with an anchor dredge. All the materials were washed over a 0.5 mm mesh sieve and the organisms retained on the sieve were fixed in 5% formalin. In the laboratory, the samples were first rinsed in freshwater and then transferred to 70% ethanol. The Aegean and Cypriot benthic materials were collected by R/V *K. Piri Reis*.

The taxonomic characters of the Phoronida were identified on histological slides, the only way to distinguish the species. The longitudinal muscle formulae have been established according to the conventional longitudinal

muscle formula given by Selys-Longchamps (1907), that is the arrangement of the longitudinal muscle bundles (as seen in transverse sections) relative to the four sub-divisions of the metacoelom formed by the mesenteries (i.e. clockwise left oral, right oral, and, right anal, left anal sub-divisions).

Results and Discussion

The faunistic analysis of twelve benthic samples collected in the Black Sea, Aegean Sea and Levant Sea yielded a total of 31 individuals belonging to two phoronid species, *Phoronis muelleri* and *P. psammophila* (Table 1). A relatively dense population of *P. muelleri* was found on muddy sand bottom at station 7 (90 ind m⁻²) and in a *Zostera marina* Linnaeus bed at station 8 (60 ind m⁻²). In contrast, *P. psammophila* occurred with only one individual per sample. The morphological, ecological and reproductive features of these two species are given below.

Phoronis muelleri Selys-Longchamps, 1903

A total of 15 specimens were examined. Their mean and composite muscle formulae are:

$$\begin{array}{c|c} 9 & 8 \\ \hline & = 24 \\ 4 & 3 \end{array} \quad \text{and} \quad \begin{array}{c|c} 6-10 & 6-10 \\ \hline & [18-30] \\ 3-6 & 3-5 \end{array}$$

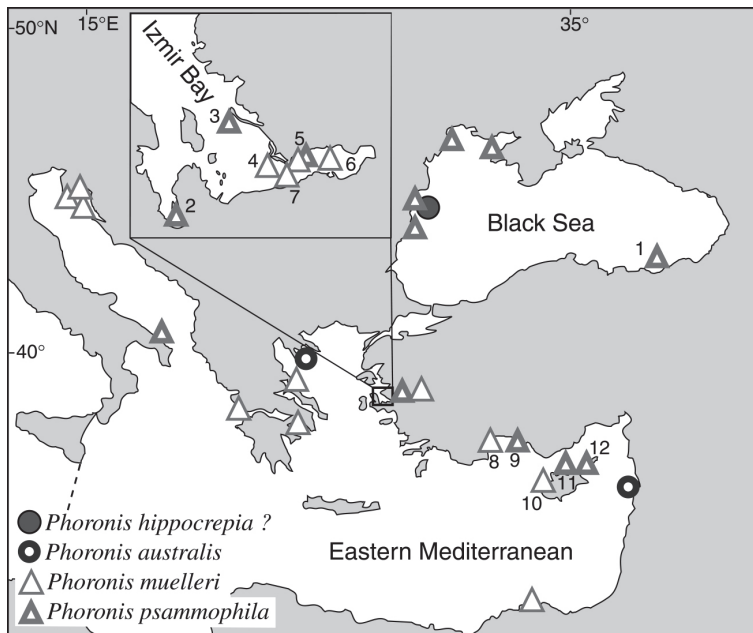


Figure 1. Distribution of the phoronid species in the eastern Mediterranean and the Black Sea, and location of sampling sites (1-12) where *Phoronis muelleri* and *P. psammophila* were found on the Turkish and Cypriot coasts.

Figure 1. Répartition géographique des espèces de phoronidiens en Mer Méditerranée orientale et en Mer Noire, et localisation des stations (1-12), étudiées sur les côtes turques et chypriotes où *Phoronis muelleri* et *P. psammophila* ont été récoltées.

All the other taxonomic characters are confident with the diagnosis of the species.

Diagnosis

Extended specimens up to 120 mm in length, 0.2-1 mm in diameter; trunk pink and lophophore transparent, occasionally with spots. Lophophore horseshoe-shaped with ends sometimes turned medially. Number of tentacles up to 100, length 1-2 mm, becoming shorter in middle of oral side. Nephridia opening into both oral and anal compartments of metacoelom by a single funnel with descending and ascending branches ending at nephridiopore on anal papilla, opening at level of anus. A single giant nerve fibre on left side, 7-40 µm in diameter; a very thin nerve fibre rarely present on right side. Left lateral mesentery absent except at level of left nephridium (indicated by a dotted line or no line in the muscle formulae). Longitudinal muscle bundles of feathery type. Based on 537 individuals (collected worldwide), the mean and composite formulae are:

$$\begin{array}{c|c} 9 & 9 \\ \hline & = 26 \\ 4 & 4 \end{array} \quad \text{and} \quad \begin{array}{c|c} 5-13 & 5-12 \\ \hline & [17-39] \\ 2-8 & 2-8 \end{array}$$

Table 1. Depths, biotope structures and localities of the 12 stations together with polychaete species collected with *Phoronis muelleri* and *P. psammophila* on the Turkish and Cypriot coasts.

Table 1. Profondeur, biotopes et localités des 12 stations de récolte de *Phoronis muelleri* et *P. psammophila* sur les côtes turques et chypriotes avec les espèces de polychètes associées.

| Stations, dates, depths and biotopes | Phoronid species | Abundant polychaete species |
|---|--|---|
| Black Sea, Trabzon | | |
| 1 18-10-2000, 4 m <i>Cymodocea nodosa</i> | <i>P. psammophila</i> (1 specimen) | <i>Melinna palmata</i> Grube, 1870 |
| Aegean Sea, Izmir Bay | | |
| 2 17-12-93, 25 m <i>Zostera marina</i> | <i>P. psammophila</i> (2 specimens) | <i>Platynereis dumerilii</i> (Audouin & M. Edwards, 1833), <i>Scoloplos armiger</i> (O. F. Müller, 1776), <i>Aricidea cerruti</i> Laubier, 1967, <i>Caulieriella alata</i> (Southern, 1914) and <i>Notomastus latericeus</i> Sars, 1851 |
| 3 15.10.98, 21 m sandy mud | <i>P. psammophila</i> (1 specimen) | <i>Glycera tridactyla</i> Schmarda, 1861, <i>Lumbrineris latreilli</i> Audouin & M. Edwards, 1834, <i>S. armiger</i> and <i>Owenia fusiformis</i> D. Chiaje, 1842 |
| 4 15.10.98, 36 m mud | <i>P. muelleri</i> (1 specimen) | <i>Lumbrineris gracilis</i> (Ehlers, 1868), <i>Monticellina heterochaeta</i> Laubier, 1961 and <i>Sternaspis scutata</i> (Ranzani, 1817) |
| 5 15.10.98, 36 m mud | <i>P. muelleri</i> (5 specimens) | <i>Malmgreniella lunulata</i> (D. Chiaje, 1841), <i>Ophiodromus pallidus</i> (Claparède, 1864), <i>Sigambra tentaculata</i> (Treadwell, 1941), <i>M. heterochaeta</i> , <i>Chaetozone</i> spp., <i>Cossura soyeri</i> Laubier, 1963 and <i>S. scutata</i> |
| 5 21.1.98, 36 m mud | <i>P. psammophila</i> (1 specimen) | <i>Nephtys hombergi</i> Savigny, 1818, <i>Chaetozone</i> spp., <i>C. soyeri</i> and <i>S. scutata</i> . |
| 6 1.1.98, 14 m mud | <i>P. muelleri</i> (1 specimen) | <i>M. heterochaeta</i> , <i>Chaetozone</i> spp., <i>Cirratulus</i> sp. |
| 7 14.5.87, 36 m muddy sand | <i>P. muelleri</i> (9 specimens) | <i>Spiochaetopterus costarum</i> (Claparède, 1870) and <i>Terebella lapidaria</i> Linnaeus, 1767 |
| Turkish Levant coast | | |
| 8 Kemer, 18.07.1993, 20 m <i>Zostera marina</i> | <i>P. muelleri</i> (6 specimens) | <i>Neanthes caudata</i> (D. Chiaje, 1818), <i>P. dumerilii</i> , <i>Nematonereis unicornis</i> Schmarda 1861, <i>M. palmata</i> and <i>Chone collaris</i> Langerhans, 1880 |
| 9 Karaburun, 19.07.1993, 20 m <i>Posidonia oceanica</i> | <i>P. psammophila</i> (1 specimen) | <i>Sigalion mathildae</i> (Audouin & M. Edwards, 1834), <i>P. dumerilii</i> , <i>Chaetozone</i> sp., <i>Polyophthalmus pictus</i> (Dujardin, 1839) and <i>O. fusiformis</i> |
| Northern Cyprus | | |
| 10 14.07.98, 35°19'9"N- 32°50'1"E 210 m, mud | <i>P. muelleri</i> (1 specimen) | <i>S. mathildae</i> , <i>Glycera rouxi</i> Audouin & M. Edwards, 1833, <i>L. gracilis</i> , <i>Spiophanes kroyeri reynsi</i> Laubier, 1964 and <i>Ampharete acutifrons</i> (Grube, 1860) |
| 11 14.07.98, 35°10'0"N-32°50'0"E 69 m, mud | <i>P. psammophila</i> (1 specimen) | <i>Nephtys incisa</i> Malmgren 1864, <i>M. heterochaeta</i> , <i>Magelona minuta</i> Eliason, 1962, <i>Rhodine loveni</i> Malmgren, 1865, <i>Syllis garciai</i> (Campoy, 1982) and <i>Micronephtys maryae</i> San Martin, 1982. |
| 12 16.5.97, 35°10'0"N-33°59'4"E, 25 m, <i>Posidonia oceanica</i> | <i>P. psammophila</i> (1 specimen) | <i>Pontogenia chrysocoma</i> (Baird, 1865), <i>Haplosyllis spongicola</i> (Grube, 1855), <i>Syllis gerlachi</i> Hartmann-Schröder, 1960 and <i>L. latreillii</i> |

Sexual reproduction is dioecious; females shed ova freely into seawater; males have large, glandular lophophoral organs. Asexual reproduction is by transverse fission. The larva of *P. muelleri* is called *Actinotrocha branchiata* Müller, 1846. Probable synonyms are

Actinotrocha brownei Selys-Longchamps, 1907; *Actinotrocha* B Ikeda, 1901; *Actinotrocha* D Ikeda, 1901.

Phoronis muelleri penetrates vertically into soft substrata particularly with high organic contents and often with coarse particles of detritus and suspended material

(Thomassin & Emig, 1983). The vertical distribution extends from the intertidal zone to about 400 m, but is mainly between 10 and 60 m. Densities may reach ca. 3000 ind m⁻². *P. muelleri* was also frequently recorded in *Macoma* and *Amphiura* communities.

Phoronis psammophila Cori, 1889

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

A total of eight specimens were collected on the coasts of the Black Sea, Aegean Sea and Cyprus. The mean and composite muscle formulae of these specimens as well as of two specimens from Crimea (Ukraine) and eight specimens near Brindisi (Italy) have been established:

| | | | | |
|---------------------|---------|----------|--------------|---------|
| Turkey Cyprus | 11 11 | = 34 and | 9-16 9-17 | [29-47] |
| | 6 6 | | 5-7 5-7 | |
| Crimea (Ukraine) | 10 9 | = 29 and | 10 10 | = 30 |
| | 5 5 | | 5 5 | |
| Brindisi (Italy) | 11 10 | = 34 and | 10-12 8-11 | [24-33] |
| | 6 6 | | 5-8 5-7 | |

All the other taxonomic characters are confident with the diagnosis of the species.

Diagnosis

Extended specimens up to 190 mm long, diameter 0.5-2 mm. Colour in life: body pink, lophophore transparent with white (occasionally yellow, green or red) pigment spots. Lophophore horseshoe-shaped with ends turned medially. Up to 190 tentacles, length 1.5-2.5 mm. Nephridia opening into both oral and anal compartments of meta-coelom with a single funnel, with descending and ascending branches; ending by nephridiopore on anal papilla and opening below anus. Single giant nerve fibre on left side, 7-27 µm in diameter; very thin nerve fibre rarely present on right side. Longitudinal muscle bundles of feathery type; the composite and mean formulae (n= 3210 individuals, mainly from the Mediterranean Sea) are:

| | | | | |
|---------|------|-----|-------------|---------|
| 11 11 | = 34 | and | 7-19 7-18 | [24-53] |
| 6 6 | | | 4-11 4-11 | |

Sexual reproduction dioecious; females brooding embryos in a single mass in lophophoral cavity through nidamental glands of type C (i.e. formed by fusion of inner row of lophophore tentacles); males with large, glandular lophophoral organs. Asexual reproduction by transverse fission. The larva of *Phoronis psammophila* is called *Actinotrocha sabatieri* Roule, 1896. Possible synonyms are *Actinotrocha metschnikoffi* Selys-Longchamps, 1907;

Actinotrocha wilsoni Selys-Longchamps, 1907; *Actinotrocha hatscheki* Selys-Longchamps, 1907; *Actinotrocha ashworthi* Selys-Longchamps, 1907.

Phoronis psammophila lives in soft substrata at depths ranging from the intertidal zone to 69 m. This species particularly prefers a sediment structure mainly composed of fine and very fine sand fractions (58 to 93%), with a moderate muddy fraction (8 to 41%).

Distribution of Phoronida in the eastern Mediterranean

Phoronis muelleri, a characteristic species of muddy bottoms, was recorded in communities of the «coastal terrigenous muds » in the Gulf of Rovigno (Croatia) from 5 to 32 m (Steuer, 1933; Vatova, 1934; 1935; 1943), and in the northern Adriatic Sea between 30 and 35 m (Gamulin-Brida et al., 1968). This species was also found at 40 m depth off Abudkir, Egypt (Steuer, 1936). More recently, *P. muelleri* was collected in Elefsis Bay (Aegean Sea) at 9.5-17 m in a sandy silt bottom (Zenetos & Bogdanos, 1987). *P. muelleri* was reported to form very sparse populations (1 ind m⁻²) in the Pagassitikos Gulf (Aegean Sea) and Patraikos Gulf (Ionian Sea) (Bogdanos & Satsmadjis, 1983, 1987). No published data concerning this species are available along the Turkish coasts, with some unpublished data concealed among notes by Çinar & Ergen, but this species had possibly been confused with the morphologically similar species *P. psammophila*. In this study *P. muelleri* was collected at depths from 14 m (Aegean Sea, station 6) to 210 m (Cyprus, station 10), but frequently encountered at 36 m in Izmir Bay. It appears to prefer muddy bottoms with high amounts of organic matter, mainly associated with opportunistic polychaete species listed in Table 1 and other indicators of organically enriched bottoms such as bivalves *Anadara demiri* (Piani, 1981), *Corbula gibba* (Olivi, 1792) and *Anomia ehippium* (Linnaeus, 1758). However, *P. muelleri* was also found in clean waters; at station 8 associated with the phanerogame *Zostera marina* and at station 10 on muddy substratum.

Phoronis psammophila, a cosmopolitan species, was collected in several communities near Brindisi (Italy) including coarse sands with the lancelet *Branchiostoma lanceolatum* (Pallas, 1774) at 22 m and *Posidonia oceanica* (L.) Delile beds, between 9 and 15 m depth (unpublished data, material collected by Carla Chimenz). *P. psammophila* was previously identified as *P. muelleri* at 0.5 m in a *Zostera marina* L. bed in the Gulbahce Bay (Turkey) (Çinar et al., 1998), but a re-examination of the specimens showed that they in fact belong to *P. psammophila*, the phoronid species widely distributed in the region, from the Black Sea (less saline, mean annual surface salinity 18.0) to Cyprus (more saline, mean annual surface salinity 38.5). However, it has a restricted depth range in the Aegean and Levant Seas, from 20 m (station 9) to 69 m (station 11). Like *P. muelleri*, this

species also occurs on soft substrata, particularly in clear waters, but we also found it at station 8, which received high input of nutrients and were dominated by opportunistic polychaete species (see Table 1). Among the phoronid species only *P. psammophila* occurs in *Posidonia oceanica* beds, a phanerogame endemic for the Mediterranean Sea, its northern distribution in the area not extending beyond the Dardanelle strait. Contrary to the coasts of Lebanon and Israel, this phanerogame forms dense meadows in the Cypriot waters, down to ca. 40 m, and hosts *P. psammophila* (station 12).

Phoronis australis, which lives within the tubes of cerianthids, was first found in association within the tube of *Cerianthus membranacea* (Spallanzani, 1784) between 30 and 55 m depth in the Haldikiki Peninsula, northern Aegean Sea (Stanjek & Wägele, 1981). Recently, this species has been observed at Selaata, north of Batroun, Lebanon at 24 m depth (G. Harmelin, pers. comm.).

Distribution of Phoronida in the Black Sea

In Odessa Bay (Ukraine), Metschnikoff (1869, 1871) described an actinotroch (the phoronid larva), which was subsequently named *Actinotrocha metschnikoffi* by Selys-Longchamps (1907), who also designated its adult form as a new species, *Phoronis euxinicola*, in the same paper. Nevertheless *P. euxinicola* remained a *nomen nudum*, and the two figures drawn by Selys-Longchamps (1907: fig. 25 and 26 on plate 7) closely resemble the general characteristics of *P. psammophila*. On the other hand, Emig (1982) synonymized the larva *Actinotrocha metschnikoffi* with *A. sabatieri* Roule, 1896, which is the typical larva of *P. psammophila*. Actinotroch larvae were also recorded in the Sevastopol area (Zernov, 1913), the western part of Karkinitzky Bay (Galadzhiev, 1948) and the southwestern part of the Black Sea (Murina & Kazankova, 1987).

On the Rumanian coast, *Phoronis hippocrepi* was reported by Iacobescu (1969) and *P. psammophila* by Bacescu et al. (1971) at 28 m, with a density of 50 ind m⁻². However, the identification of *P. hippocrepi* is uncertain: according to figure 4 and the description of the tube in Iacobescu's (1969) paper, the specimens he collected and examined actually seem to belong to *P. psammophila* (see Emig, 1973).

On the Bulgarian coast, Marinov (1990) recorded phoronids in silty sand bottoms down to 100 m depth, with a population density up to 450 ind m⁻². During recent benthic surveys in the Bourgas Bay and off Cape Emine (Bulgaria), Stoykov & Uzunova (2001) collected phoronid specimens and identified as *P. euxinicola*. In spite of several attempts to get the material from the authors for examination, we did not receive it up to now, making the validity of *P. euxinicola* still doubtful.

Phoronis psammophila (identified by C. Emig) was collected on the northwestern coasts (mainly in Odessa Bay) in *Mytilus*, *Abra* and *Melinna* communities (Zolotarev, 1994). In Karkinitzky Bay, *P. psammophila* (identified by C. Emig) was also found at depths between 20 to 35 m in *Abra* and *Mytilus* communities with a density up to 160 ind m⁻² (Povchin, 1987, 1990). Faunistic analysis of many benthic samples collected along the coasts of Crimea and Caucasus yielded a relatively dense population of *Phoronis* sp. (ca. 110 ind m⁻²) in the *Venus* community at 10-20 m, in the *Pitar* community at 30 m, in the *Modiolus* community at 60-70 m, and in the *Pachicerianthus* community at 78-100 m (Kisseleva, 1981; Zaika et al., 1992). There is no previous report about Phoronida along the Turkish Black Sea coast. In this study, *Phoronis psammophila* was collected in shallow water (4 m) in a sea-grass bed of the phanerogame *Cymodocea nodosa* (Ucria) Aschers. The benthic community structure along the Turkish Black Sea coast has been largely unexplored, however a recent seasonal analysis of polychaetes associated with various algae around Sinop suggested that a relatively peculiar difference existed between the community structure on the Turkish Black Sea coast and that in other parts of the Black Sea coasts (unpublished data).

Polychaete species associated with Phoronis spp.

In the Black Sea, the ampharetid *Melinna palmata* was the only abundant polychaete species associated with *Phoronis psammophila*. However, the phoronid co-occurred with a number of abundant polychaete species in the Aegean and Levant Sea coasts (see Table 1). As *P. psammophila* seems to occur on a variety of habitats (i.e. sands, *Zostera*, *Posidonia* and *Cymodocea* beds, and sometimes mud), the key polychaete species associated with it are diverse. *P. muelleri* inhabited muddy bottoms and *Zostera marina* beds harbouring different dominant polychaete species. However, *P. muelleri* much prefers muddy substratum with high organic compounds and builds up relatively dense populations in polluted or semi-polluted bottoms, which are mainly dominated by the polychaete species *Malmgreniella lunulata* (Polynoidae), *Ophiodromus pallidus* (Hesionidae), *Spiochaetopterus costarum* (Chaetopteridae), *Monticellina heterochaeta* and *Chaetozone* spp. (Cirratulidae) and *Terebella lapidaria* (Terebellidae). In addition, *P. muelleri* also lives in deeper waters of Cyprus (210 m) where it co-occurred with *Sigalion mathildae* (Sigalionidae), *Glycera rouxi* (Glyceridae), *Lumbrineris gracilis* (Lumbrineridae), *Spiophanes kroyeri reysi* (Spionidae) and *Ampharete acutifrons* (Ampharetidae).

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