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PHORONIDA FROM AUSTRALIA

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SUMMARY

Five species of Phoronida2 have been recorded in Australian waters, from the vicinities of Brisbane, Sydney and Melbourne: Phoronis pallida, P. psammophila, P. australis, Phoronopsis albomaculata and Phoronopsis harmeri. A diagnosis for each species is given, together with notes on their taxonomy and ecology. The descriptions of three species, Phoronis pallida, P. psammophila and Phoronopsis albomaculata, have been expanded or modified. Phoronopsis albomaculata possesses nephridia with a single funnel, not two, and sometimes has a spiral lophophore. A new key to the species of Phoronida is provided, modifying the key established by Emig (1971).

INTRODUCTION

The earliest records of Phoronida in Australian waters were by Haswell (1883, 1885, 1893), from Port Jackson. Phoronis australis Haswell, 1883 was described burrowing in the tube wall of cerianthids (Coelenterata: Anthozoa), while a second species, considered to be probably Phoronis psammophila Cori, 1889 was recorded growing over empty mussel shells (Haswell, 1893). Other records of Phoronida have been of P. australis, from Port Jackson (Benham, 1889) and from Moreton Bay (Ponder, 1971).

An examination of material from recent survey work has increased the number of species of Phoronida known from Australia to five. Phoronis psammophila has been definitely identified, and Australian records are now available for Phoronis pallida (Schneider, 1862), Phoronopsis albomaculata Gilchrist, 1907, and Phoronopsis harmeri Pixell, 1912. The occurrences of the five species in Australian waters are discussed below, together with brief descriptions, and a key to the species is provided. Records from Port Phillip Bay, in south-eastern Australia, are given with the station designations used previously (MMBW and FWD, 1973).

1 Present address: Division of Fisheries and Oceanography, Box 21, Cronulla, N.S.W. 2230, Australia.
2 Recently a sixth species, Phoronis muelleri, has been discovered from Moreton Bay, Queensland.

Fig. 1. Phoronis pallida: distribution and abundance (nos/m²) in Port Phillip Bay, Victoria.
PHORONIDA FROM AUSTRALIA

SYSTEMATICS

Genus Phoronis Wright, 1856

**Phoronis pallida** (Schneider, 1862) Silén, 1952

Figs 1, 2, 7a-f


**MATERIAL:** Port Phillip Bay (Vict.), — 2515 specimens, from series 0900 between 17 October, 1969, and 11 October, 1971, by Smith-McIntyre grab and diver-operated suction dredge, mainly in fine sediments; — 4 spec., stn 1214, 2 km SE of Yarra River mouth, coll. 9 March, 1971, by grab from silty sediment, 4 m (Australian Museum W6551); — 6 spec., stn 1221, 3.5 km W of stn 1223, coll. 9 March, 1971, by grab from very fine sand, 8 m (Aust. Mus. W6552); — 35 spec., stn 1223, 2 km S of stn 1214, off Yarra River mouth, coll. 9 March, 1971, by grab from very fine sand, 8 m (Aust. Mus. W6553); — 3 spec., stn 1269, 10 km SSW of Werribee River, coll. 11 March, 1971, by grab from fine sand, 8 m (Aust. Mus. W6554).

**DIAGNOSIS:** Length — up to 140 mm, diameter 0.3-1 mm. Colour — in life, yellowish-pink. Lophophore — horseshoe-shaped (fig. 7a). Tentacles — 50-140, length 2-2.5 mm. Nephridia — with 2 funnels each, anal slightly larger than oral; descending branch nearly as long as ascending branch; nephridiopore on anal papilla, opening at or immediately below level of anus (fig. 7b, d). Giant nerve fibre — on left side only, diameter 10-20 μm (fig. 7f). Longitudinal muscle formula — range [17-19] = $\frac{3+4}{1+3} \cdot 3$, mean $18 = \frac{5}{4} \cdot 4$. Gonads — hermaphroditic (fig. 7e); lophophoral organs large, glandular, nidamental glands absent (fig. 7a, c); no brooding. Larval form — *Actinotrocha pallida*. Other characters — unusual musculature arrangement (fig. 7f, fig. 2); circular muscles present three strong sphincters, longitudinal muscles divide into six zones.

**REMARKS:** The body length of our fixed specimens of *P. pallida* is 10-30 mm; their extended length should thus reach 100 mm (Emig, 1969a). This compares with lengths of up to 140 mm estimated elsewhere (Emig, 1969b). The tentacles number 80-120 and are about 2 mm long.

The nephridia are typical, with two funnels and the descending branch nearly as long as the ascending branch (Emig, 1969b, 1971). The upper part of the ascending branch is often prominent (fig. 7b, d). The nephridiopore sometimes opens immediately below the anus (fig. 7b).

The diameter of the giant nerve fibre (fig. 7f) ranges from 10 to 18 μm.

Longitudinal muscle bundle formulae were obtained for 104 specimens; the values are as follows, using the conventional formula of Selys-Longchamps (1907): $17 = \frac{3+4}{1+3}$ in 1 specimen; $19 = \frac{3+4}{1+3}$ in 3 specimens; $18 = \frac{5}{4} \cdot 4$ in all other specimens (fig. 7f). A general muscle formula for *Phoronis pallida* may be given as: [17-19] = $\frac{3+4}{1+3}$. The arrangement of longitudinal and circular muscles (fig. 2) is unusual in this species (Silén, 1952; Emig, 1971).

*P. pallida* is hermaphroditic. A well-developed ovary and testis were present in all specimens examined (fig. 7e). The ovary lies on the dorsal side of the lateral vessel, the testis on the ventral side; the reverse situation found generally by Silén (1952) and Emig (1969b) was not observed, but the two gonads are often not firmly fixed in relation to each other.

All features examined in our animals agree generally with those specified by Silén (1952) and Emig (1969b, 1971), although the diameter of the giant fibre and the longitudinal muscle bundle numbers have been modified from the diagnosis established by Emig (1974).

In Port Phillip Bay *Phoronis pallida* was found in sediments ranging from fine sand to clayey-silt, occurring in numbers of up to 598 individuals/m$^2$ in fine sand with an admixture of silt. The tubes built by *P. pallida* tended to reflect the predominant sediment fraction...
present, the walls being covered with fine sand grains and comparatively inflexible in regions of sandy sediment. In all instances, the tube ends immediately below the ampulla in a clear, flexible, membranous bulb free of attached sediment.

Salinities at the bottom in Port Phillip Bay generally range between 34%0 and 36%0. Recorded salinities in 1970-71 for areas where *P. pallida* occurred were 34.1-36.6%0. Lower salinities occur periodically near the mouth of the Yarra R., in the north, at times of flood. A strong salt wedge is usually present in this area, and the occurrence of *P. pallida* near the Yarra mouth may not signify tolerance of salinities markedly below 34%0. Temperatures at the bottom range from 10°C to 24°C.

No strong relationship with any faunal association is apparent. In general, the distribution of *P. pallida* follows that of surface-deposit feeding molluscs in Port Phillip Bay (Poore and Rainer, 1974).

**DISTRIBUTION:** Australia — Port Phillip Bay (Vic.); Wider distribution — Pacific and Atlantic oceans (Emig, 1973b).

Figs 7-9.

Fig. 7. *Phoronis pallida*. (a) and (c) cross section of the lophophore at the level of the lophophoral organs; (b) cross section of the anal papilla and nephridia; (d) cross section at descending branch of nephridia; (e) cross section of the ampulla through the gonads (testis and ovary); (f) cross section of the muscular region, zone 4. *Phoronis psammophila*. (g) cross section of the muscular region.
Fig. 3. Phoronis psammophila: distribution and abundance (nos/m²) in Port Phillip Bay, Victoria.
PHORONIDA FROM AUSTRALIA

Phoronis psammophila Cori, 1889

Figs 3, 7g

Phoronis psammophila. — Emig, 1969a: 312-323 (in part), figs 2-9


Phoronis architecta Andrews, 1890: 445-449, fig. 1.

MATERIAL: Port Phillip Bay (Vic.), — 42 specimens, from series 0900 stations (fig. 3) of Port Phillip Bay Environmental Study, collected between 13 February, 1970, and 3 February, 1972, by Smith-McIntyre grab (S-M) from fine sand or silty sand, 2-25 m; — 6 spec., stn 953, coll. 11 June, 1971, by S-M grab from medium sand, 3 m (Aust. Mus. W6555).

Western Port (Vic.), — 1 specimen, stn 515, lat. 38°21’22”S, long. 145°13’58”E, coll. 25 March, 1965, by S-M grab from coarse sand, 17 m; — 2 spec., stn M2, lat. 38°22’30”S, long. 145°14’16”E, coll. 7 January, 1974, by S-M grab from coarse sand-gravel sediment, 2 m.

DIAGNOSIS: Length — 60-190 mm, diameter 0.5-2 mm. Colour in life — lophophore transparent with white pigment spots, or occasionally lophophore yellow, red or green; body pink. Lophophore — horseshoe-shaped with ends turned medially. Tentacles — 60-130, length 1.5-2.5 mm. Nephridia — with one funnel each; descending branch short; nephridiopore on anal papilla, opening below anus. Giant nerve fibre — on left side only, diameter 7-27 μm (fig. 1g); rarely, very thin nerve fibre present on right side. Longitudinal muscle formula — range (25-53) = 25.11(4+7+9), mean 34 = 11.12(1+7+9), 12.13(4+7+9), 13.14(4+7+9) in 4 specimens; range (51-53) = 36.17(7+9+10), mean 52 = 16.17(10+11) in 4 specimens.

The general and mean formulae of Phoronis psammophila from different localities are compared in Table 1. Significant variations in the mean formula occur from place to place, as previously noted by Emig (1971, 1972), and the present data confirm this. The high upper limit to the number of longitudinal muscle bundles in the Australian material indicates that it belongs to a separate population, as does material from Florida and the Azores (Emig, 1972). The formula given in the diagnosis above represents the limits of variation for the three populations.

The distribution of P. psammophila overlapped that of Phoronis pallida (figs 1, 3) although the former species generally occurs in shallower water and coarser sediments. The character of the tube wall varied with sediment in the same way as in P. pallida. Salinity and temperature values at the stations where P. psammophila occurred are generally similar to those given for P. pallida.
A close relationship exists between the distribution of *P. psammophila* and that of *Phoronopsis albomaculata*, at least in Port Phillip Bay (figs 3, 4).

**DISTRIBUTION:** Australia — Port Phillip Bay, Western Port (Vic.); Wider distribution — cosmopolitan (Emig, 1973b).

**Table 1. Comparison of longitudinal muscle bundle formulae of Phoronis psammophila in different localities; (a) data published by Emig in other works.**

<table>
<thead>
<tr>
<th>Locality</th>
<th>Number of specimens</th>
<th>Mean formula</th>
<th>General formula</th>
</tr>
</thead>
<tbody>
<tr>
<td>Port Phillip Bay (Australia)</td>
<td>37</td>
<td>47 = 15(9_1^1) 11-19 11-17 6=117 6=11</td>
<td>[34-53]</td>
</tr>
<tr>
<td>Azores (a)</td>
<td>76</td>
<td>42 = 14(7_1^1) 12-19 11-17 5=97 3=9</td>
<td>[36-50]</td>
</tr>
<tr>
<td>Florida (U.S.A.) (a)</td>
<td>38</td>
<td>40 = 11(7_1^1) 11-15 11-17 5=81 5=9</td>
<td>[34-44]</td>
</tr>
<tr>
<td>Concarneau (France) (a)</td>
<td>18</td>
<td>37 = 12(7_1^1) 8-17 9-15 5=11 4=9</td>
<td>[26-46]</td>
</tr>
<tr>
<td>Solomon Islands</td>
<td>4</td>
<td>37 = 11(7_1^1) 10-12 11-12 7=81 6=9</td>
<td>[35-38]</td>
</tr>
<tr>
<td>Chesapeake Bay (U.S.A.)</td>
<td>20</td>
<td>36 = 12(6_1^1) 10-14 10-15 5=81 5=6</td>
<td>[32-42]</td>
</tr>
<tr>
<td>Dinard (France) (a)</td>
<td>30</td>
<td>36 = 12(6_1^1) 9-14 9-15 4=81 4=8</td>
<td>[26-42]</td>
</tr>
<tr>
<td>Nosy-Bé (Malagasy) (a)</td>
<td>9</td>
<td>35 = 12(6_1^1) 10-13 10-12 5=71 5=6</td>
<td>[32-38]</td>
</tr>
<tr>
<td>Gulf of Marseilles (France) (a)</td>
<td>1934</td>
<td>34 = 11(6_1^1) 8-16 8-16 4=91 4=9</td>
<td>[26-46]</td>
</tr>
<tr>
<td>Ivory Coast</td>
<td>5</td>
<td>34 = 11(6_1^1) 10-12 5=61 5=6</td>
<td>[32-35]</td>
</tr>
<tr>
<td>Etang de Berre (France) (a)</td>
<td>117</td>
<td>31 = 10(6_1^1) 8-13 8-12 4=71 4=7</td>
<td>[25-38]</td>
</tr>
<tr>
<td>Etang de Thau (France) (a)</td>
<td>100</td>
<td>28 = 9(5_1^1) 8-14 7-12 4=71 4=7</td>
<td>[25-39]</td>
</tr>
<tr>
<td>Calanque de Port-Miou (France) (a)</td>
<td>29</td>
<td>29 = (10_9) 6=11 7=11 6=41 6=4</td>
<td>[25-33]</td>
</tr>
<tr>
<td>Mean of all localities</td>
<td>2417</td>
<td>34 = 11(6_1^1) 27=9 11-17 6=11 4=11</td>
<td>[25-53]</td>
</tr>
</tbody>
</table>

*Phoronis australis* Haswell, 1883

Fig. 9d-f.


**MATERIAL:** Wreck Bay (N.S.W.), lat. 34°60’S, long. 150°E (Aust. Mus. W6016). Camp Cove, Port Jackson (N.S.W.), lat. 33°50’S, long. 151°17’E (Aust. Mus. W6017).

**DIAGNOSIS:** Biotope — burrowing into tube-wall of cerianthid; an obligate inquiline of cerianthids. Length — 50-200 mm; diameter 2-6 mm. Colour in life — anterior body part black, deep reddish or pink. Lophophore — spiral, with 2.5-3.5 coils on each side (fig. 9d).
Tentacles — 600-1600, length 5-16 mm, tentacles united basally for about one third or one quarter of total length. Nephridia — with 2 funnels each, anal larger than oral, small; no descending branch; nephridiopore on nephridial papilla, opening at or above level of anus (fig. 9e). Giant nerve fibres — paired, diameter of left one 5-13 μm, diameter of right one 3-13 μm (fig. 9g). Longitudinal muscle formula — range [43-87] = \[\frac{20}{8} + \frac{28}{12} \] = 60; \[\frac{20}{19} + \frac{23}{10} \] = 66; \[\frac{23}{12} + \frac{24}{11} \] = 68; \[\frac{23}{23} + \frac{24}{31} \] = 68; \[\frac{24}{13} + \frac{23}{1} \] = 72;

The general formula for these specimens is [60-87] = \[\frac{20}{8} + \frac{28}{12} \] and the mean formula 73 = \[\frac{23}{12} + \frac{24}{11} \]. The different values reported previously by Emig (1971, 1973a) indicate that considerable regional variation exists. The mean and general formulae given in the diagnosis encompass the range of variation so far encountered.

Mature gonads were found in specimens collected at one locality (Camp Cove), in March 1974.

The burrowing habit of Phoronis australis is characteristic. Individuals occur in numbers of up to 100 per tube in the tube-wall of Cerianthus sp. The material in the present study was collected from mud and muddy sand from 7-13 m deep; the recorded depth range is 0-30 m. Emig et al. (1972) regard the cerianthid tubes as a hard substrate in which P. australis burrows, with the ampulla extending into the fourth layer of the cerianthid tube-wall and the lophopore spreading out on the outer surface of the tube. Our present observations agree with this, in contrast to statements made by Ikeda (1903) and Ponder (1971) that the lophopore emerges on the inner surface of the cerianthid tube.

The association between Phoronis australis and a cerianthid has been defined by Emig et al. (1972) as an inquilinism.

DISTRIBUTION: Australia — Sydney area, Wreck Bay (N.S.W.), Moreton Bay (Qld.); Wider distribution — Pacific and Atlantic oceans (Emig, 1974).
Genus *Phoronopsis* Gilchrist, 1907

*Phoronopsis albomaculata* Gilchrist, 1907

Figs 4-6, 8a-g.


**MATERIAL:** Port Phillip Bay (Vic.), — 135 specimens, from series 0900 stations (fig. 4) of Port Phillip Bay Environmental Study, collected between 17 October, 1969, and 3 February, 1972, by Smith-McIntyre grab from fine sand or silty sand, 2-25 m; — 2 spec., stn 1221, 3.5 km W of stn 1223, coll. 9 March, 1971, by S-M grab from very fine sand, 8 m (Aust. Mus. W6556) — 3 spec., stn 1223, 4 km SSE of Yarra R. mouth, coll. 9 March, 1971, by S-M grab from very fine sand, 8 m (Aust. Mus. W6557); — 3 spec., stn 1224, 1.5 km SE of stn 1223, coll. 9 March, 1971, by S-M grab from fine sand, 8 m (Aust. Mus. W6558); — 1 spec., stn 1266, 5 km SE of Werribee R., coll. 11 March, 1971, by S-M grab from fine sand, 8 m (Aust. Mus. W6559).

Western Port (Vic.), — 1 spec., stn 22N, lat. 38°20'36"S, long. 145°13'12"E, coll. 18 March 1965 by S-M grab from shelly sand, 13 m.

Brisbane River (Qld), fig. 5 (Aust. Mus. W6024).

**DIAGNOSIS:** Length — 80-150 mm, diameter, 0.5-2 mm. Colour in life — lophophore pigmented with white spots; body yellowish. Lophophore — horseshoe-shaped or spiral, with a single coil on each side (fig. 8a, c). Tentacles — 70-160, length 2-3 mm. Nephridia — with one funnel each; descending branch short; epithelium thick; nephridiopore on anal papilla, opening below level of anus, on collar fold within invagination (figs. 6, 8b, d, g). Giant nerve fibre — paired, left fibre only present below nephridial level, left fibre diameter 15-35 μm (fig. 8e). Longitudinal muscle formula — range [46-102] 0.12-0.18, mean 71 ± 14.12. Gonads — dioecious; lophophoral organs more or less glandular; no nidamental glands observed (fig. 8c). Larva unknown. Asexual propagation by transverse fission. Invagination — about 0.1 mm deep, often not distinct on oral side (fig. 8b, d, g).

**REMARKS:** The present material is distinct in a number of features considered diagnostic by Emig (1972, 1974).

The lophophore is horseshoe-shaped, with the ends turned inwards to form a single-coiled spiral on each side (fig. 8a). The number of tentacles reaches 160.

The nephridia possess only a single funnel (fig. 6, 8b, d, g), not two as suggested by Emig and Thomassin (1969) and Emig (1971). They are very similar to the nephridia of *Phoronis psammophila*, differing only in the larger size of the nephridial branches and in the position of the nephridiopore on the collar fold within the invagination in *Phoronopsis albomaculata* (fig. 7b, d). In both species the lateral mesenteries are lacking between the nephridial funnel and the diaphragm (fig. 8b, d, g). Accordingly, using the phoronid nephridial types established by Emig (1971, 1974), the nephridia of *Phoronopsis albomaculata* do not belong to category 5, but rather to category 2, and have the characteristics given in the diagnosis.

The diameter of the left giant nerve fibre averages 20-35 μm (fig. 8e).

Longitudinal muscle formulae were obtained for 14 specimens from Port Phillip Bay and 18 specimens from Brisbane River.
Fig. 4. *Phoronopsis albomaculata*: distribution and abundance (nos/m²) in Port Phillip Bay, Victoria.
Port Phillip Bay: \[ \frac{19.18}{10.11} = 58; \frac{19.20}{11.11} = 59; \frac{19.20}{11.11} = 60; \frac{22.22}{11.11} = 63; \frac{23.23}{11.11} = 63 \]

Brisbane R.: \[ \frac{19.19}{12.12} = 62; \frac{21.21}{14.14} = 67; \frac{22.22}{14.14} = 69; \frac{25.25}{14.14} = 73 \]

Tulear (Malagasy) (a) \[ \frac{24.24}{17.17} = 76; \frac{25.25}{17.17} = 78; \frac{28.28}{17.17} = 83 \]

Nosy-Mitsio (Malagasy) (a) \[ \frac{28.28}{17.17} = 85; \frac{30.30}{16.16} = 86; \frac{31.31}{17.17} = 88; \frac{37.37}{16.16} = 89 \]

Mean of all localities \[ \frac{33.33}{20.20} = 102. \]

Table 2. Comparison of longitudinal muscle bundle formulae of Phoronopsis albomaculata in different localities; (a): see Emig (1973a).

<table>
<thead>
<tr>
<th>Locality</th>
<th>Number of specimens</th>
<th>Mean formula</th>
<th>General formula</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brisbane River (Australia)</td>
<td>18</td>
<td>79 = 26.24 / 13.74</td>
<td>19-33, 19-33 12-20 12-16 [62-102]</td>
</tr>
<tr>
<td>Tulear (Malagasy) (a)</td>
<td>18</td>
<td>74 = 23.24 / 14.13</td>
<td>20-30, 21-27 11-18 10-14 [67-82]</td>
</tr>
<tr>
<td>Nosy-Mitsio (Malagasy) (a)</td>
<td>10</td>
<td>69 = 22.21 / 14.12</td>
<td>20-25, 19-24 11-17 10-14 [61-79]</td>
</tr>
<tr>
<td>Ivory Coast (a)</td>
<td>1</td>
<td>66 = 21.19 / 12.12</td>
<td>21.19 12.12 [66]</td>
</tr>
<tr>
<td>Port Phillip Bay (Australia)</td>
<td>14</td>
<td>61 = 20.20 / 11.11</td>
<td>14-23, 15-24 7-13 7-13 [46-68]</td>
</tr>
<tr>
<td>Mean of all localities</td>
<td>66</td>
<td>71 = 23.22 / 14.12</td>
<td>14-33, 15-24 7-20 7-16 [46-102]</td>
</tr>
</tbody>
</table>

General and mean formulae extend the range of values reported previously for Phoronopsis albomaculata (Table 2), and the diagnostic muscle formulae take the new values into account.

Previous observations (Emig, 1973a) that Phoronopsis albomaculata is dioecious, has large and more-or-less glandular lophophoral organs (fig. 8c), and seems to lack nidamental glands, are confirmed on the Brisbane R. material (the Port Phillip Bay specimens were not in breeding condition). The absence of nidamental glands suggests that brooding does not occur. As in Phoronopsis californica and sometimes in Phoronis psammophila (Emig, 1973a), the testis occurs both along the lateral vessel in the left oral cavity of the trunk coelom and along the secondary lateral vessel in the right oral cavity (fig. 8f).
Fig. 5. Brisbane River and Moreton Bay: localities at which *Phoronopsis albomaculata* and *Phoronis australis* (Ponder, 1971) have been found. (1. Quarantine Station; 2. Meeandah; 3. Bulimba; 4. New Farm Park.)

Fig. 6. Diagram of a nephridium of *Phoronopsis albomaculata*. The dotted line indicates the possible extent of tunnel development that may occur, especially during gonad maturation (cf. Emig, 1971). Abbreviations, see figs 7-9.
In Port Phillip Bay *Phoronopsis albomaculata* has a distribution very similar to that of *Phoronis psammophila*, although more extensive (fig. 4), occurring in a density of up to 30 individuals/m$^2$ in silty-sand. It is subject to the same range of water temperature and salinity, and has the same depth range (2-25 m). The tube is similar to that of *P. psammophila*.

Some difficulty was experienced in differentiating *Phoronopsis albomaculata* from *Phoronis psammophila*, due to their similar general morphology and overlapping longitudinal muscle formulae. The invagination diagnostic of the genus *Phoronopsis* is often imperfectly developed in specimens that have recently undergone asexual propagation, or are regenerating the lophophore for any other reason. Such specimens were found at most stations, but any misidentification that may have occurred would not influence the general pattern of distribution as illustrated in figure 4.

In the estuary of the Brisbane River (fig. 5), *Phoronopsis albomaculata* was found subtidally as far upstream as New Farm Park, 22 km from the mouth, but was most abundant (up to 272/m$^2$) at the Quarantine Station site, 7 km from the mouth. Sediments at these sites ranged from muddy-sand at Quarantine Station to very soft mud at Bulimba and New Farm Park. Salinity at Quarantine Station is about 34%$\text{o}$ during much of the year, but dropped to 27%$\text{o}$ in December, 1971, and to 10%$\text{o}$ in February, 1972, following a flood caused by passage of a cyclone. At New Farm Park salinity is about 30%$\text{o}$ during low-flow conditions, but became near 0%$\text{o}$ in February, 1972. No *Phoronopsis albomaculata* were found above Quarantine Station just after the flood. The annual temperature range in the Brisbane River is approximately 16-28°. Benthic invertebrates associated with *Phoronopsis albomaculata* in the Brisbane River include the polychaetes *Prionospio* sp., *Heteromastus filiformis*, *Notomastus* sp., *Owenia fusiformis* and *Potamilla* sp; the bivalve *Notospisula parva*, the tanaid *Apsuedes estuarius* and the amphipod *Eriopisa australiensis*.

**Distribution:** Australia — Port Phillip Bay, Western Port (Viet.), Brisbane River (Qld); Indian and Atlantic oceans (Emig, 1973b). 

*Phoronopsis harmeri* Pixell, 1912

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**Phoronopsis harmeri.** — Emig, 1967: 984-983, figs 1-4

**Phoronis pacifica** Torrey, 1901: 283-288, figs 1-5.

**Phoronopsis viridis** Hilton, 1930: 33-34, figs 1-4.

**Phoronopsis striata** Hilton, 1930: 34-35, figs 5-9.

**Material:** Careel Bay, Pittwater (N.S.W.), north of Sydney, lat. 151°20'E, long. 33°38'S (Aust. Mus. W6018, W6019, W6020, W6021, W6022, W6023).


**Diagnosis:** Length — 40-220 mm, diameter 0.6-4 mm. Colour in life — greenish with white-pigmented tentacles. Lophophore — spiral, with 1.5-2 coils on each side. Tentacles — 100-400, length 2-5 mm. Nephridia — with two funnels each, anal smaller than oral (fig. 3b); long descending branch; nephridiopore opening on collar fold in invagination, below level of anus (fig. 3a). Giant nerve fibres — paired, diameter of left one 20-60 μm (fig. 3c); right giant nerve fibre present above level of right nephridium, atrophied below. Longitudinal muscle formulae — range [75-138] = 20-40 27-28 37-48 35-39, mea 111 = 26.3 μm; gonads — dioecious; lophophoral organs large, membranous; nidamental glands absent; no brooding pattern. Larval form — *Actinotrocha A* (Zimmer, 1964). Invagination — very distinct (fig. 9a, b).
Fig. 9. Phoronopsis harmeri. (a) cross section of the collar fold, through the anal papilla and the nephridiopore; (b) cross section (below a) of the descending branch and two funnels of the right nephridium; (c) cross section of the muscular region. Phoronia australis. (d) cross section of the lophophore (left spiral only), showing the anterior part of the nidamental gland; (e) cross section of the nephridial papilla, with accessory sex glands in the lophophoral concavity; (f) cross section of the muscular region.
REMARKS: The material examined agrees well with the specific characteristics of *Phoronopsis harmeri*. The collar fold is very distinct, with the invagination much stronger than in *Phoronopsis albomaculata* (fig. 8b, d, g; fig. 9a, b).

The longitudinal muscle bundle formula was determined in six specimens:

\[
\begin{align*}
\frac{28 + 29}{18 + 13} &= 88; \\
\frac{30 + 29}{18 + 13} &= 90; \\
\frac{31 + 28}{18 + 13} &= 99; \\
\frac{31 + 30}{21 + 18} &= 100; \\
\frac{32 + 31}{21 + 18} &= 100; \\
\frac{33 + 32 + 31}{20 + 19} &= 114.
\end{align*}
\]

The Australian specimens, along with those recently described from the Cook Islands (Emig, 1973b) and from Marovo Lagoon (New Georgia Group, Solomon Islands: unpublished data), are smaller than *Phoronopsis harmeri* so far collected from the Pacific coast of North America. No gonads or other reproductive features were present in the local specimens, which may be juveniles.

At Careel Bay *P. harmeri* was found in *Zostera* beds in fine mud near low tide and at Wallis Lake this species occurs in muddy sand at 6-8 m depth.

DISTRIBUTION: Australia, Careel Bay, Wallis Lake (N.S.W.); Wider distribution — Pacific and Atlantic oceans (Emig, 1973b).

KEY TO SPECIES OF PHORONIDA

The results of the present study and the observations of Stancyk et al. (in press) and Emig (unpublished) concerning the nephridia and lophophore of *Phoronopsis albomaculata* and of *Phoronis ijimai* Oka have been incorporated in the key established by Emig (1971). Only the main taxonomic characters of the species are used, but all characters must be verified for the determination of a phoronid species.

1. Lophophore oval or horseshoe-shaped................................. 2
   — Lophophore spiral or helicoidal .................................. 8
2. Lophophore oval; nephridia with one funnel, descending branch absent; no lateral mesentery; burrowing habit ......................... *Phoronis ovalis*
   — Lophophore horseshoe-shaped .................................... 3
3. Nephridia with one funnel, descending branch present; usually only left giant nerve fibre present .................................... 4
   — Nephridia with two funnels, anal larger than oral; no invagination at base of lophophore; hermaphrodite .............................. 6
4. Invagination present at base of lophophore, although often not distinct on oral side; nephridiopore opening on collar fold below anus .............
   — Invagination not present ............................................ 5
5. All mesenteries present; nephridiopore below anus ............. *Phoronis psammophila*
   — Left lateral mesentery absent in muscular region; nephridiopore at level of anus; prebuccal and postbuccal tentacles of same length, lateral tentacles longer .................................................. *Phoronis muelleri*
6. Descending branch of nephridia nearly as long as ascending branch; left giant nerve fibre only; circular muscles (three sphincters) and longitudinal muscles (six zones) unusual ................................ *Phoronis pallida*
   — Descending branch of nephridia absent; nephridial papilla present; two giant nerve fibres; burrowing or encrusting habit ...................... 7
7. Ascending branch of nephridia in two horizontal chambers; longitudinal muscle bundles number 24-43 ........................................... Phoronis hippocrepia
   — Ascending branch of nephridia curved; longitudinal muscle bundle numbers 37-69 ........................................... Phoronis ijimai

8. Lophophore spiral ...................................................... 9
   — Lophophore helicoidal; nephridia with two funnels and descending branch; invagination present at base of lophophore, deep ........ Phoronopsis californica

9. Invagination present at base of lophophore; right giant nerve fibre absent in muscular region; nephridia with descending branch ................. 10
   — Invagination not present; nephridia with two funnels, anal larger than oral; nephridia without descending branch; two giant nerve fibres .................. 11

10. Nephridia with one funnel ........................................ Phoronopsis albomaculata
    — Nephridia with two funnels, anal smaller than oral; invagination very distinct ........................................ Phoronopsis harmeri

11. Burrowing or encrusting species .................................. Phoronis ijimai
    — Inhabiting cerianthid tube-wall; lophophore multispiral ... Phoronis australis

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Fig. 8. Phoronopsis albomaculata. (a) cross section of the lophophore, without accessory sex glands; (b) cross section, slightly oblique, through the funnel; (c) cross section of the lophophore through the lophophoral organs; (d) cross section (below b) of the nephridia; (e) cross section of the muscular region; (f) cross section of the ampulla, showing testis in the two oral cavities; (g) cross section of the nephridia.
REFERENCES


APPENDIX

Recently, *P. australis*, *Phoronopsis harmeri*, *Phoronopsis albomaculata*, and a species new to Australian waters, *Phoronis muelleri* have been discovered near Peel Island and Middle Banks (Moreton Bay). Data on these specimens will be published later.