

NOTES ON THE BIOLOGY AND DISTRIBUTION OF *PASIPHAEA* SPECIES FROM THE SOUTHERN OCEAN

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ABSTRACT. Pasiphaeid decapods taken in deep water hauls by the British Antarctic Survey between 1980 and 1983 are described. Samples came from South Georgia and the Scotia Sea at depths down to 2500 m. *Pasiphaea scotiae* is probably synonymous with *P. longispina* and is a common and widespread species in the midwater of the Southern Ocean. *Pasiphaea rathbunae* was also taken near South Georgia.

INTRODUCTION

Although collections of midwater crustaceans have been made by many oceanographic cruises to the Southern Ocean, very little work has been published. Substantial collections were made by H.M.S. *Challenger*, the *Discovery* Investigations, the Deutsche Sudpolar-Expedition, the BANZ Antarctic Research Expedition, the *Terra Nova* Expedition and the scientific cruises of USNS *Eltanin* between 1963 and 1968. Despite this work, however, Yaldwyn (1965) was able to list only five species of midwater decapod from the Southern Ocean and Kirkwood (1984) only 11 species of decapod in all.

Between 1980 and 1983 during the course of the British Antarctic Survey Offshore Biological Programme (OBP) around South Georgia, a number of net hauls were made to depths of 2500 m. These were intended to sample for eggs and larvae of *Euphausia superba* but produced small numbers of midwater crustaceans as by-catch. Most of these specimens were deep-frozen for lipid analysis (Clarke and Holmes, in press) but some were preserved in formalin for identification. In this paper we report new information on the biology and biogeography of two species of *Pasiphaea* taken in these hauls; we also review current knowledge of the occurrence of species of *Pasiphaea* in the Southern Ocean.

MATERIALS AND METHODS

All samples were taken during oceanographic cruises in the Southern Ocean by the RRS *John Biscoe* as part of the British Antarctic Survey Offshore Biological Programme. Midwater crustaceans were collected from discrete depth horizons with a multiple RMT 8 assembly, opening and closing of the nets being controlled acoustically from the ship (Roe and Shale, 1979). A thermally protected cod-end was not required since surface water temperatures were always less than 5°C and crustaceans were frequently alive when brought to the surface. Sample details are given in Appendices I and III.

Specimens of Southern Ocean mesopelagic decapod crustaceans in the following collections were also examined:

British Museum (Natural History), London (material collected by several early expeditions to the Southern Ocean);

Institute of Oceanographic Sciences, Wormley, Surrey (material collected by RRS *Discovery* in 1979);

Smithsonian Oceanographic Sorting Centre, Washington, USA (material collected by USNS *Eltanin* between 1962 and 1968).

The aim of these studies was to document the distribution of *Pasiphaea* species in the Southern Ocean.

NOTES ON INDIVIDUAL SPECIES

The genus *Pasiphaea* contains 32 species (Burukovskii, 1976). Species have been recorded from 70° N to 70° S, and there is a distinct tendency for many to be found over the continental shelves or associated with islands. The genus has a wide bathymetric range, from the surface to about 3000 m, although about half the species have not been recorded below 1000 m. They are usually coloured deep red in life. Characteristically they show a strong reduction in the third to fifth pereopods with both the first and second pereopods strongly chelate.

Pasiphaea scotiae (Stebbing, 1914)

This species proved to be the commonest pasiphaeid sampled, forming roughly two-thirds of all individuals caught around South Georgia and in the Scotia Sea (73 out of 106 specimens, with 5 individuals too small or damaged to be identified). *P. scotiae* was identified from the key to the genus *Pasiphaea* in Burukovskii (1976), and by reference to the original description (Stebbing, 1914). The diagnostic features of this species are the long, pointed, slightly upturned rostrum and the presence of six or seven large spines on the merus of the second pereopod.

Midwater decapods collected on scientific cruises by USNS *Eltanin* between 1962 and 1968 contain many specimens of *P. scotiae*, as does the collection taken by RRS *Discovery* in 1979. These records are listed in Appendix I. All available records for *P. scotiae* are plotted in Fig. 1.

P. scotiae appears to have a circumpolar distribution, ranging from close to the continent as far north as the Antarctic Convergence (the Polar Frontal Zone). The lack of records south of Australia probably reflects where samples have been taken rather than any real gap in the distribution.

P. scotiae has been collected from 2500 m to quite shallow depths (about 200 m). There is a tendency for the smaller juvenile specimens to be taken at shallower depths than adults; although this is a frequent occurrence in mesopelagic crustaceans (Omori, 1974) the depth data for *P. scotiae* are too imprecise for the pattern to be more than suggestive. However, pasiphaeids also occur in the prey of several species of Southern Ocean seabirds, including albatrosses, Emperor penguin, *Aptenodytes forsteri*, snow petrel, *Pagodroma nivea* and Antarctic petrel, *Thalassoica antarctica* (Clarke and Prince, unpub. obs.; Ainley and others, 1986). Emperor penguins are deep divers and so may be able to capture live shrimp, but neither albatrosses nor petrels can take food more than a metre or so below the surface. Recently it has been shown that pasiphaeids occur at the surface amongst pack-ice or near icebergs (Ainley and others, 1986) where they are taken by seabirds. In addition, Southern Ocean pasiphaeids are very rich in lipid (Clarke and Holmes, in press), making them close to neutrally buoyant and so likely to rise to the surface when moribund. This lipid is clearly visible as a globule beneath the thoracic carapace and is frequently released by mechanical damage in formalin preserved specimens.

Females carrying eggs have been taken in seven months, scattered throughout the year. Although very few such individuals have been collected this would suggest either that embryonic development takes a long time in *P. scotiae*, possibly over a year, or

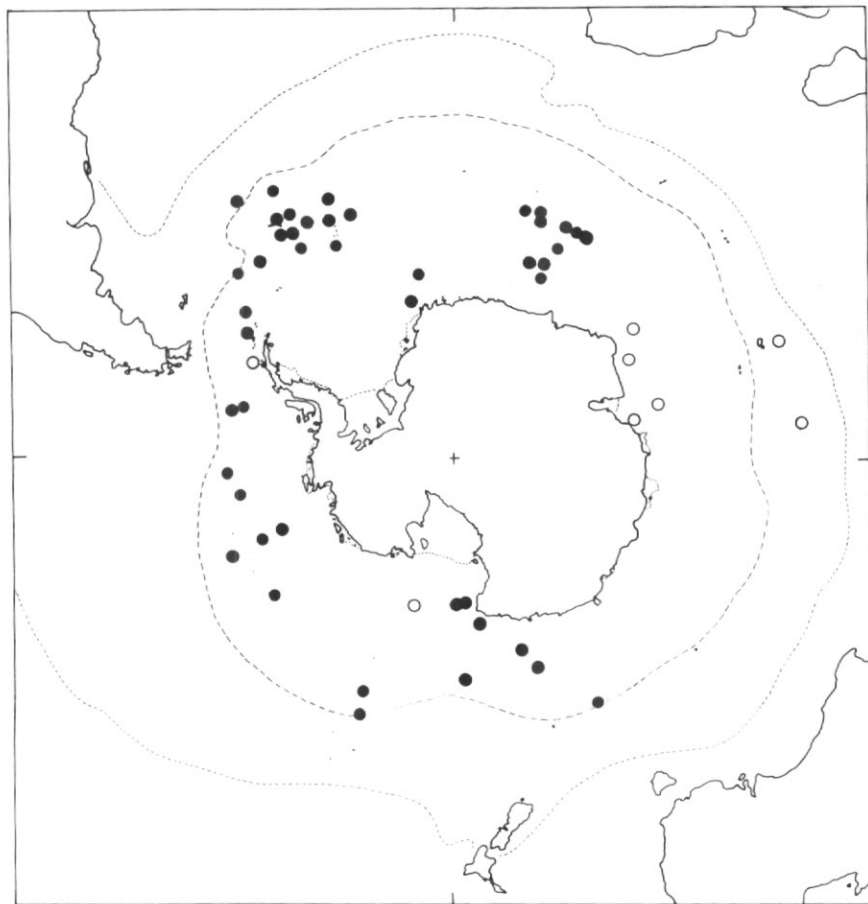


Fig. 1. Map of the Southern Ocean showing position of reported specimens of *Pasiphaea scotiae* (●) and *P. longispina* (○). Many specimens of *P. scotiae* from around South Georgia not plotted for clarity (see Appendix I). Dashed lines show the appropriate position of the Antarctic Frontal Zone; broad dash) and Sub-tropical Convergence (or Polar Frontal Zone; fine dash).

that spawning is asynchronous within the population being sampled. Long development times are normal for high latitude crustaceans with large eggs (Clarke, 1983) and in the bathypelagic mysid *Gnathophausia ingens* from the San Clemente Basin embryonic development takes 530 days (Childress and Price, 1978). There was no significant relationship between egg weight and female size (0.01, $P > 0.05$), the overall mean reproductive output (weight eggs/weight female) being 0.117 (SE = 0.16, $n = 9$).

Pasiphaea scotiae and *Pasiphaea longispina*

Pasiphaea scotiae was first described by Stebbing (1914) as *Phye scotiae* from two specimens collected in the eastern Weddell Sea off Queen Maud Land in March 1904. One specimen from 1410 fathoms (2580 m) was in good condition, whereas a second taken in a vertical net had a damaged rostrum. The type specimen is held at the British Museum (Natural History); it consists of fragments of material previously mounted on

slides (the 3rd maxilliped and other appendages). The specimen is unregistered and the whereabouts of the rest of the material appears to be unknown. Also in 1914, however, Lenz and Strunk (1914) described *Pasiphaea longispina* from the stomach of an Emperor penguin taken in April 1903 from 65° 15' S, 80° 19' E (at the ice-edge off Princess Elizabeth Land). This specimen too had a broken rostrum. We have not managed to locate the type specimen.

Several authors have suggested that *P. scotiae* and *P. longispina* are synonymous (Yaldwyn, 1965; Burukovskii, 1976), although Kirkwood (1984) treats the two taxa separately. The original descriptions and illustrations reveal that these two taxa have a number of distinctive characters in common, notably the strikingly long and pointed rostrum, the presence of six or seven pronounced spines on the merus of the second pereiopod and the absence of spines on the first pereiopod. It has proved impossible to establish precedence in naming; Stebbing's description of *P. scotiae* was presented to the Royal Society of Edinburgh on 16 March 1914 and published on 4 June 1914. The description of *P. longispina* by Lenz and Strunk was published in June 1914 (exact date unknown).

Subsequent descriptions of *P. scotiae* and *P. longispina* have further confused the position. Borradaile (1916) collected two pasiphaeids, one from 71° 41' S, 166° 47' W and 'the other from the stomach of an albatross, at a locality which is not stated, but must have been considerably further north' (p. 84). In Borradaile's specimens the rostrum 'slightly outreaches the eye, and has a sharp, downwardly hooked tip'. Borradaile called his specimens *P. longispina*, the type specimen of which had a broken rostrum (Lenz and Strunk, 1914: plate XIX, p. 315). Ledoyer (1979) illustrates a specimen of *P. longispina* with a long undamaged rostrum with no sign of a downward curve (Fig. 3, p. 152). This specimen was taken north-east of Kerguelen on 12 March 1975. The original illustration of *P. scotiae* (Stebbing, 1914, plate XXX) also shows an undamaged rostrum with a distinct upward, not downward, curve. In our experience the rostrum of the latter species is frequently broken or damaged. In the undamaged state the rostrum curves gently upwards but damaged specimens occasionally give the appearance of downward hook. This would suggest that the use of this feature to separate *P. scotiae* and *P. longispina* (cf. Kirkwood, 1984) is not reliable.

Hale (1941) reported *P. longispina* from three localities off Enderby Land (one being taken from the stomach of a snow petrel) and one from considerably further north at 45° 53' S, 84° 33' E. Hale (1941) also reports and figures a single specimen described as *Pasiphaea rathbunae* (Fig. 3, p. 263), collected south west of Tasmania at 44° 11' S. The specimen drawn, however, appears not to be *P. rathbunae* and may be a specimen of *P. scotiae* judging by the shape of the rostrum (damaged) and the armour of the second pereiopod. However, the first pereiopod is also shown with four spines which is not usual in *P. scotiae*. Without recourse to the original specimens it is impossible to assess whether the specimens have been misidentified, or the published figures mis-labelled.

Recently *P. longispina* has been reported from Croker Passage, Antarctic Peninsula (Hopkins, 1985), from the Australian sector of the Southern Ocean (Iwasaki and Nemoto, 1986) and at the sea surface amongst sea-ice in the Weddell Sea (Ainley and others, 1986). In none of these latter reports were details of identification or sampling provided. All records of *P. longispina* are listed in Appendix II and plotted in Fig. 1.

Pasiphaea rathbunae (Stebbing, 1914)

A small number of individuals of this species were taken from around South Georgia. Specimens were identified from the key in Burukovskii (1976) and by reference to the original description (Stebbing, 1914). *Pasiphaea rathbunae* was first described by Stebbing (1914) as *Phye rathbunae*. It appears to be closely related to the arctic species *Pasiphaea tarda* Kroyer 1845. The original description and illustration (Stebbing, 1914, plate XXXI, p. 295) show a number of differences from *P. scotiae*, the most notable of which are that the rostrum has a sharply keel-shaped, not extending beyond the eyes, and that the merus of the second pereiopod is armed with a series of 13–17 smallish spines. There are also differences in the structure of the telson, and the proportions of the antennules and pereiopods. Stebbing's type specimen came from 1332 fathoms (2436 m) at 48° S, 9° 50' W. The type specimen is located in the British Museum (Natural History). It consists of a series of fragments taken from slides; the specimen is unregistered and the location of the rest of the type appears to be unknown.

Since the original description the species appears only to have been recorded by Hale (1941) and Ledoyer (1979). Hale describes a single specimen taken in a vertical haul from 1710 m to the surface at 44° 11' S south-west of Tasmania. The specimen actually figured, however, may be *P. scotiae* (see discussion above). Ledoyer reports three specimens taken in 165 m at 46° 26' S, 57° 58' E on 21 April 1974. The carapace and second pereiopod of one individual are illustrated (Ledoyer, 1974, fig. 3C, p. 152) and are similar to Stebbing's original illustration.

The specimens taken near South Georgia had a variable rostrum shape and a varying number of spines on the pereiopods. In most individuals there were between 13 and 20 (mostly 14–17) small spines on the merus of the second pereiopod and between four and eight small spines on the merus of the first pereiopod. The rostrum was always keel shaped but was occasionally broken or otherwise damaged. The telson was bifurcate with numerous small spines.

Specimens of *P. rathbunae* have been taken by the British Antarctic Survey Offshore Biological Programme around South Georgia, and also by USNS *Eltanin*. All except a single specimen at 62° S, 76° W were taken between 55° and 59° S. *P. rathbunae* thus appears to be a Subantarctic species which extends south into the northern regions of the Southern Ocean (Fig. 2). Known occurrences of *Pasiphaea rathbunae* in the Southern Ocean are listed in Appendix III.

Other Southern Ocean Pasiphaea species

The collection of pasiphaeid shrimps taken by USNS *Eltanin* contains at least four individuals which are clearly neither *P. scotiae* nor *P. rathbunae*. They have a sharp keel-like rostrum, more pointed than that of *P. rathbunae* but much shorter than that of *P. scotiae*. The merus of the second pereiopod bears a dense array of about 30 small spines, the merus of the first pereiopod about 20 spines. The telson is bifurcated.

These characters suggest that the shrimps may belong to *Pasiphaea grandicula* (Burukovskii, 1976) described from the South Atlantic. Burukovskii reports *P. grandicula* from 26° 11' S, 06° 03' E (at 1150 m depth, the type locality) as far south as 51° 13' S, 02° 01' E in the Southern Atlantic, more or less at the position of the Antarctic Convergence.

Koronkiewicz (1979) has reported taking eight female *Pasiphaea multidentata* Esmark 1865, from a pelagic trawl fished to 800 m at 54° S, 35° W, close to South Georgia. Burukovskii (1976) comments that *P. grandicula* and *P. multidentata* are

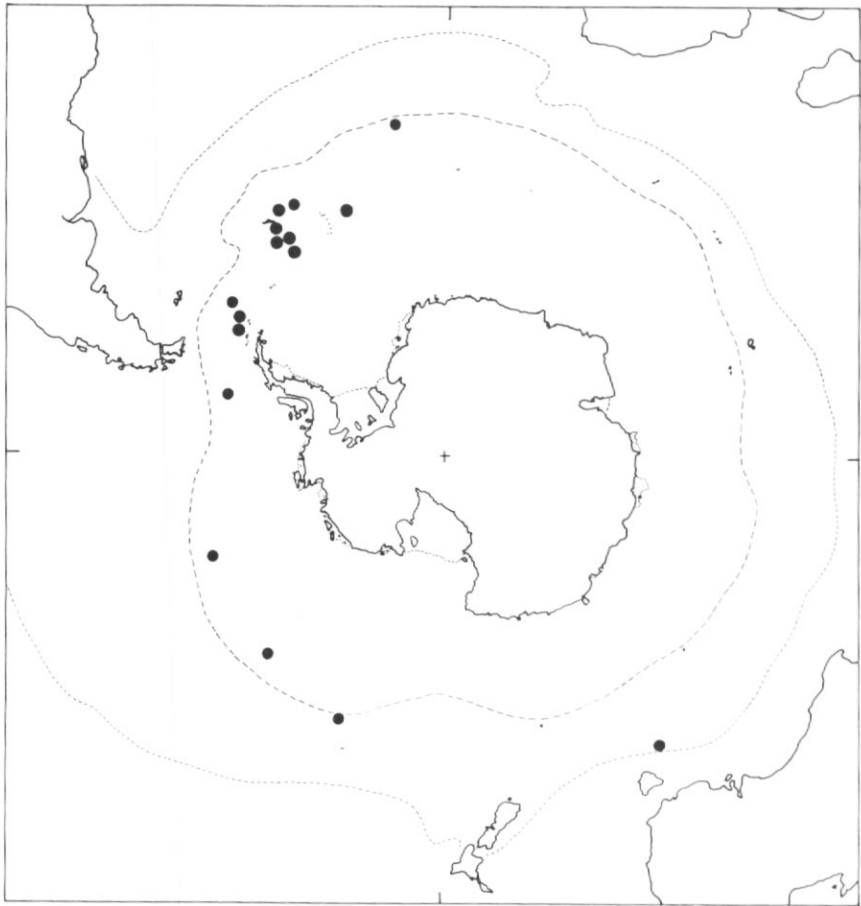


Fig. 2. Map of the Southern Ocean showing known distribution of *Pasiphaea rathbunae*. Presentation as for Fig. 2.

very similar, the major difference being the number of spines on the pereiopods (which, size for size, is always greater in *P. grandicula*). Since *P. multidentata* has not otherwise been reported further south than Cape Cod or Villa Cisneros in the north Atlantic (Burukovskii, 1976), it seems probable that the specimens reported by Koronkiewicz may also be *P. grandicula*. These specimens are listed in Appendix III.

Pasiphaea acutifrons Bate 1888, was described from a specimen taken on 11 January 1876 in 245 fathoms (450 m) by H.M.S. *Challenger* at 52° 45' S, 73° 46' W off Port Churraco, Patagonia (together with another taken south of Japan). Subsequent records of this species have all been in the vicinity of Tierra del Fuego (Boschma, 1949; Retamal, 1973; Vinuesa, 1977) apart from one further north along the Chilean coast (Rathbun, 1910). Holthuis (1952) regarded *P. acutifrons* as one of a group of deeper water Chilean decapods. *Pasiphaea dofleini* Schmitt 1932, has also been reported from waters around southern South America (Schmitt, 1932; Holthuis, 1952; Retamal, 1974). Zarenkov (1970) reported a single specimen, identified with reservations as *P. acutifrons*, collected from below 3000 m at 59° 28' S, 67° 41' W in the Drake Passage on 7 April 1958, and recently Iwasaki and Nemoto (1986) have reported *P. acutifrons* from the Southern Ocean south of Australia.

DISCUSSION

It seems very likely that *Pasiphaea scotiae* and *P. longispina* are synonymous. *P. scotiae* is widely distributed in the Southern Ocean. It ranges from the Antarctic Convergence to the Antarctic continent and is circumpolar (Fig. 1); it is probably the commonest pasiphaeid in the Southern Ocean. *P. longispina* has been reported from the Weddel Sea, Croker Passage and also as generally distributed in the Australian sector of the Southern Ocean (Iwasaki and Nemoto, 1986). If *P. scotiae* and *P. longispina* are taken as synonymous, then this species has a complete circumpolar distribution south of the Polar Front extending as far south as the Antarctic Continent. Furthermore following Burukovskii (1976) as the first revisor of the genus, the species should be referred to as *P. scotiae*.

Two other pasiphaeids have been reliably reported from the Southern Ocean, *P. grandicula* and *P. rathbunae*. The limited data available suggest that both are Subantarctic species which occur in the northern parts of the Southern Ocean around the Antarctic Convergence. The salient taxonomic features of the Southern Ocean pasiphaeid shrimps are given in Table I. A scattering of 'difficult' individuals in collections suggests that other species may also occur in the Southern Ocean.

Table I. Salient taxonomic features of Southern Ocean species of *Pasiphaea*

P. scotiae

Rostrum long, extending beyond eye, with slight upturn (but often damaged or broken)
 Mid-dorsal carina extending from rostrum to 6th abdominal segment
 Carapace with these lateral carinae merging anteriorly
 Merus of 1st pereiopod smooth; merus of 2nd pereiopod armoured with 6-7 strong spines
 Telson bifurcate with 7-8 pairs of spines

P. longispina

Rostrum long, extending beyond eye, with slight upturn (but often damaged or broken)
 Mid-dorsal carina extending from rostrum to 6th abdominal segment
 Carapace with three lateral carinae merging anteriorly
 Merus of 1st pereiopod smooth; merus of 2nd pereiopod armoured with 6-7 strong spines
 Telson bifurcate with 7-8 pairs of spines

P. rathbunae

Rostrum short, keel-shaped, not extending beyond eye
 Mid-dorsal carina weak, absent on all but 5th abdominal segment
 Carapace with single lateral carina
 Merus of 1st pereiopod with about 9 small teeth; merus of the 2nd pereiopod 13-17 small teeth
 Telson bifurcate with 9 pairs of spines

P. grandicula

Rostrum well developed, extending beyond edge of carapace, but not beyond eye
 Mid-dorsal carina extending from rostrum to 6th abdominal segment
 Carapace with two lateral carinae merging anteriorly
 Merus of 1st pereiopod with 4-20 (or more) small spines, the number increasing with size:
 merus of 2nd pereiopod with 11-44 small spines
 Telson bifurcate, with spines

Descriptions compiled from Stebbing (1914), Lenz and Strunk (1914), Burukovskii (1976) and Kirkwood (1984).

In lower latitudes of the Southern Ocean, several other well described decapod species occur, including *Acantheephyra pelagica*, *Hymenodora gracilis* and *Petalidium foliaceum* (see maps in Kirkwood, 1984). The mysids *Gnathophausia gigas* and *Eucopia* sp. also occur here. This would suggest that many of the species recorded for the Southern Ocean are actually cold temperate species at the southern (high-latitude)

limit to their range. This is not surprising for both the Antarctic Convergence or Polar Frontal Zone (usually used to delimit the northern extent of the Southern Ocean) and the Sub-tropical Convergence (taken by Peres, 1982, to delimit the Antarctic pelagic assemblage) are both surface features. Both will be largely irrelevant to organisms living in the Antarctic intermediate current or the warm deep current at depths below 500 m.

ACKNOWLEDGEMENTS

We would like to thank the Master and crew of the RRS *John Biscoe* and the team of the British Antarctic Survey Offshore Biological Programme for help in the collection of specimens. We would also like to thank Dr Tony Fincham (British Museum of Natural History) for guidance with the identification of several species. We are most grateful to the British Museum (Natural History), Institute of Oceanographic Sciences and the Smithsonian Oceanographic Sorting Centre for allowing us to examine their collections of Southern Ocean midwater crustaceans. Ms Kate Chidgey was particularly helpful with regard to the *Discovery* material. We are grateful to Dr Frank Williamson of the Natural Science Foundation Division of Polar Programmes for permission to view the *Eltanin* material, and particularly to Dr Frank Ferrari and Ms Betty Landrum for their generous help with this task. Finally we would like to thank Dr John Croxall for valuable comments on the manuscript and Miss Christine Phillips for her help with the references.

Received 2 July 1986; accepted 10 September 1986

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APPENDIX I. Details of *Pasiphaea scotiae* specimens taken in the Southern Ocean

Expedition or cruise	Station no.	Position	Date	Depth (m)	Number of Specimens	Remarks	
<i>Scotia</i> (Scottish National Antarctic Expedition)	417	71° 22' S, 16° 34' W	18 Mar. 1904	2580	1		
	422	68° 32' S, 12° 49' W	23 Mar. 1904	1100-0	1	Vertical haul; Stebbing, 1914 (description of <i>Pasiphaea scotiae</i>)	
<i>Specimens collected by USNS Eltanin, 1962-1968</i>							
6	396	58° 56' S, 56° 00' W	29 Dec. 1962	714-85	1		
	448	61° 10' S, 59° 03' W	14 Jan. 1963	2580	1		
8	449	60° 12' S, 59° 00' W	15 Jan. 1963	1610	1		
	563	48° 15' S, 40° 24' W	7 Apr. 1963	732	3		
	571	54° 43' S, 25° 00' W	15 Apr. 1963	840	2	1 ovigerous female 1 gravid female	
	578	57° 17' S, 27° 22' W	19 Apr. 1963	1464-1867	1	Rostrum broken	
	580	57° 23' S, 23° 11' W	21 Apr. 1963	3074	1		
	581	57° 30' S, 23° 16' W	21 Apr. 1963	988	3		
	626	60° 28' S, 29° 20' W	17 May 1963	1647	1	Ovigerous female	
	654	57° 56' S, 27° 38' W	28 May 1963	1812	2	1 with broken rostrum	
	9	670	50° 23' S, 34° 55' W	21 Aug. 1963	1565	2	
		683	55° 13' S, 38° 20' W	25 Aug. 1963	1867	2	
687		55° 24' S, 37° 57' W	26 Aug. 1963	2214	6	1 ovigerous female	
691		56° 25' S, 36° 57' W	27 Aug. 1963	3118	1		
696		56° 53' S, 37° 27' W	28 Aug. 1963	3001	5		
697		56° 59' S, 37° 17' W	28 Aug. 1963	637	6	2 with broken rostrums	
703		58° 51' S, 37° 22' W	31 Aug. 1963	1111	4		
718		56° 55' S, 33° 59' W	6 Sept. 1963	1307	3	2 ovigerous females	
738		53° 12' S, 37° 54' W	13 Sept. 1963	778	2		
10		855	63° 47' S, 79° 00' W	16 Nov. 1963	2288-2745	1	
	859	62° 49' S, 78° 56' W	18 Nov. 1963	824-1052	1		
11	915	65° 54' S, 114° 34' W	13 Jan. 1964	2059	4	Immatures	
	919	68° 15' S, 114° 42' W	16 Jan. 1964	1007-1098	1	Immatures, very battered	
14	1201	56° 14' S, 160° 31' W	8 Aug. 1964	1120	2		
	1214	59° 17' S, 159° 46' W	13 Aug. 1964	2200	13	Mostly subadult	
17	28-69	62° 56' S, 95° 15' W	21 Apr. 1965	3146	1		
22	1587	55° 34' S, 50° 03' W	12 Mar. 1966	1792-1956	1		
	1567	63° 39' S, 101° 59' W	15 Apr. 1966	825-1350	2	1 ovigerous female	
23	1683	60° 16' S, 114° 33' W	3 May 1966	1611-1783	1		
	357	62° 46' S, 128° 12' W	3 Nov. 1966	1750	4	1 ovigerous female	
25	1855	63° 14' S, 177° 41' E	8 Jan. 1967	2081-2784	5	1 ovigerous female	
	1868	70° 57' S, 172° 06' E	13 Jan. 1967	867-1437	13	1 ovigerous female	
27	1936	72° 51' S, 178° 24' E	30 Jan. 1967	913-1080	1		
	1959	65° 11' S, 160° 49' E	7 Feb. 1967	1015-1786	5		
1963	1963	50° S, 158° 22' E	8 Feb. 1967	1786-2114	6		
	1977	54° 13' S, 150° 59' E	20 Feb. 1967	2746-3248	6		
32	2114	73° 19' S, 174° 58' W	10 Feb. 1968	1830	1	Ovigerous female, damaged rostrum	

APPENDIX I (cont.)

Specimens collected by RRS Discovery, 1979

	9961-1	52° S, 29° 00' E	11 Feb. 1979	0-500 OH		
	9961-3	58° 57' S, 28° 58' E	11 Feb. 1979	1000-2000 OH	5	Juveniles and adults
	9962-2	58° 60' S, 26° 08' E	12 Feb. 1979	490-1000	2	
	9963-4	61° 58' S, 26° 11' E	14 Feb. 1979	500-995	1	
	9964-2	64° 20' S, 25° 47' E	15 Feb. 1979	500-995	2	
	9964-3	64° 22' S, 25° 50' E	16 Feb. 1979	510-995	1	
	9965-2	66° 53' S, 25° 55' E	16 Feb. 1979	510-995	1	
17	28-69	62° 56' S, 95° 15' W	21 Apr. 1965	3146	1	
22	1587	55° 34' S, 50° 03' W	12 Mar. 1966	1792-1956	1	
23	1567	63° 39' S, 101° 59' W	15 Apr. 1966	825-1350	2	1 ovigerous female
	1683	60° 16' S, 114° 33' W	3 May 1966	1611-1783	1	
25	357	62° 46' S, 128° 12' W	3 Nov. 1966	1750	4	1 ovigerous female

Specimens collected by RRS John Biscoe, 1980-83

BAS Offshore Biological Programme Cruise JB02		56° 52' S, 45° 53' W	13 Feb. 1980	200	1	Immature
		53° 63' S, 35° 33' W	14 Apr. 1980	980-1500	2	
BAS Offshore Biological Programme Cruise JB03	64	52° 18' S, 38° 01' W	27 Nov. 1981	240-2045	1	
	103	54° 50' S, 40° 45' W	29 Nov. 1981	280-2000	3	1 ovigerous female
	105	54° 58' S, 40° 19' W	29 Nov. 1981	250-2060	1	
	151	52° 29' S, 37° 32' W	1 Dec. 1981	245-2005	2	
	152	52° 31' S, 37° 04' W	2 Dec. 1981	250-1740	3	1 ovigerous female
	188	55° 18' S, 39° 20' W	4 Dec. 1981	250-2005	2	
	191	55° 27' S, 39° 01' W	5 Dec. 1981	255-1700	2	
	228	55° 50' S, 37° 57' W	8 Dec. 1981	250-1900	1	
	230	55° 56' S, 37° 30' W	8 Dec. 1981	230-2120	4	2 ovigerous females
	266	53° 28' S, 34° 40' W	11 Dec. 1981	250-2000	1	
	267	53° 37' S, 34° 18' W	11 Dec. 1981	250-2020	2	
	310	56° 21' S, 36° 30' W	13 Dec. 1981	190-2195	2	
	311	56° 28' S, 36° 10' W	13 Dec. 1981	?-2010	8	2 ovigerous females
	353	53° 58' S, 33° 14' W	16 Dec. 1981	250-2445	4	
	354	54° 08' S, 32° 42' W	16 Dec. 1981	125-1990	5	1 ovigerous female
	396	56° 47' S, 35° 08' W	19 Dec. 1981	225-2500	2	
BAS Offshore Biological Programme Cruise JB04	25	53° 18' S, 35° 24' W	28 Jul. 1983	30-1000	2	
	96	52° 59' S, 36° 22' W	1 Aug. 1983	525-1000	3	
	118	52° 17' S, 38° 17' W	1 Aug. 1983	500-960	2	
	248	54° 54' S, 40° 49' W	6 Aug. 1983	480-1000	1	Ovigerous female
	265	55° 10' S, 40° 03' W	6 Aug. 1983	500-1000	1	
	471	55° 24' S, 39° 24' W	11 Aug. 1983	540-1005	8	1 ovigerous female
	479	55° 38' S, 38° 41' W	12 Aug. 1983	495-1000	3	
	609	55° 54' S, 37° 58' W	15 Aug. 1983	505-995	2	
	612	56° 57' S, 37° 22' W	16 Aug. 1983	510-1020	1	
	726	53° 16' S, 35° 21' W	29 Aug. 1983	500-1000	4	

Abbreviations (for Appendices I-IV): nd, no data given, OH, recorded oblique haul. Gravid females contain mature (internal) ovaries, ovigerous females are brooding eggs.

APPENDIX II. Details of *Pasiphaea longispina* from the Southern Ocean. Presentation as for Appendix I

<i>Expedition or Cruise</i>	<i>Station no.</i>	<i>Position</i>	<i>Date</i>	<i>Depth (m)</i>	<i>Number of specimens</i>	<i>Remarks</i>
Deutsch Sudpolar Expedition	—	69° 15' S, 80° 19' E	2 Apr. 1903	—	1	From stomach of Emperor penguin: Lenz and Strunk, 1914 (description of <i>Pasiphaea longispina</i>)
<i>Terra Nova</i> (British National Antarctic Expedition)	276	71° 41' S, 166° 47' W	5 Jan. 1913	nd	1	Description suggests possibly not <i>P. longispina</i> ; 2nd specimen taken from albatross stomach, 'further north': Borradaile, 1916
BANZ Antarctic Research Expedition	27	64° 32' S, 75° 55' E	17 Dec. 1929	1000	1	Hale, 1941
	33	66° 30' S, 61° 8' E	5 Jan. 1930	—	1	From stomach of snow petrel
	45	63° 51' S, 54° 16' E	28 Mar. 1930	2000		
	67	45° 53' S, 84° 33' E	7 Mar. 1930	2000	1	
Marion-Dufresne MD.08	98	46° 48' S, 70° 30' E	12 Mar. 1975	nd	1	Ledoyer, 1979
R.V. <i>Hero</i>	—	Croker Passage	Mar.–Apr. 1983	0–1000	2	Hopkins, 1985
AMERIEZ	—	Weddell Sea	Nov. 1983	nd	nd	Ainley and others, 1986

<i>Expedition or cruise</i>	<i>Station no.</i>	<i>Position</i>	<i>Date</i>	<i>Depth (m)</i>	<i>Number of specimens</i>	<i>Remarks</i>	
Scotia (Scottish National Antarctic Expedition)	450	48° 00' S, 9° 50' W	nd	2436	1	Stebbing, 1914 (original description of <i>Pasiphaea rathbunae</i>)	
BANZ Antarctic Research Expedition	n11	44° 11' S, 143° 36' E	17 Mar. 1931	0-1700	1	Hale, 1941	
<i>Specimens taken by USNS Eltanin, 1962-1968</i>							
6	392	57° 38' S, 55° 58' W	27 Dec. 1962	2201-2324	3		
	396	58° 56' S, 56° 00' W	29 Dec. 1962	714-895	nd		
	449	60° 12' S, 59° 00' W	15 Jan. 1963	1610	1		
8	580	57° 23' S, 23° 11' W	21 Apr. 1963	3074	1		
	9	683	55° 13' S, 38° 20' W	25 Aug. 1963	1867	1	
9	691	56° 25' S, 36° 57' W	27 Aug. 1963	3118	1		
	696	56° 53' S, 37° 87' W	28 Aug. 1963	3001	1		
	701	58° 05' S, 37° 44' W	30 Aug. 1963	2086	1	Ovigerous female	
	10	835	62° 04' S, 75° 18' W	5 Nov. 1963	915	1	Ovigerous female
	14	1204	55° 57' S, 159° 23' W	10 Aug. 1964	930-1080	1	Ovigerous female
15	1362	57° 06' S, 139° 20' W	12 Nov. 1964	2306-2416	1		
23	1684	59° 07' S, 114° 59' W	5 May 1966	300-425	2	1 ovigerous female	
<i>Specimens taken by RRS John Biscoe, 1981-1983</i>							
BAS offshore	103	54° 50' S, 40° 45' W	29 Nov. 1981	280-2000	1		
Biological Programme JB03	105	57° 58' S, 40° 19' W	29 Nov. 1981	250-2060	1		
	191	55° 27' S, 39° 01' W	5 Dec. 1981	255-1700	2		
	228	55° 50' S, 37° 57' W	8 Dec. 1981	250-1900	1		
	230	55° 56' S, 37° 30' W	8 Dec. 1981	230-2120	2		
	266	53° 37' S, 34° 18' W	11 Dec. 1981	250-2020	2		
	310	56° 20' S, 36° 30' W	13 Dec. 1981	190-2195	1		
	311	56° 28' S, 36° 10' W	13 Dec. 1981	2010	3		
	353	53° 57' S, 33° 14' W	16 Dec. 1981	250-2445	2		
	354	54° 08' S, 32° 43' W	16 Dec. 1981	125-1990	2		
	396	56° 47' S, 35° 08' W	19 Dec. 1981	225-2500	1		
	BAS Offshore	25	53° 18' S, 35° 25' W	28 Jul. 1983	30-1000	1	
	Biological Programme JB04	96	52° 59' S, 36° 22' W	1 Aug. 1983	525-1000	3	1 ovigerous female
		360	52° 30' S, 37° 33' W	8 Aug. 1983	495-920	2	
609		55° 54' S, 37° 58' W	15 Aug. 1983	505-995	1		
612		56° 57' S, 37° 22' W	16 Aug. 1983	510-1020	1		
726		53° 16' S, 35° 21' W	20 Aug. 1983	500-1000	2		

APPENDIX IV. Sampling details for *Pasiphaea* species other than *P. scotiae*, *P. longispina* or *P. rathbunae* in the Southern Ocean

<i>Cruise</i>	<i>Station no.</i>	<i>Position</i>	<i>Date</i>	<i>Depth (m)</i>	<i>Number of specimens</i>	<i>Remarks</i>
<i>Pasiphaea grandicula</i> (data from Burukovskii, 1976)						
		50° 02' S, 03° 38' W	11 Oct. 1974	20-140	7	Males
		51° 13' S, 02° 01' E	18 Oct. 1974	800	2	Ovigerous females
<i>Specimens taken by USNS Eltanin</i>						
14	1204	55° 57' S, 159° 23' W	10 Aug. 1964	930-1080	1	With 2 smaller specimens, together, with 29 immature pasiphaeids
24	1728	44° 54' S, 145° 20' W	21 Jul. 1966	385	2	
25	341	50° 12' S, 104° 50' W	19 Oct. 1966	561	1	
<i>Specimens taken by R.V. Professor Bugucki</i> (data from Koronkiewicz, 1979)						
		54° S, 35° W	15 Apr. 1977	800	8	All females