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Kingdom Animalia, phylum Priapulida

priapulid worms

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CHAPTER 32

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32 Kingdom Animalia, phylum Priapulida (priapulid worms)

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Summary

Our knowledge of the Aotearoa New Zealand Priapulida fauna is fragmentary. Only three species, *Priapulopsis australis* (de Guerne, 1886), *Priapulus tuberculatospinosus* Baird, 1868 and one undescribed species of *Priapulopsis* have been confirmed from New Zealand (Table 32.1; Fig. 32.1). New Zealand records of two further species, (*Priapulus abyssorum* Menzies, 1959 and *Acanthopriapulus horridus* (Théel, 1911)) are doubtful, and have now been deleted from the New Zealand record (Table 32.2). A checklist of extant New Zealand Priapulida is provided.

Introduction

Phylum Priapulida includes only 2 extant species (plus one questionable species and including one species currently in description; see below), but these have a wide distribution in marine sediments in oceans worldwide (Fig. 32.1). Some genera are microscopically small (only a few millimetres long); these occur mainly in tropical and subtropical regions and rarely in temperate waters. Macroscopic priapulids are in the centimetre range (Fig. 32.1A, B) and can be up to 40 cm long. They occur mainly in temperate and polar regions. The macroscopic species usually live in fine-grained sediments. They burrow through the sediment by eversion and withdrawal of the anterior body region, which is called an introvert (Fig. 32.1A, B). The introvert is covered with 25 longitudinal rows of small cuticular hooks, called scalids. Each of these scalids contains receptor cells, which open under the tip of the scalid. Species in the genera *Priapulus*, *Priapulopsis* and *Acanthopriapulus* have a caudal appendage (Fig. 32.1A–C). In *Acanthopriapulus* this is a segmented, muscular, spiny structure (Fig. 32.1C), but in *Priapulus* and *Priapulopsis*, the single (*Priapulus*) or paired (*Priapulopsis*) (Fig. 32.1B) appendage carries numerous thin-walled vesicles that likely support the uptake of oxygen. Reviews of Priapulida are given by Van der Land (1970), Adrianov & Malakhov (1996) and Schmidt-Rhaesa (2013, 2020).

The macroscopic priapulids are predators that feed on other marine organisms. The anterior part of their intestinal tract, the pharynx, is equipped with strong cuticular teeth that are arranged in several rings with five teeth per ring (Fig. 32.1D). The anterior part of the pharynx with the first rings of teeth can be everted (when the introvert is fully everted) and the teeth then spread wide open. When the pharynx and introvert are withdrawn, the teeth grasp their prey and pull it into the pharynx. The meiobenthic priapulids have pharyngeal teeth with comb-like spines, which are used to scrape algae and bacteria from sand grains (Schmidt-Rhaesa 2020).

Priapulids are dioecious. The macroscopic species release their gametes into the water, where fertilisation takes place. Embryogenesis takes place within the sediment, pelagic larvae are not present. Smaller, meiobenthic species have internal fertilisation. With one viviparous exception, priapulids develop through a series of stages by molting. Larvae, composed of trunk and introvert, with few scalids, hatch from the eggs, but this early larva is known only from two species. Characteristic for priapulids is the next larval stage, in which the cuticle forms several thick plates. These plates form a solid case called a lorica. In larvae of macroscopic priapulids, the lorica is composed of large dorsal and ventral plates, as well as six smaller lateral plates, which are connected by a flexible, thinner cuticle. This allows volume changes, which are needed to accommodate the withdrawn introvert. Loricate larvae are known from most species, but a complete series, which documents changes in size and structure, is not known from any species. At a certain size larvae lose their lorica and become postlarval stages. These resemble the adults, but several structures develop gradually, as has been recently shown in the North Atlantic species *Priapulopsis bicaudatus* (Schmidt-Rhaesa & Raeker 2022). The number of postlarval stages is unknown.

Little is known about the ecology of priapulids. Some species are found in regions with low oxygen

Table 32.1. Summary of Priapulida diversity in the Aotearoa New Zealand region expressed as total numbers and percentage change. Data for 2010 are derived from Van der Land (2010: p. 477). OTU = Operational Taxonomic Unit.

	Priapulida		% change
	2010	2023	
Total species diversity	4	3	–25
Described extant species	3	2	–33
Undescribed extant species (OTU)	1	1	0
Described endemic extant genera	0	0	0
Described endemic extant species	0	1	100

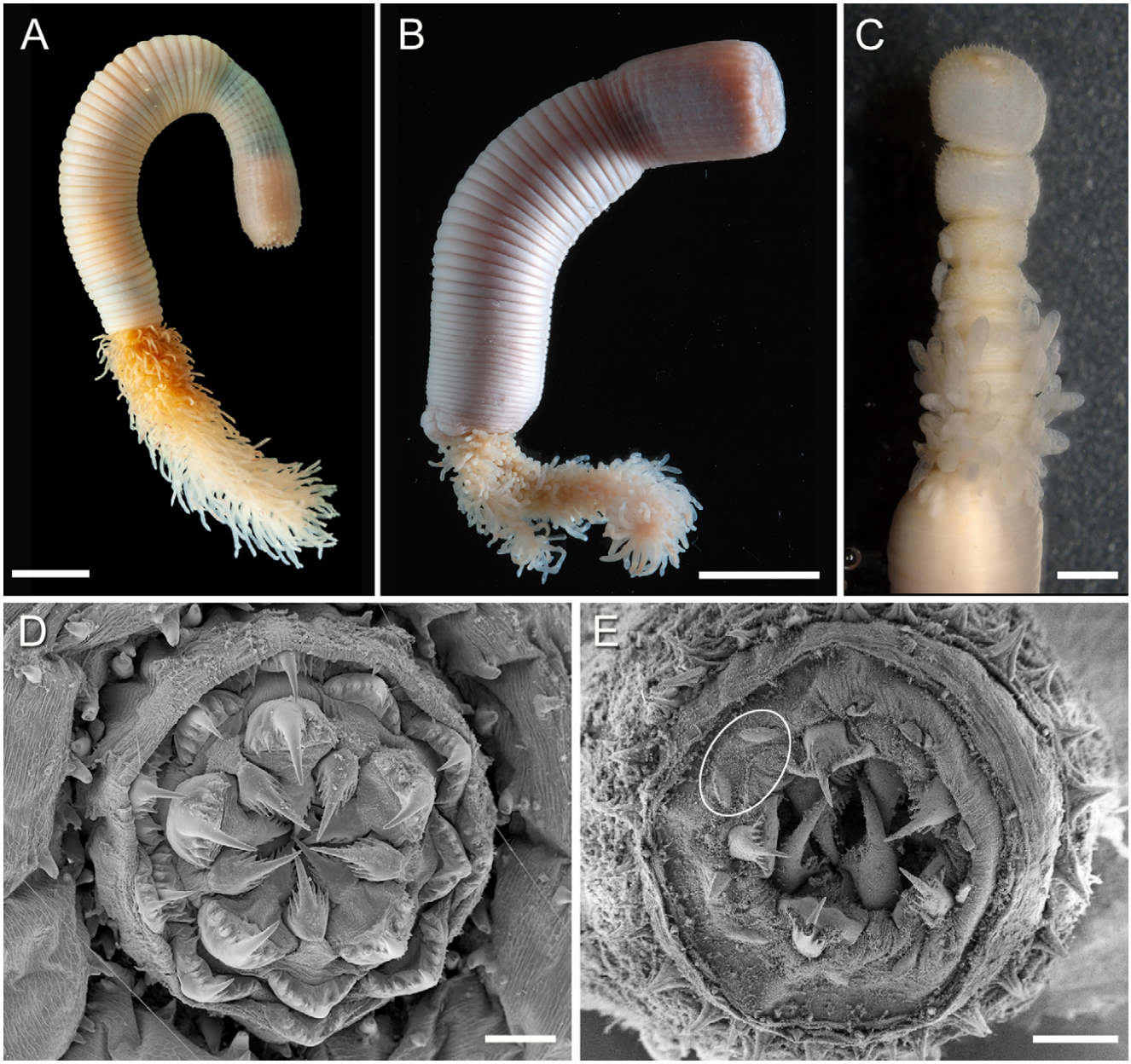

Figure 32.1. Phylum Priapulida, a selection of images showing morphology and various species: **A.** A previously unrecorded specimen with what looks like a single, caudal appendage, the fluffy mass of thin-walled vesicles, collected from muddy sand at 52 m water depth, on 24 November 2020, 5 km north of Cape Rodney, Leigh, Northland, New Zealand, scale = 5 mm; **B.** *Priapulopsis australis* (de Guerne, 1886) with paired caudal appendage, collected from mud at 41 m water depth, on 28 August 1995, from Omaha Bay, Northland, New Zealand, scale = 10 mm; **C.** Caudal appendage of *Acanthopriapulus horridus* (Théel, 1911) from Chile, scale = 1 mm; **D.** Frontal view of a macroscopic priapulid (Northern Hemisphere species *Priapulus caudatus* Lamarck, 1816) with pharyngeal teeth arranged in rings of five teeth around the central mouth opening. The peri-pheral papillar structures are scalids, scale = 100 µm; **E.** Mouth opening of a young adult of *Priapulopsis bicaudatus* (Danielssen, 1869) from the Northern Atlantic showing the small paired teeth of the first ring (circle), scale = 500 µm. Images in A & B by Richard Taylor and reproduced with permission. Image B reproduced from the figure of *Priapulopsis australis* in Van Der Land (2010: 476), taken by Richard Taylor, reproduced with permission by Canterbury University Press, Christchurch, New Zealand.

Table 32.2. Extant species deleted from the New Zealand record. Species cited in Van der Land (2010) that are no longer considered to be valid for the New Zealand region, because they were added in error (as a historical mistake) or because their global taxonomic distribution has been updated, or they require renaming. All are deleted from the New Zealand record.

Taxon name cited in Van der Land (2010)	Reason
Priapulus abyssorum Menzies, 1959	Murina & Starobogativ (1961) identified a postlarval specimen from Hikurangi Trench as *Priapulus abyssorum*, but Van der Land (2010) noted that the specimen lacked any characters that clearly identified it to species level. This record in Van der Land (2010) is considered to be unidentified and thus unreliable.
Acanthopriapulus horridus (Théel, 1911)	The image published in Adrianov & Malakhov (1996) of a specimen identified as *A. horridus*, from the Bay of Plenty, does not correspond to the published descriptions of this species and thus remains a doubtful record until identification can be confirmed.

content. Priapulids are rarely found in the intertidal, but more regularly on the shelf and in deeper waters.

Priapulids are closely related to the taxa Kinorhyncha and Loricifera, Chapters 30 and 31 in this volume, respectively, with which they share the introvert with scalids. The common taxon group is named Scalidophora and is part of Ecdysozoa, the molting animals. There is a rich fossil record of priapulid-like species, but on closer examination only a few of them can be considered as crown-group priapulids. Others may belong to early members of the scalidophoran lineage or even be ecdysozoan ancestors.

The majority of the recently known priapulid species are meiofaunal or very small species in the genera *Meiopriapulus* (one species), *Maccabeus* (two species) and *Tubiluchus* (10 species). Four genera belong to the macroscopic priapulids, *Halicryptus* (two species), *Acanthopriapulus* (one species), *Priapulus* (three species) and *Priapulopsis* (two species). The two latter genera have interesting "bipolar" distributions. Both have two species with broad distributions, one of which occurs in the Northern Hemisphere and one in the Southern Hemisphere. *Priapulus caudatus* Lamarck, 1816 and *Priapulopsis bicaudatus* (Danielssen, 1869) are the Northern Hemisphere species; *Priapulus tuberculatospinosus* Baird, 1868 and *Priapulopsis australis* (De Guerne, 1886) are the Southern Hemisphere species.

Status of New Zealand Priapulida

New Zealand species of priapulids are still largely unknown. Little has changed since Van der Land´s review in 2010, although the record is reviewed critically in this chapter. Van der Land (2010) reported three species to be present in New Zealand. One species, *Priapulopsis australis*, is common (Fig. 32.1B), while the presence of the other two is questionable (Table 32.1).

Priapulopsis australis is the only identified New Zealand species in the NIWA Invertebrate Collection in Wellington. Specimens of this species are up to 6 cm long, although it is not known whether this includes the appendage. Some morphological details were published by Van der Land (1970) and in the only SEM investigation by Storch *et al.* (1985). Two characters are important to distinguish *P. australis* from other priapulids. It has a paired caudal appendage and each pharyngeal tooth in the first ring is divided into two (Fig. 32.1E). Both are characters shared with *P. bicaudatus* from the Northern Hemisphere, but are unique for priapulids from the Southern Hemisphere. Van der Land (2010) noted that the two caudal appendages might easily clump together or are lost during development. Schmidt-Rhaesa & Raeker (2022) showed that in *P. bicaudatus* the appendages develop asynchronously, therefore only one appendage may be present in early postlarval stages. Consequently, the lack of paired appendages may be due to an early developmental stage rather than to a loss of one appendage. Van der Land (2010) did not mention the most characteristic feature of the genus *Priapulopsis*: the division of the first-ring pharyngeal teeth (see Storch *et al.* 1995). When the introvert is everted, it is often possible to observe the first rings of pharyngeal teeth. When 10 teeth are present in the first ring, the specimen belongs to *Priapulopsis* (Fig 32.1E). In *P. bicaudatus* it was demonstrated that this separation occurs gradually during postlarval development, but the bipartition is indicated already in larvae (Schmidt-Rhaesa & Raeker 2022).

The larva of *P. australis* was described by Adrianov & Malakhov (1996), likely from material collected in New Zealand. It has a characteristic sculpture on the dorsal and ventral plates, in which ridges form a median zig-zag line. This pattern was confirmed by specimens from the Antarctic (Schmidt-Rhaesa & Freese 2019). All in all, a more detailed description of *P. australis* and its different life stages is greatly desired.

Priapulopsis australis was reported from the southern regions of South America, Africa, the Antarctic Peninsula, and New Zealand. The first New Zealand record comes from Hurley (1962), from Hawke Bay in 53–58 m water depth. Estcourt (1967) reported the species from Marlborough Sounds, in particular Pelorus Sound. Storch *et al.* (1995) collected specimens in Pāuatahanui Inlet, Te Awarua-o-Porirua Harbour, Wellington, in 3 m water depth. Adrianov & Malakhov (1996) collected specimens without giving exact locations. Van der Land (2010) added a figure of National Institute of Water and Atmospheric Research (NIWA) distribution records, ranging in water depths between 2 and 1190 m. Additionally, he reported a specimen from 1195 m water depth from c. 38° S, 178° W. Finally, there are two early records under different species names, which are assumed also to be *P. australis*; these are Benham (1932) from 15 m water depth at Islington Bay, Waitematā Harbour, Auckland (as *Priapulus tuberculatospinosus*) and Dell (1955) from Hicks Bay (185 m) and Cape Campbell, Cook Strait (73 m) (as *Priapulus caudatus tuberculatospinosus*).

One specimen from Hikurangi Trench, east of Cape Palliser was assigned to *Priapulus abyssorum* Menzies, 1959 (as *P. tuberculatospinosus abyssorum* in Murina & Starobogatov 1961). Apart from the question as to whether deep-sea priapulids belong to one or several species (Van der Land 1972, 2010), the specimen from New Zealand is a postlarval specimen, which does not show, according to Van der Land (2010), any character that makes it possible to identify it to species level. Therefore, the postlarval specimen from Hikurangi Trench should be regarded as an unidentified specimen.

Acanthopriapulus horridus (Théel, 1911) is a very rare priapulid species. It is characterised and easily recognised by a strongly muscular caudal appendage, which is segmented and covered by strong spines (Fig. 32.1). Only six specimens have been reported from a region between Southern Brazil and the Magellan Strait (Schmidt-Rhaesa *et al.* 2022) and a single additional

specimen reported from New Zealand (Adrianov & Malakhov 1996). It was collected in 120 m depth in the Bay of Plenty. The only published image in Adrianov & Malakhov (1996) does not correspond to the published descriptions of this species. Van der Land (2010) cites an oral confirmation on the identification of this species by one of the authors (Malakhov), but until the specimen is documented in a more convincing way, the occurrence of *A. horridus* in New Zealand has to be regarded as doubtful.

A review of the New Zealand species of Priapulida is currently in preparation (Schmidt-Rhaesa & Raeker, in prep.). In this contribution, *Priapulus tuberculatospinosus* is shown to be present in New Zealand waters. Additionally, a new species of *Priapulopsis* is described. The external morphology of the three New Zealand species is described by light microscopy and scanning electron microscopy. The results are expected to be published in 2024.

Knowledge gaps, research progress and future priorities

A more detailed investigation of New Zealand priapulids would be rewarding and is underway (Schmidt-Rhaesa & Raeker, in prep.). The life cycle, especially the post-larval stages, could be documented in better detail. The possible presence of *Acanthopriapulus horridus* and *Priapulus abyssorum* should be confirmed by further specimens. In addition to the macroscopic species, meiofauna research can still be intensified around New Zealand. Although having their main distribution in tropical and subtropical areas, the occurrence of meio-benthic priapulids in New Zealand (genera *Tubiluchus* and *Meiopriapulus*) is not excluded.

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References

References to the taxonomic authorities and dates for priapulid taxa in this chapter and the associated checklist can be located in World Register of Marine Species (WoRMS) (https://www.marinespecies.org/).

Adrianov, A.V., Malakhov, V.V. (1996) *Priapulida: Structure, development, phylogeny, and classification*. KMK Scientific Press, Moscow, 266 pp. [In Russian with English summary]

Benham, W.B. (1932) *Priapulus caudatus* in New Zealand waters. *Nature* 130: 890.

Dell, R.K. (1955) The occurrence of *Priapulus* in New Zealand waters. *Transactions of the Royal Society of New Zealand* 82: 1129–1133. https://doi.org/10.1038/130890a0

Estcourt, I.N. (1967) Distributions and associations of benthic invertebrates in a sheltered water soft-bottom environment (Marlborough Sounds, New Zealand). *New Zealand Journal of Marine and Freshwater Research* 1: 352–370. https://doi.org/10.1080/00288330.1967.9515211

Hurley, D.E. (1962) A second species of *Priapulus* from New Zealand waters. *New Zealand Journal of Science* 5: 13–16.

Murina, V.V., Starobogatov, J.I. (1961) [Classification and zoogeography of Priapuloidea]. *Trudy Instituta Okeanologii* 46: 178–200. [In Russian]

Schmidt-Rhaesa, A. (2013) Priapulida. Pp. 147–180 *in*: Schmidt-Rhaesa, A. (Ed.) *Handbook of Zoology: Nematomorpha, Priapulida, Kinorhyncha and Loricifera*, Volume 1. Walter de Gruyter, Berlin, 381 pp. https://doi.org/10.1515/9783110272536.147

Schmidt-Rhaesa, A. (2020) Priapulida. Pp. 387–390 *in*: Schmidt-Rhaesa, A. (Ed.) *Guide to the Identification of Marine Meiofauna*. Verlag Dr. Friedrich Pfeil, Munich, 607 pp.

Schmidt-Rhaesa, A., Canete, J.I., Mutschke, E. (2022) New record and first description including SEM and µCT of the rare priapulid *Acanthopriapulus horridus* (Priapulida, Scalidophora). *Zoologischer Anzeiger* 298: 1–9. https://doi.org/10.1016/j.jcz.2022.03.001

Schmidt-Rhaesa, A., Freese, M. (2019) Microscopic priapulid larvae from Antarctica. *Zoologischer Anzeiger* 282: 3–9. https://doi.org/10.1016/j.jcz.2019.06.001

Schmidt-Rhaesa, A., Raeker, J. (2022) Morphology of larval and postlarval stages of *Priapulopsis bicaudatus* (Danielssen, 1869) (Priapulida) from the North Atlantic Ocean. *Zoologischer Anzeiger* 302: 1–16. https://doi.org/10.1016/j.jcz.2022.11.006

Schmidt-Rhaesa, A., Raeker, J. (in press) Review of the Priapulida of New Zealand with the description of a new species. *New Zealand Journal of Zoology*.

Storch, V., Higgins, R.P., Anderson, P., Svavarsson, J. (1995) Scanning and transmission electron microscopic analyses of the introvert of *Priapulopsis australis* and *Priapulopsis bicaudatus* (Priapulida). *Invertebrate Biology* 114: 64–72. https://doi.org/10.2307/3226954

Van der Land, J. (1970) Systematics, geography, and ecology of the Priapulida. *Zoologische Verhandelingen, Leiden* 112: 1–118.

Van der Land, J. (1972) *Priapulus* from the deep sea. *Zoologische Mededelingen, Leiden* 47: 358–368.

Van der Land, J. (2010) Chapter 12. Phylum Priapulida, penis worms. Pp. 476–479 *in*: Gordon, D.P. (Ed.) *New Zealand Inventory of Biodiversity*: *Volume 2. Kingdom Animalia, Chaetognatha, Ecdysozoa, Ichnofossils.* Canterbury University Press, Christchurch, 528 pp.

Checklist of extant Priapulida known from the New Zealand EEZ

The checklist is arranged according to the currently accepted systematics and classificatory scheme, employed by the World Register of Marine Species, Priapulida (https://www.marinespecies.org/aphia.php?p=taxdetails&id=101063).

Phylum PRIAPULIDA
Order PRIAPULOMORPHA
Family PRIAPULIDAE
Priapulopsis australis (de Guerne, 1886)
Priapulopsis sp. nov.
Priapulus tuberculatospinosus Baird, 1868

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