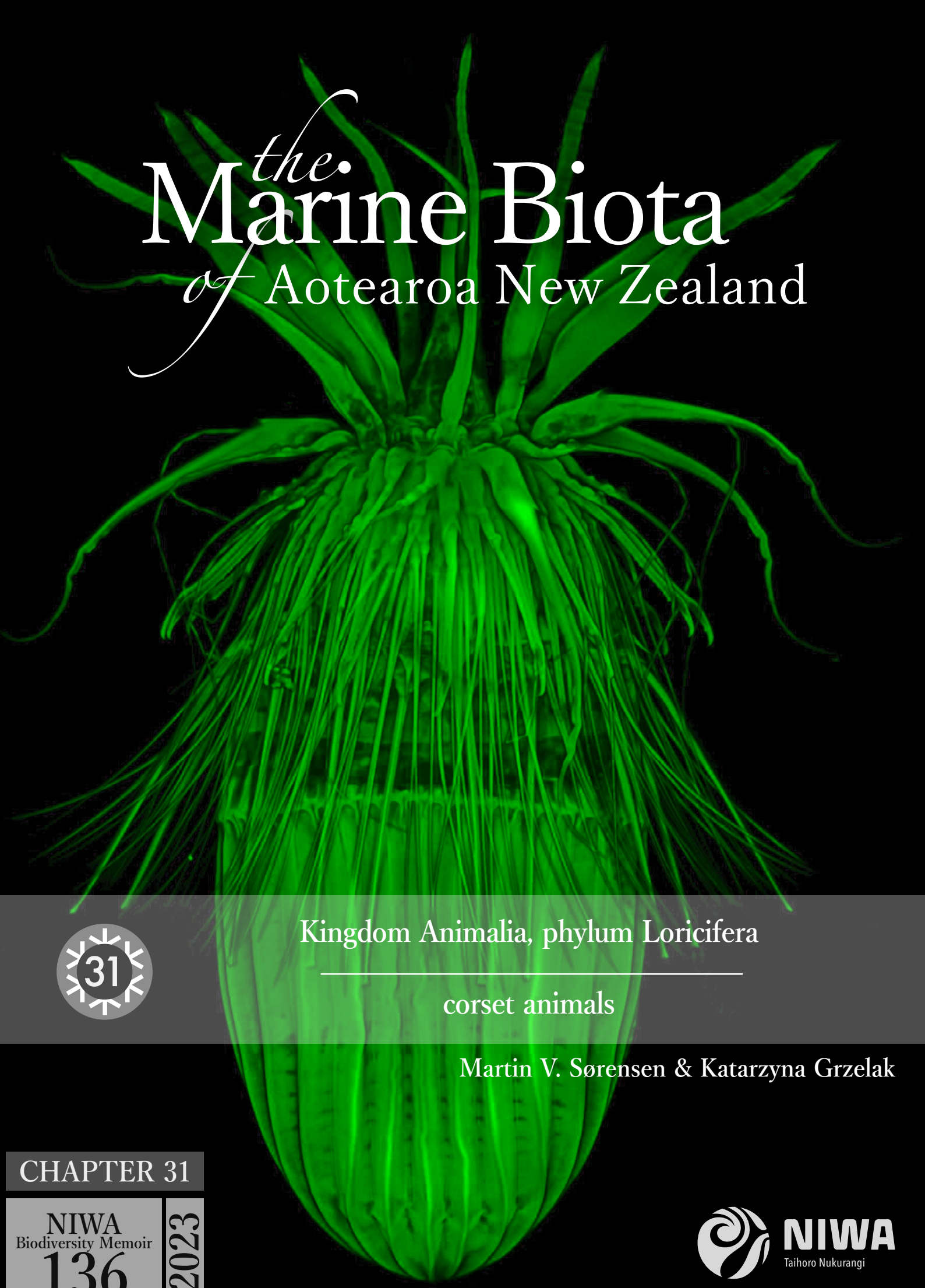
the Marine Biota of Aotearoa New Zealand



31

Kingdom Animalia, phylum Loricifera

corset animals

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CHAPTER 31

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Kingdom Animalia, phylum Loricifera (corset animals)

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Summary

Prior to 2022, no loriciferans had been collected and identified to species from the Aotearoa New Zealand region (Table 31.1). The group was first reviewed for New Zealand by Heiner & Neuhaus (2010); at that time, only a few records of unidentified species were known. However, in June 2022 the first two New Zealand loriciferans, *Pliciloricus apteryx* Sørensen, Grzelak, Kristensen & Herranz, 2022 and *Patuloricus tangaroa* Sørensen, Grzelak, Kristensen & Herranz, 2022, were described from the Bay of Plenty, North Island (Sørensen *et al.* 2022) (Fig. 31.1). The two species represent 4% of the global total for phylum Loricifera. A checklist of New Zealand Loricifera is provided.

Introduction

Loriciferans are marine, meiobenthic animals, with body sizes between 100 to 800 µm (Fig. 31.1). The first loriciferan specimens were collected in the 1970s in Denmark and off the east coast of the USA, being formally described in 1983; the loriciferans are one of the most recently discovered animal phyla (Kristensen 1983). They are moulting animals, and thus belong to the diverse clade Ecdysozoa. Their closest relatives are kinorhynchs (see chapter 30 in this volume) and priapulids, and together the three phyla form the group Scalidophora (Howard *et al.* 2022). Anatomically, the loriciferan body is divided into a head, a neck, a thorax, and an abdomen (Kristensen 1983; Bang-Berthelsen *et al.* 2013). The head is divided into a cylindrical mouth cone with a terminal mouth, and an introvert equipped with numerous radially arranged cuticular appendages, the so-called scalids. The short neck region behind the head is equipped with three rings of small plates, and the posterior-most ring of plates carries special scalids called trichoscalids. Head and neck can be retracted into the loricated trunk. The thoracial region of the trunk has accordion-like folds, which gives the thorax the required flexibility when the head and neck are retracted. The abdomen is completely covered by the prominent lorica that characterises all loriciferans. In species of the family Nanaloricidae, the lorica is composed of large plates with anterior spikes, while the lorica in family Pliciloricidae is made up by numerous smaller plates or elongated folds.

Loriciferans have been collected from most depths and most kinds of sediments, but they seem to prefer deeper waters and coarser or mixed sediments. From fine sediments, they are most easily extracted through centrifugation methods, whereas specimens from clean, coarse segments can be extracted with freshwater shocking. The recently published meiofauna guide chapter by Fujimoto & Kristensen (2020) offers identification to genus level, whereas the slightly older key by Neves *et al.* (2016) provides identification to species level for the 36 species known up to 2016.

By end-2023, the phylum Loricifera accommodated 46 described extant species, distributed in 16 genera, globally. The most recent overview of loriciferan diversity is presented by Neves *et al.* (2016) but note that five additional genera have been described since then, including a new genus from the Bay of Plenty, New Zealand (Fujimoto & Murakami 2020; Fujimoto *et al.* 2020; Neves *et al.* 2021; Sørensen *et al.* 2022, 2023). Following the recent phylogenetic analysis of Sørensen *et al.* (2023), Loricifera is split into two families: Nanaloricidae and Pliciloricidae, each accommodating eight genera. The latter genus includes the enigmatic genera *Tenuiloricus* and *Patuloricus*, so far only represented by Shira larvae. A Shira larva is a highly aberrant Higgins larva, with a large bulbous head, accordion-like thorax, and a short and slender abdomen (Fig. 31.1A). Adults from Shira larvae have so far never been found.

Some loriciferans are known to have extremely complex life cycles. The simplest life cycles are found among nanaloricids (e.g., *Nanaloricus mysticus*

Table 31.1. Summary of Loricifera diversity in the Aotearoa New Zealand region expressed as total numbers and percentage change. Data for 2010 are derived from Heiner & Neuhaus (2010: p. 474). OTU = Operational Taxonomic Unit.

	Loricifera		% change
	2010	2022	
Total species diversity	4	3	–25
Described extant species	0	2	n/a
Undescribed extant species (OTU)	4	1*	–75
Described endemic genera	0	1	n/a
Described endemic species	0	2	n/a

*Heiner & Neuhaus (2010) report four undescribed species in their checklist. Three of these were collected beyond the New Zealand EEZ and Extended Continental Shelf and have thus been deleted from the New Zealand record. Only a single, undescribed species is now retained in the checklist.

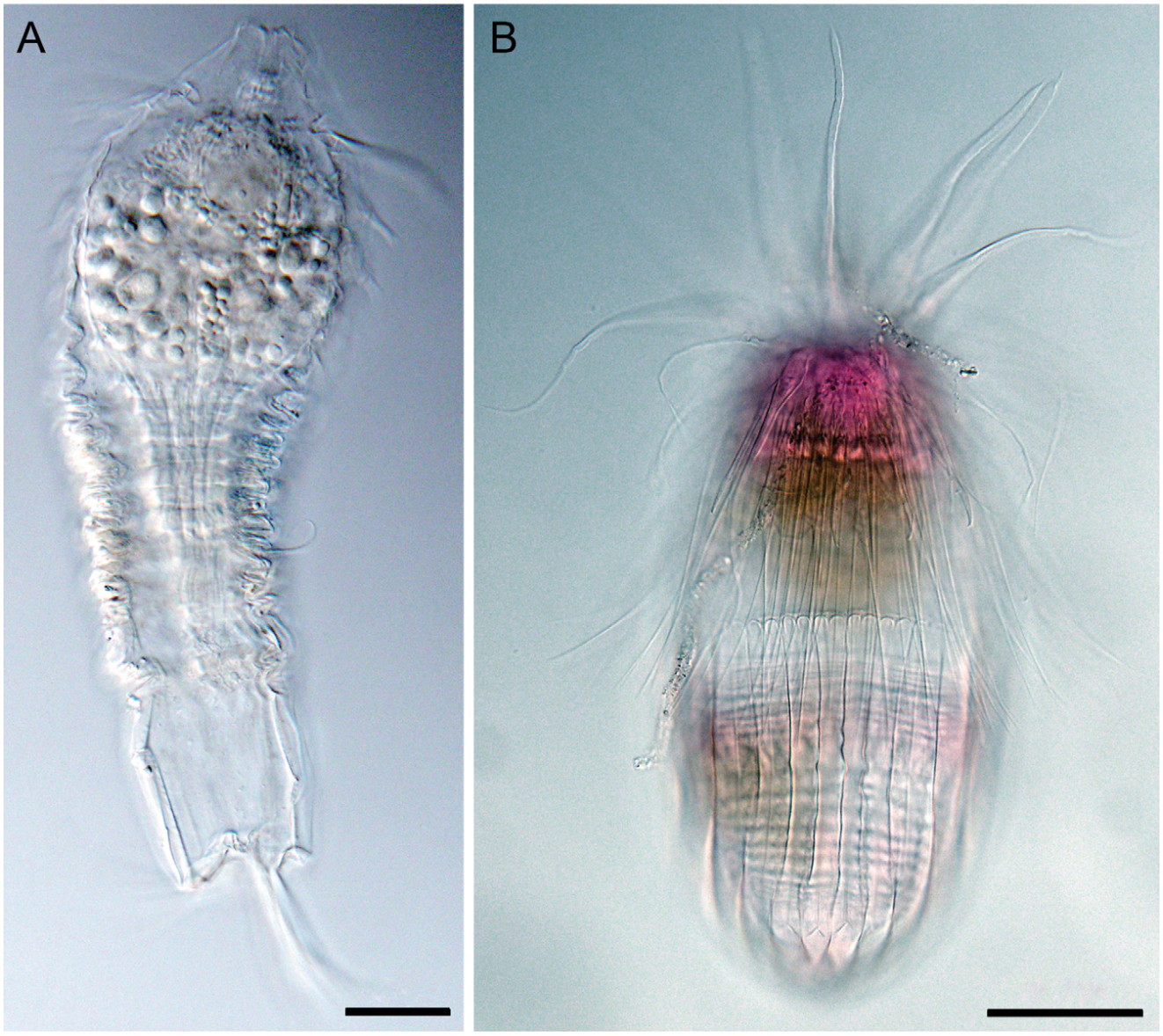

Figure 31.1. Loricifera from the outer Bay of Plenty, North Island, New Zealand (NIWA voyage TAN1206): **A.** Shira larva of *Patuloricus tangaroa* Sørensen *et al.*, 2022; **B.** Adult *Pliciloricus apteryx* Sørensen *et al.*, 2022. Reproduced with permission from the authors.

Kristensen, 1983), which are always dioecious, and after mating, the fertilised egg will hatch into a Higgins larva. The Higgins larva resembles the adult, but is easily distinguished by its two, caudal paddle-like toes. The larva will develop towards adult morphology through several stages, and switch between the stages by shedding its cuticle. When reaching the final stage, it becomes a postlarva. The postlarva has lost the toes and resembles an adult without reproductive organs. After an additional moult, the postlarva becomes a sexually mature adult (Kristensen 1991). The pliciloricid life cycle is, in certain cases, much more complex. Most of the pliciloricid species are also considered to be dioecious, although a few examples of hermaphroditism do exist (e.g., *Rugiloricus renaudae* Kristensen *et al.* 2013). The pliciloricids have a part of their sexual cycle resembling that of nanaloricids. This cycle also includes a Higgins larva that may moult into a postlarva, and subsequently into an adult, which closes the sexual cycle. However, as described from *Rugiloricus bacatus* Heiner, 2008, the Higgins larva may also choose a different path (Heiner 2008). Instead of becoming a postlarva it may enter a paedogenetic cycle, i.e., a cycle where the larva becomes the reproductive stage, and form a so-called ghost larva. The ghost larva has very few external characteristics, and no internal organs, besides an ovary. This ovary will form new, parthenogenetic Higgins larvae, which will develop through moulting, and finally become a postlarva that re-enters the sexual cycle. A third group of loriciferans, the urnaloricids, appear to have lost their sexual cycle completely, and reproduce exclusively through parthenogenetic Higgins larvae that develop inside a megalarva (Heiner & Kristensen 2009). For the genera *Tenuiloricus*, *Scaberiloricus* and *Patuloricus*, sexually mature adults have so far never been found, which makes it difficult to make any predictions about their reproductive cycles (Neves & Kristensen 2014; Sørensen *et al.* 2022, 2023).

Table 31.2. Extant species deleted from the New Zealand record. Species cited in Heiner & Neuhaus (2010) that are no longer considered be valid for the New Zealand region. Whilst Heiner & Neuhaus (2010) constitutes the first formal confirmation of loriciferans in the New Zealand region, none of the specimens were identified further as they were never recovered from their tubes after initial sorting and are of little future value. These are hereby deleted from the New Zealand record.

Taxon name in Heiner & Neuhaus (2010)	Reason
Rugiloricus nov. sp. 2	Collected outside the New Zealand EEZ and Extended Continental Shelf
Pliciloricus nov. sp.	Collected outside the New Zealand EEZ and Extended Continental Shelf
gen. et sp. indet. Heiner & Neuhaus	Collected outside the New Zealand EEZ and Extended Continental Shelf

Table 31.3. Revised extant species in the New Zealand record. Species cited in Heiner & Neuhaus (2010) that have been revised taxonomically, had their spelling updated, had nomenclatural changes and updates. Updates follow the World Register of Marine Species (WoRMS) (https://www.marinespecies.org/).

Taxon name in Heiner & Neuhaus (2010)	Revised name in checklist	Comment & reference
Rugiloricus nov. sp. 1	*Rugiloricus* sp. nov. 1 (Chatham Rise)	This chapter

Considering their minute size, and the relatively low abundance of extant Loricifera, it might sound surprising that they are represented in the fossil record, but there are several well-documented examples of Cambrian loriciferans. Peel (2010) described the extinct genus *Sirilorica*, which has lorica sizes reaching 70 mm, suggesting that loriciferans could have evolved from a macroscopic ancestor (Peel *et al.* 2013). However, this suggestion was challenged by the finding of another Cambrian loriciferan, *Eolorica deadwoodensis* Harvey & Butterfield, 2017 that only measures 300 µm in total length (Harvey & Butterfield 2017).

Knowledge gaps, research progress and future priorities

Until very recently, the Loricifera fauna of New Zealand was essentially unexplored. In the previous summary on the New Zealand fauna, Heiner & Neuhaus (2010) report the existence of four undescribed species. However, three of these were collected outside the New Zealand region; thus, strictly speaking, there is only a single species known: *Rugiloricus* sp. nov. (1 of Heiner & Neuhaus 2010, Chatham Rise), from the northern slope of Chatham Rise (Heiner & Neuhaus 2010 (Tables 31.1–31.3). The only loriciferans collected since 2010 are from a meiofaunal survey in the outer Bay of Plenty (National Institute of Water and Atmospheric Research (NIWA) voyage TAN1206; Rosli *et al.* 2016). Loriciferans from this study were passed subsequently to the authors of the present chapter and are now formally described. The specimens include a Shira larva that represents the new genus and species *Patuloricus tangaroa* (Fig. 31.1A), and the new species of *Pliciloricus apteryx* (Fig. 31.1B), represented by two adults and three Higgins larvae.

Because our knowledge of the New Zealand loriciferan fauna is so limited, and the New Zealand region nearly unexplored, it is difficult to make any biodiversity estimates or point out areas of particular interest. However, since loriciferans are known to exist in the Bay of Plenty and on the Chatham Rise, these would be logical locations to initiate a deeper exploration. Based on the limited information that is currently available (Heiner & Neuhaus 2010; Rosli *et al.* 2016; and the present chapter), we expect these areas to reveal at least four to five loriciferan species, and further exploration of other areas could potentially bring the number of species closer to about twelve.

Acknowledgements

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

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Checklist of extant Loricifera known from the New Zealand EEZ

The checklist is arranged according to the currently accepted systematics and classificatory scheme employed in the World Register of Marine Species (WoRMS) (https://www.marinespecies.org/) and follows Sørensen *et al*. (2022, 2023). Endemic taxa are indicated by 'E'. More than two taxonomic authorities have been abbreviated to 'first author *et al*.' in the checklist.

Phylum LORICIFERA
Family PLICILORICIDAE
Patuloricus tangaroa Sørensen *et al.*, 2022 E
Pliciloricus apteryx Sørensen *et al.*, 2022 E
Rugiloricus sp. nov. 1 (Chatham Rise) Heiner & Neuhaus, 2010 E

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