

An annotated checklist of intertidal reef invertebrates from Marmion and Shoalwater Islands marine parks

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ABSTRACT

An annotated checklist of 71 invertebrate species recorded from intertidal reefs in Marmion and Shoalwater Islands marine parks in the temperate south-west of Western Australia (WA) is presented, with information on their relative prevalence in the reserves and the habitats in which they were found. Most of the species have temperate distributions that extend across southern Australia and few are primarily tropical (at the southern limits of their distribution in the study area) to the study area. Twelve species are endemic to WA. This checklist will assist the development and implementation of long-term intertidal reef monitoring across WA's temperate marine parks.

Keywords: checklist, intertidal, marine protected area, monitoring

INTRODUCTION

The coastal geomorphology of the Perth region comprises sandy beaches and rocky headlands with a complex system of offshore islands, emergent rocks and subtidal reefs formed by eroded limestone (Searle & Semeniuk 1985). The process of erosion has also formed shoreline and offshore intertidal platform reefs that are a distinctive feature of this region (Playford 1988). Shoreline intertidal reefs comprise a relatively flat limestone platform that may be at the shore, backed by a distinctive notched cliff or ramp. Similarly flat intertidal platform reefs that occur as part of reef systems up to 10 km offshore from the mainland in this area may be associated with emergent rocks or lack any permanently exposed feature. The size and structure of intertidal platform reefs vary widely; those at Rottneest Island commonly exceed 50 m in width and are typically larger than those at the adjacent mainland, which are generally less than 20 m wide.

Biological communities associated with intertidal reefs are strongly influenced by physical conditions such as tidal range and exposure to wave action (Hodgkin 1959a). Changes in the algal and invertebrate communities are usually obvious on shoreline reefs that slope upward towards the land, and the drier upper intertidal area is populated by organisms with a higher resistance to desiccation. Offshore intertidal reefs that are comparatively flat generally lack such obvious differences. Intertidal reefs can also be influenced by periodic events like sand burial or prolonged exposure to heat stress at low tide, which may lead to the mortality of organisms and processes of

succession as the reefs are recolonised (Hodgkin 1959b; Kohn 1993).

Intertidal reef research has been carried out in the Perth region since the 1950s, with initial focus on Rottneest and Carnac Islands (Marsh 1955; Hodgkin et al. 1959; Marsh & Hodgkin 1962). Scientific interest in intertidal organisms at Rottneest Island has continued as it provides numerous accessible study sites and the biota is influenced by the Leeuwin Current, as illustrated by the presence of tropical species with different life history traits at the west end of the island (see Black & Johnson 1983; Wells & Walker 1993). Only a few community-level studies have been carried out on intertidal reefs of the mainland coast adjacent to the Perth metropolitan area (Marsh 1955; Wells et al. 1987, 2007), although additional ecological research has examined particular species or functional groups, such as grazers (Wells & Keesing 1987; Wells & Sellers 1987; Scheibling 1994; Wells & Keesing 1990; Hancock 2000).

Coastal waters adjacent to the Perth metropolitan area feature two marine protected areas, Marmion Marine Park (MMP) and Shoalwater Islands Marine Park (SIMP), which are managed by WA's Department of Parks and Wildlife (DPaW). Although intertidal reefs are recognized as key ecological values of both marine parks (CALM 1992; DEC 2007), the current ecological knowledge of these communities is considered to be inadequate for effective reserve management. Here we present a checklist of invertebrate species which has been compiled from research undertaken to determine spatial and temporal patterns in the structure of intertidal reef communities in these marine parks from 2010–2012. In addition to examining spatial and temporal patterns in the distribution of intertidal invertebrates, the broader study also aimed

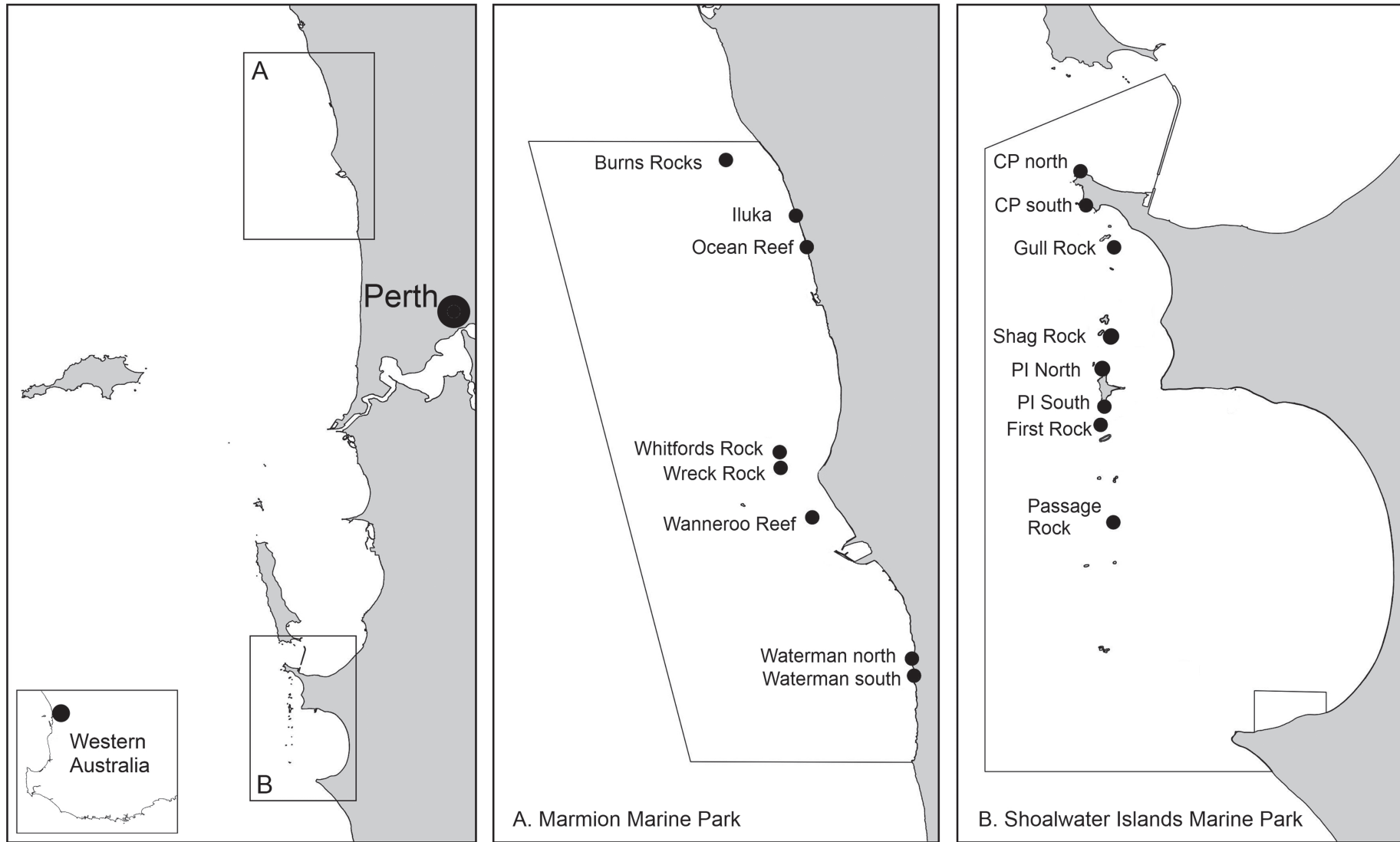


Figure 1. The study area in Western Australia. Insets show the positions of A) Marmion Marine Park and B) Shoalwater Islands Marine Park. Sites sampled during the study are indicated by dots. PI = Penguin Island; CP = Cape Peron.

to inform the development of long-term monitoring that could be used to assess the 'condition' of intertidal communities in MMP and SIMP over time. This checklist will complement more detailed ecological analyses by providing information on most of the species recorded during this research, with notes on their relative prevalence across the different sampling locations, to assist future monitoring of intertidal reef communities in MMP and SIMP.

SAMPLING LOCATIONS, SITES AND METHODS

Located on the coast of metropolitan Perth, MMP extends from north of Burns Rocks (31° 43.45' S) to Trigg (31° 52.63' S) and SIMP extends from north of Cape Peron (32° 14.85' S) to south of Becher Point (32° 22.58' S). Sampling was conducted at four shoreline and four offshore intertidal reefs at both MMP and SIMP (n = 16 sites, Fig. 1). Shoreline reefs were those adjacent to land and thus included reefs fringing Penguin Island in SIMP. A spatial study comprising all sixteen sites was undertaken in 2011, while seven of the sites were sampled in each of three consecutive years from 2010–2012 to examine temporal patterns.

To accommodate major differences across shoreline reefs, samples were collected at inner (i.e. shoreward) and outer (i.e. seaward) areas of the platform. In most instances, these areas conformed to broadly visible changes in the algal community with the inner part of the reef supporting canopy-forming macro-algae (e.g. *Sargassum*) while the outer part was relatively bare (Wells et al. 2007). In contrast, offshore reefs were typically more homogenous with few obvious differences across the platform. At shoreline reefs, ten 1 m² sampling quadrats were haphazardly placed approximately parallel to the shore in each of the inner and outer areas, while at offshore reefs ten 1 m² quadrats were haphazardly placed across the platform. Anemones, molluscs and echinoderms greater than 5 mm in size were sampled by searching the substratum within each quadrat by hand and by removing the algal canopy, which was thoroughly washed in a 5 mm sieve to remove animals. While these groups were not specifically targeted by this study, many other groups (e.g. crabs, barnacles) were rarely encountered. Likewise, highly mobile or cryptic organisms (e.g. some crabs, brittle stars, holothurians) were not included as their presence was inconsistently observed. The number of individuals of each species was recorded and voucher specimens of unknown species were retained or photographed for later identification. The scientific names and authorities of species presented here are consistent with the Codes for Australian Aquatic Biota (CAAB Code; <http://www.marine.csiro.au/caab/>) as of March 2014. The CAAB code for each species has been included here to allow for the checking and tracking of current names in the CAAB database.

For this checklist, the relative prevalence of each species was designated as rare (n = 1 individual), occasional (n

= 2–10 individuals), frequent (n = 11–100 individuals), common (n = 101–1000 individuals) or abundant (> 1000 individuals) across the 16 sites. Broader species distributions were collated from published works (Lamprell & Whitehead 1992; Lamprell & Healy 1998; Wilson 1993, 1994; Wells & Bryce 1988; Miskelly 2002; Edgar 2008; Gowlett-Holmes 2008). This checklist is not exhaustive and does not include some taxa, such as holothurians and ophiuroideans, which were not identified to species during the surveys. Some species, such as high-shore littorinids, that were recorded in pilot sampling at SIMP and MMP have been included in the checklist although they were not observed during the actual surveys. In such cases, their relative prevalence was not assessed.

RESULTS AND DISCUSSION

A total of 71 species, comprising three anemones, 59 molluscs and nine echinoderms, are presented here. This large number of species compared to previous intertidal reef studies in the same region (Marsh 1955; Marsh & Hodgkin 1962; Wells et al. 2007; Irvine et al. 2008), is most likely a consequence of the relatively intensive sampling effort associated with this study. The species documented here are mostly biogeographically temperate (n = 56 or ca. 79%), with distributions that extend across southern Australia. Relatively few species (n = 5 or ca. 7%), such as *Rhinoclavis* (*Rhinoclavis*) *bituberculata* and *Monetaria caputserpentis*, have predominantly tropical distributions that extend southwards to the study area. Some, like *Stomatella impertusa*, are widespread across temperate and tropical regions. This outcome is consistent with the results of previous analyses of intertidal fauna in this region and contrasts with the marine fauna of nearby Rottnest Island, where the influence of the Leeuwin Current has led to the occurrence of a higher proportion of tropical species compared with the adjacent mainland coast (Wells 1985). Twelve (ca. 17%) of the species recorded here are endemic to WA. The geographic range of these endemic species varies greatly, with some being solely temperate (e.g. *Turbo kenwilliamsi*) while others (e.g. *Echinolittorina australis*) range widely across temperate and tropical regions of the state.

Few of the species recorded here are exclusively intertidal and most also inhabit the subtidal reefs of MMP and SIMP. Indeed, some recorded in low numbers in this study, such as *Campanile symbolicum* and *Phyllacanthus irregularis*, are much more abundant on adjacent subtidal reefs. It should also be noted that some obligate intertidal species, such as neritids, littorinids, siphonariids, that inhabit the high intertidal (or 'splash zone') were generally attached to rocks above the inner shoreline reef area where samples were collected. Although their relative prevalence was not assessed as they were only recorded in pilot sampling, some of these high intertidal species (e.g. *Nerita atramentosa* and *Austrolittorina unifasciata*) were very common across rocky shores of MMP and SIMP.

With regard to implementing long-term monitoring of intertidal reef communities in MMP and SIMP and

other marine parks and reserves in temperate WA, this checklist highlights the fact that organisms inhabit a range of habitats on the reefs and efforts to monitor the overall intertidal fauna should ensure these different areas, such as the rock surface, sand patches and the algal canopy, are representatively sampled. This is particularly the case with regard to shoreline reefs, which are commonly more heterogeneous than offshore reefs because they frequently have a high intertidal area towards the shore and can also be subject to sand deposition from adjacent beaches. In both instances, these habitats support species not typically found on other parts of the reef.

Another focus of monitoring should be on species that are subject, or potentially subject, to human impacts. The most obvious direct impact is the collection of organisms, such as the abalone *Haliotis roei*, which is subject to a managed fishery in an area that includes MMP and SIMP (Hancock & Caputi 2006). However, other species are also taken from intertidal reefs for bait or food (Kingsford et al. 1991; Keough et al. 1993), and such activity has previously been documented in MMP (Farrell 1986). More broadly, sites that are established to monitor the condition of intertidal reefs in MMP and SIMP should also be chosen with consideration of other impacts, such as locations where sustained access has led to trampling effects or where pollutants or nutrients are discharged from drains into intertidal or nearshore areas (DoW 2007). Some intertidal species can be useful indicators of contamination, as indicated by the occurrence of imposex in molluscs like *Dicathais orbita* and *Conus* spp. due to the presence of pollution from the antifouling additive tributyltin in coastal waters near Perth (Kohn et al. 1999; Reitsemma et al. 2003).

ACKNOWLEDGEMENTS

Thanks to the marine operational staff from DPaW's Swan Coastal District for their assistance in the field and to Anne Brearley, Karen Gowlett-Holmes and Loisetta Marsh for taxonomic advice. This paper benefited from the comments of two anonymous referees.

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APPENDIX 1

Annotated checklist of intertidal reef species collected at Marmion and Shoalwater Islands marine parks from 2010–2012.

Phylum Cnidaria

Family Actiniidae

Actinia tenebrosa Farquhar, 1898.

CAAB Code: 11 232001.

Distribution: Southern Australia including Tasmania, from Shark Bay (WA) to Heron Island in Queensland (Edgar 2008; Gowlett-Holmes 2008).

Prevalence: Abundant.

Notes: This species occurred widely on shoreline and offshore reefs at MMP and SIMP, but was only occasionally recorded at the inner area of shoreline reefs. Densities of *A. tenebrosa* at the outer area of shoreline reefs at MMP commonly exceeded 10 m⁻², in contrast to SIMP where they more typically occurred at 1–2 m⁻². Higher densities of >20 m⁻² commonly occurred at offshore reefs, including at Burns Rocks in MMP where the highest density of 92 m⁻² was recorded in one quadrat. This species was most commonly found on exposed rock surfaces and hollows without dense algae.

Aulactinia veratra (Drayton in Dana, 1846).

CAAB Code: 11 232003.

Distribution: Southern Australia including Tasmania, from Rottnest Island (WA) to southern Queensland (Edgar 2008; Gowlett-Holmes 2008).

Prevalence: Common.

Notes: This species occurred widely on shoreline and offshore reefs at MMP and SIMP, and was present at both inner and outer areas on shoreline reefs. While densities of this species rarely exceeded 5 m⁻² at shoreline reefs, densities of >10 m⁻² occurred frequently at MMP offshore reefs.

Oulactis mcmurrichi (Lager, 1911).

CAAB Code: 11 232021.

Distribution: Southern Australia from Perth (WA) to Coffin Bay in South Australia (Edgar 2008).

Prevalence: Common.

Notes: This species mostly occurred at the inner and outer areas of shoreline reefs in MMP and SIMP and was far less common on offshore reefs. It was, however, recorded at Passage Rock and Shag Rock in SIMP and at Wreck Rock in MMP. When present, densities of this species only occasionally exceeded 2 m⁻², although a maximum of 11 m⁻² was recorded on two instances at inner areas at Cape Peron south (SIMP) and at Iluka (MMP). This species often occurred in sand-filled hollows.

Phylum Mollusca

Family Chitonidae

Liolophura hirtosa (Blainville, 1825).

CAAB Code: 23 118005.

Distribution: Endemic to WA, from Shark Bay to Albany (Edgar 2008).

Prevalence: Abundant.

Notes: This species occurred mostly on the outer area of shoreline reefs and on offshore reefs, and was more common at MMP than at SIMP. At MMP, *L. hirtosa* was most abundant at the outer areas of Iluka and Ocean Reef, where densities of >10 m⁻² were common and much higher densities of about 100 m⁻² were occasionally recorded. In contrast, densities of *L. hirtosa* at SIMP only exceeded 10 m⁻² at First Rock, where a maximum of 39 m⁻² was recorded.

Family Cryptoplacidae

Cryptoplax iredalei Ashby, 1923.

CAAB Code: 23 121002.

Distribution: Southern Australia, including Tasmania (Gowlett-Holmes 2008).

Prevalence: Rare.

Notes: A single specimen was recorded at Gull Rock (SIMP).

Family Haliotidae

Haliotis roei Gray, 1826.

CAAB Code: 24 038005.

Distribution: Southern Australia, from Shark Bay (WA) to western Victoria (Edgar 2008).

Prevalence: Abundant.

Notes: This was the second most abundant species recorded in this study. It occurred mostly at MMP offshore reefs and the outer area of shoreline reefs, where densities frequently exceeded 100 m⁻². At SIMP, *H. roei* occurred primarily at Passage and First rocks, but less frequently than the high densities often recorded at MMP reefs. This species was also consistently present at Penguin Island south at lower densities of <10 m⁻². It was most typically found on exposed rock surfaces and hollows with little or no macroalgae. Large *H. roei* (up to ca. 120 mm) were one of the most prominent species in the study area and are an important recreational fishery species on MMP and SIMP intertidal reefs.

Haliotis scalaris (Leach, 1814).

CAAB Code: 24 038015.

Distribution: Southern Australia, including northern Tasmania, from Dongara (WA) to Cape Liptrap in Victoria (Edgar 2008).

Prevalence: Rare.

Notes: A single specimen was recorded at the outer area at Penguin Island north (SIMP).

Family Fissurellidae

Macroschisma productum Adams, 1850.

CAAB Code: 24 040031.

Distribution: Southern Australia, including Tasmania, from Dongara (WA) to New South Wales (Wells & Bryce 1988).

Prevalence: Common.

Notes: This species was present at both MMP and SIMP, but was

recorded only at the inner area of MMP shoreline reefs. In contrast, at SIMP it was found at the inner and outer areas of shoreline reefs and also at Gull Rock and Shag Rock. Although this species most commonly occurred at low densities of 1–2 m⁻², abundances of about 10 m⁻² were occasionally recorded. It was typically concealed amongst sand and turfing algae and in rock hollows.

Macroschisma baikiei (A Adams, 1855).

CAAB Code: 24 040026.

Distribution: Endemic to WA, from Geraldton to Esperance (Wilson 1993; Wells & Bryce 1988).

Prevalence: Rare.

Notes: A single specimen was recorded at the inner area at Penguin Island north (SIMP).

Amblychilepas oblonga (Menke, 1843).

CAAB Code: 24 040024.

Distribution: Southern Australia, from Geraldton (WA) to Western Port in Victoria (Edgar 2008).

Prevalence: Frequent.

Notes: This species was only recorded at the inner areas at Ocean Reef and Iluka (MMP). Although recorded on relatively few instances, 13 individuals were found in a single quadrat. It was typically concealed amongst sand and turf algae.

Amblychilepas nigrita (GB Sowerby, 1835).

CAAB Code: 24 040023.

Distribution: Southern Australia, including Tasmania, from Geraldton (WA) to Caloundra in Queensland (Edgar 2008).

Prevalence: Occasional.

Notes: A small number of this species were recorded from the inner areas at Iluka and Waterman south (MMP).

Family Patellidae

Scutellastra peronii (Blainville, 1825).

CAAB Code: 24 005004.

Distribution: Southern Australia, including Tasmania, from Shark Bay (WA) to New South Wales (Edgar 2008).

Prevalence: Abundant.

Notes: This species occurred mostly at the outer area of MMP shoreline reefs, where densities frequently exceeded 100 m⁻² and on several instances exceeded 200 m⁻². It was only recorded in low densities at First Rock (SIMP). This species was typically found attached to bare rock surfaces or those with low sparse algae.

Scutellastra laticostata (Blainville, 1825).

CAAB Code: 24 005003.

Distribution: Southern Australia from Shark Bay (WA) to Port Lincoln in South Australia (Edgar 2008).

Prevalence: Occasional.

Notes: A small number of this species was recorded at First Rock (SIMP). This particularly large (up to ca. 110 mm) limpet is locally abundant on intertidal reefs at the west end of Rottnest Island (Scheibling & Black 1993) and, together with *H. roei*, acts as a host for the commensal limpet *P. nigrosulcata* (Scheibling et al. 1990).

Family Lottidae

Patelloida alticostata (Angas, 1865).

CAAB Code: 24 010002.

Distribution: Southern Australia, including Tasmania, from Kalbarri (WA) to The Entrance in New South Wales (Edgar 2008).

Prevalence: Abundant.

Notes: This was the most abundant species recorded in this study. It was most prevalent at the outer area of MMP shoreline reefs, where densities commonly exceeded 100 m⁻² and occasionally exceeded 500 m⁻². It was considerably less abundant at SIMP, where it occurred mostly at Passage and First rocks at densities of typically <50 m⁻². This species was usually found attached to bare rock surfaces or those with low sparse algae.

Lottia onychitis (Menke, 1843).

CAAB Code: 24 010008.

Distribution: Southern Australia, from Point Quobba (WA) to South Australia (Wells & Bryce 1988).

Prevalence: Abundant.

Notes: This species occurred mostly at the outer area of MMP shoreline reefs, where densities frequently exceeded 50 m⁻² and on several instances approached 100 m⁻². It was recorded in far lower densities at the Cape Peron south inner area (SIMP). This species was typically found attached to bare rock surfaces.

Patelloida nigrosulcata (Reeve, 1855).

CAAB Code: 24 010022.

Distribution: Endemic to WA, from the Houtman Abrolhos to Esperance (Wells & Bryce 1988).

Prevalence: Frequent.

Notes: This species was only recorded attached to the shells of living *H. roei* and *S. laticostata*. Individual numbers were not recorded, but it occurred at all locations where the host species were present.

Family Trochidae

Austrocochlea rudis (Gray, 1826).

CAAB Code: 24 046071.

Distribution: Southern Australia, from Kalbarri (WA) to South Australia (Wells & Bryce 1988).

Prevalence: Occasional.

Notes: A small number of this species were recorded at inner and outer areas at Iluka (MMP).

Stomatella impertusa (Burrow, 1815).

CAAB Code: 24 046068.

Distribution: Indo-west Pacific, circum-Australian (Wilson 1993; Gowlett-Holmes 2008). Prevalence: Common.

Notes: This species occurred mostly at inner and outer areas of SIMP shoreline reefs, but was only occasionally recorded at SIMP offshore reefs and at MMP. Densities only occasionally exceeded 5 m⁻² and it was most commonly found amongst turf algae, in rock hollows and on algal fronds.

Cantharidus pulcherrimus (Wood, 1828).

CAAB Code: 24 046095.

Distribution: Southern Australia, from Jurien Bay (WA) to Victoria (Wilson 1993).

Prevalence: Abundant.

Notes: This species was most abundant at shoreline reefs and markedly less so at offshore reefs. While densities at the inner areas of MMP shoreline reefs commonly exceeded 50 m⁻² and occasionally exceeded 150 m⁻², densities at the inner and outer areas of SIMP shoreline reefs were rarely >15 m⁻². This species was most commonly found attached to algal fronds.

Clanculus spp.

CAAB Code: 24 046915.

Distribution: Widespread across temperate and tropical regions (Wilson 1993).

Prevalence: Common.

Notes: These juvenile shells with undeveloped features of the umbilicus, columella and aperture were recorded widely across shoreline and offshore reefs at MMP and SIMP but in relatively low densities that never exceeded 7 m⁻². They were typically found attached to the fronds of tall algae such as *Sargassum*.

Prothalotia lehmanni (Menke, 1843).

CAAB Code: 24 046094.

Distribution: Southern Australia from Kalbarri (WA) to Victoria (Edgar 2008).

Prevalence: Common.

Notes: This species occurred widely across shoreline and offshore reefs at MMP and SIMP but in low densities that only occasionally exceeded 2 m⁻². This species was typically found attached to the fronds of algae.

Thalotia chlorostoma (Menke, 1843).

CAAB Code: 24 046112.

Distribution: Southern Australia from the Houtman Abrolhos (WA) to Victoria (Wells & Bryce 1988).

Prevalence: Occasional.

Notes: A small number of this species were recorded at inner and outer areas at Iluka (MMP) and at Cape Peron North and Penguin Island south (SIMP). It was typically found attached to the fronds of algae.

Notogibbula preissiana (Philippi, 1848).

CAAB Code: 24 046092.

Distribution: Southern Australia, from Fremantle (WA) to Victoria (Wilson 1993).

Prevalence: Occasional.

Notes: This species was recorded only twice at the outer area of Penguin Island south (SIMP).

Family Turbinidae

Lunella torquata (Gmelin, 1791).

CAAB Code: 24 045003.

Distribution: Southern Australia from Port Gregory (WA) to eastern

South Australia and from Green Cape to Brunswick Heads in New South Wales (Edgar 2008).

Prevalence: Abundant.

Notes: This species was widespread on shoreline and offshore reefs in MMP and SIMP. Larger individuals were usually found attached to the reef surface while smaller shells were often concealed in turf algae or among the fronds of algae. While the density of large shells (up to ca. 100 mm) rarely exceeded 10 m⁻², juveniles were occasionally recorded at densities of >20 m⁻². Large *L. torquata* are one of the most prominent species on intertidal reefs of MMP and SIMP. The commensal bonnet limpet *H. conicus* was commonly attached to this species.

Turbo kenwilliamsi Williams, 2008.

CAAB Code: 24 045052.

Distribution: Endemic to WA, from Point Quobba to Esperance (Edgar 2008).

Prevalence: Occasional.

Notes: This large species (up to ca. 80 mm) was recorded at the inner and outer areas of shoreline reefs at Ocean Reef (MMP), Cape Peron north and south and Penguin Island north (SIMP).

Family Neritidae

Nerita atramentosa Reeve, 1855.

CAAB Code: 24 057001.

Distribution: Southern Australia from Western Australia to New South Wales, including Tasmania (Spencer 2007). Prevalence: Not assessed.

Notes: This species was recorded during pilot sampling at SIMP. It occurred across the study area at sites that provide a mid to high intertidal area, which was typically above the shoreline reef inner area sampling conducted during this study.

Family Littorinidae

Austrolittorina unifasciata (Gray, 1826).

CAAB Code: 24 095001.

Distribution: Southern Australia, including Tasmania, from North West Cape (WA) to Yeppoon in Queensland (Edgar 2008).

Prevalence: Not assessed.

Notes: This species was recorded during pilot sampling at Ocean Reef (MMP). It occurred across the study area at sites that provide a high intertidal area, which was typically above the shoreline reef inner area sampling conducted during this study.

Echinolittorina australis (Quoy and Gaimard, 1826).

CAAB Code: 24 095024.

Distribution: Endemic to WA, from Kimberley to Esperance (Edgar 2008).

Prevalence: Not assessed.

Notes: This species was recorded during pilot sampling at Ocean Reef (MMP). It occurred across the study area at sites that provide a high intertidal area, which was typically above the shoreline reef inner area sampling conducted during this study.

Family Phasianellidae

Phasianella ventricosa Swainson, 1822.

CAAB Code: 24 042006.

Distribution: Southern Australia, including Tasmania, from the Houtman Abrolhos (WA) to Noosa (Qld) (Edgar 2008).

Prevalence: Occasional.

Notes: A small number of this species were recorded at inner areas at Iluka and Waterman north (MMP) and at Shag Rock (SIMP). They were found attached to the fronds of algae.

Phasianella variegata Lamarck, 1822.

CAAB Code: 24 042005.

Distribution: Endemic to WA, from Cheyne Beach to Dampier (Wilson 1993).

Prevalence: Occasional.

Notes: A small number of this species were recorded at the outer area at Penguin Island south (SIMP), where they were found attached to fronds of algae.

Family Cerithiidae

Rhinoclavis (Rhinoclavis) bituberculata (Sowerby, 1865).

CAAB Code: 24 076048.

Distribution: Northern Australia, extending southwards to Cape Leeuwin (WA) and southern Queensland (Wilson 1993, Edgar 2008).

Prevalence: Frequent.

Notes: This species was only collected from shoreline reef inner areas at MMP, where it was found concealed in sand patches and sand-filled hollows. On several instances it was recorded at densities of 6–7 m⁻² but was usually less common.

Family Campanilidae

Campanile symbolicum Iredale, 1917.

CAAB Code: 24 090001.

Distribution: Endemic to WA, from Geraldton to Esperance (Edgar 2008).

Prevalence: Occasional.

Notes: A small number of this large species (up to ca. 230 mm) were recorded at Shag Rock and the outer area at Cape Peron north (SIMP). This and other large gastropod species, such as *D. orbita* and *L. torquata*, act as hosts for the bonnet limpet *H. conicus*.

Family Hipponicidae

Hipponix australis (Lamarck, 1819).

CAAB Code: 24 130001.

Distribution: Around southern Australia, from NSW to Shark Bay, including Tasmania (Gowlett-Holmes, 2008).

Prevalence: Common.

Notes: This species occurred only on the shells of large molluscs such as *D. orbita*, *L. torquata* and *C. symbolicum*. Individual numbers were not recorded, but it occurred at all locations where the host species were present. More than ten could occur on a

single host shell, where they typically cluster near the aperture and feed on faecal pellets produced by the host.

Family Epitoniidae

Opalia granosa (Quoy & Gaimard, 1834).

CAAB Code: 24 191006.

Distribution: Southern Australia, including Tasmania, from Fremantle (WA) to Victoria (Wells & Bryce 1988).

Prevalence: Occasional.

Notes: A small number of this species were recorded from the inner area of shoreline reefs at Iluka and Waterman north (MMP) and Penguin Island north (SIMP). They were typically buried in sand.

Family Cypraeidae

Monetaria caputserpentis (Linnaeus, 1758).

CAAB Code: 24 155018.

Distribution: Indo-west Pacific and southwards to Albany (WA) and New South Wales (Wilson 1993; Wells & Bryce 1988).

Prevalence: Rare.

Notes: A single specimen was recorded at Passage Rock (SIMP).

Family Muricidae

Dicathais orbita (Gmelin, 1791).

CAAB Code: 24 200008.

Distribution: Southern Australia, including Tasmania, from Barrow Island (WA) to southern Queensland (Edgar 2008).

Prevalence: Common.

Notes: This large species (up to ca. 75 mm) was widespread across shoreline inner and outer areas and offshore reefs in both MMP and SIMP. Larger individuals were usually found attached to the reef surface and smaller shells were often concealed in hollows. While it most commonly occurred at 1–3 m⁻², densities of 10–15 m⁻² were occasionally recorded. The commensal bonnet limpet *H. conicus* was often attached to this species. Along with *H. roei* and *L. torquata*, larger *D. orbita* were among the most prominent species in the study area. The presence of imposex in this species has been used to monitor the impact of tributyltin contamination in coastal waters near Perth (Reitsemá et al. 2003).

Lepsiella (Bedeva) paivae (Crosse, 1864).

CAAB Code: 24 200003.

Distribution: Southern Australia, including Tasmania, from Shark Bay (WA) to Queensland (Wells & Bryce 1988).

Prevalence: Rare.

Notes: A single specimen was recorded at the inner area at Iluka (MMP).

Murexsul planiliratus (Reeve, 1845).

CAAB Code: 24 200152.

Distribution: Southern Australia, from Fremantle (WA) to central Victoria (Wilson 1993).

Prevalence: Not assessed.

Notes: This species was recorded during pilot sampling at MMP.

Cronia avellana (Reeve, 1846).

CAAB Code: 24 200005.

Distribution: Endemic to WA, from the Kimberley to Cheynes Beach (Wilson 1993).

Prevalence: Frequent.

Notes: Most individuals of this species were recorded at Burns Rocks (MMP), with smaller numbers also occurring at Gull Rock (SIMP) and the inner areas of Waterman south (MMP) and Penguin Island north (SIMP).

Family Buccinidae

Cominella eburnea (Reeve, 1846).

CAAB Code: 24 202001.

Distribution: Southern Australia, including Tasmania, from Geraldton (WA) to Moreton Bay in Queensland (Edgar 2008).

Prevalence: Rare.

Notes: A single specimen was recorded at the inner area at Iluka (MMP).

Family Nassariidae

Nassarius glans particeps (Hedley, 1915).

CAAB Code: 24 202006.

Distribution: Southern Australia, including Tasmania, from North West Cape (WA) to southern Queensland (Wilson 1993; Gowlett-Holmes 2008).

Prevalence: Rare.

Notes: A single specimen was recorded at Shag Rock (SIMP).

Family Ranellidae

Ranella australasia (Perry, 1811).

CAAB Code: 24 176002.

Distribution: Southern Australia, including Tasmania, from the Houtman Abrolhos (WA) to Tin Can Bay in Queensland (Edgar 2008).

Prevalence: Rare.

Notes: A single specimen was recorded at the outer area at Penguin Island south (SIMP).

Family Columbelloidea

Euplica scripta (Lamarck, 1822).

CAAB Code: 24 203051.

Distribution: Indo-west Pacific, from North West Cape (WA) to northern New South Wales (Wilson 1993).

Prevalence: Common.

Notes: This species was widespread across shoreline and offshore reefs at MMP and SIMP. It was frequently recorded at densities of >10 m⁻² and occasionally exceeded 50 m⁻². This species most commonly occurred in the fronds of large brown algae like *Sargassum*.

Euplica bidentata (Menke, 1843).

CAAB Code: 24 203045.

Distribution: Southern Australia, from North West Cape (WA) to South Australia (Edgar 2008).

Prevalence: Common.

Notes: This species was widespread across shoreline and offshore reefs at MMP and SIMP. It was recorded in similar densities to *E. scripta* was also most commonly found on the fronds of large brown algae like *Sargassum*.

Mitrella austrina (Gaskoin, 1851).

CAAB Code: 24 203027.

Distribution: Southern Australia, including Tasmania, from Fremantle (WA) to southern New South Wales (Edgar 2008).

Prevalence: Common.

Notes: This species was widespread across shoreline and offshore reefs at MMP and SIMP. Like *Euplica* spp., it was most commonly found among the fronds of large brown algae, but in the case of this species densities only occasionally exceeded 10 m⁻².

Mitrella menkeana (Reeve, 1858).

CAAB Code: 24 203025.

Distribution: Southern Australia from the Houtman Abrolhos (WA) to Victoria (Wells & Bryce 1988).

Prevalence: Frequent.

Notes: This species was recorded at the inner and outer areas of shoreline reefs at Iluka and Waterman north (MMP) and at Cape Peron south and Penguin Island south (SIMP). When present, it mostly occurred at densities of 1–2 m⁻².

Mitrella lincolnensis (Reeve, 1859).

CAAB Code: 24 203002.

Distribution: Southern Australia, including Tasmania, from the Houtman Abrolhos (WA) to Victoria (Wells & Bryce 1988).

Prevalence: Frequent.

Notes: This species was recorded at the inner and outer areas of shoreline reefs at Iluka and Waterman north (MMP) and at Penguin Island north and south (SIMP). When present, it mostly occurred at densities of 1–2 m⁻².

Family Conidae

Conus anemone Lamarck, 1810.

CAAB Code: 24 222010.

Distribution: Southern Australia, including Tasmania, from Port Gregory (WA) to southern Queensland (Edgar 2008).

Prevalence: Frequent.

Notes: This species occurred mostly at the inner and outer areas of shoreline reefs at SIMP. It was rarely recorded at SIMP offshore reefs or at MMP, where only single specimens were recorded at the inner areas at Iluka and Ocean Reef. When present, it only occurred at densities of 1–2 m⁻² and was usually concealed in turf algae.

Conus dorensis Péron, 1807.

CAAB Code: 24 222044.

Distribution: Endemic to WA, from the Montebello Islands to Albany (Edgar 2008).

Prevalence: Frequent.

Notes: This species occurred mostly at the inner and outer areas of shoreline reefs at SIMP with a lesser number being recorded at the inner areas of shoreline reefs at MMP. Among offshore reefs, it was only recorded at Gull Rock and Shag Rock (SIMP). This species was most commonly concealed under turf algae or sand. When present, it typically occurred at densities of 1–2 m⁻², although on one occasion eight were recorded from an inner area quadrat at Penguin Island north (SIMP). The presence of imposex in this species as a consequence of tributyltin contamination has been recorded at intertidal reefs at Rottneest Island near Perth (Kohn et al. 1999).

Family Olividae

Ancillista cingulata (GB Sowerby I, 1830).

CAAB Code: 24 208003.

Distribution: Northwards from Albany (WA) to north Qld (Wilson 1993).

Prevalence: Rare.

Notes: A single specimen was recorded from the inner area at Cape Peron north (SIMP).

Family Mitridae

Mitra chalybeia Reeve, 1844.

CAAB Code: 24 211011.

Distribution: Endemic to WA, from Shark Bay to Alexander Bay (Edgar 2008).

Prevalence: Occasional.

Notes: This species was mostly recorded at inner and outer areas of shoreline reefs at MMP and SIMP, with only recorded from an offshore reef at Gull Rock (SIMP). This species was usually concealed in rock hollows, sand or turf algae.

Family Costellariidae

Vexillum (Pusia) marrowi Cernohorsky, 1973.

CAAB Code: 24 213059.

Distribution: Endemic to WA, from Kalbarri to Hopetoun (Wilson 1993).

Prevalence: Occasional.

Notes: A small number of this species were recorded at inner and outer areas of shoreline reefs at Iluka and Ocean Reef (MMP) and at Penguin Island north and south (SIMP).

Family Siphonariidae

Siphonaria zelandica Quoy & Gaimard, 1833.

CAAB Code: 24 488002.

Distribution: Broome (WA) to Keppel Bay (Qld) (Edgar 2008).

Prevalence: Frequent.

Notes: This species was only recorded at the inner area at Cape Peron south (SIMP), where it was attached to bare rock at the mid to high intertidal.

Siphonaria kurracheensis Reeve, 1856.

CAAB Code: 24 488007.

Distribution: Endemic to temperate WA (ABRS 2014). Prevalence: Occasional.

Notes: A small number of this species were recorded at the inner area at Cape Peron south (SIMP), where it was attached to bare rock at the mid to high intertidal.

Family Bullidae

Bulla quoyii Gray in Dieffenbach, 1843.

CAAB Code: 24 335001.

Distribution: Southern Australia, including Tasmania, from Carnarvon (WA) to southern Queensland (Edgar 2008).

Prevalence: Frequent.

Notes: This species was only recorded at the inner area of shoreline reefs at Iluka and Ocean Reef (MMP) and Penguin Island south (SIMP). It was typically concealed under turf algae or sand.

Family Mytilidae

Brachidontes ustulatus (Lamarck, 1819).

CAAB Code: 23 220081.

Distribution: Kimberley (WA) to South Australia (Wells & Bryce 1988).

Prevalence: Abundant.

Notes: This species occurred mostly at the inner and outer areas of shoreline reefs at Ocean Reef and Waterman north (MMP) and Cape Peron north and south and Penguin Island south (SIMP). It occurred individually, in clusters, or as dense habitat-forming beds that covered the rock surface. While individual numbers of this species were not recorded, it occasionally occurred at densities of >100 m⁻² where dense beds had formed.

Xenostrobus securis (Lamarck, 1819).

CAAB Code: 23 220014.

Distribution: Moore River (WA) to Queensland (Wells & Bryce 1988).

Prevalence: Not assessed.

Notes: This species was recorded during pilot sampling at MMP.

Septifer bilocularis (Linnaeus, 1758).

CAAB Code: 23 220029.

Distribution: Indo-west Pacific, from Rottneest Island (WA) to New South Wales (Wells & Bryce 1988).

Prevalence: Common.

Notes: This species was widespread across shoreline and offshore reefs at MMP and SIMP. Unlike *B. ustulatus* it did not form dense clusters or beds and was typically found as individuals. The highest densities of >10 m⁻² were recorded occasionally at offshore reefs at MMP, and particularly at Wanneroo Reef.

Family Malleidae

Malleus meridianus Cotton, 1930.

CAAB Code: 23 237001.

Distribution: Southern Australia, from Fremantle (WA) to the Gulf of St Vincent in South Australia (Edgar 2008).

Prevalence: Occasional.

Notes: This species was recorded only twice at offshore reefs at Gull Rock (SIMP) and Wreck Rock (MMP).

Family Veneridae

Irus carditoides (Lamarck, 1818).

CAAB Code: 23 380016.

Distribution: Southern Australia, including Tasmania, from south WA to Victoria (Lamprell & Whitehead 1992).

Prevalence: Occasional.

Notes: A small number of this species was recorded at the inner areas of Waterman north and south (MMP).

Venerupis galactites (Lamarck, 1818).

CAAB Code: 23 380156.

Distribution: Southern Australia, including Tasmania, from south WA to New South Wales (Lamprell & Whitehead 1992).

Prevalence: Not assessed.

Notes: This species was recorded during pilot sampling at Waterman north (MMP).

Family Chamidae

Chama ruderalis Lamarck, 1819.

CAAB Code: 23 301002.

Distribution: Southern Australia, from south WA to New South Wales (Lamprell & Whitehead 1992).

Prevalence: Not assessed.

Notes: This species was recorded during pilot sampling at MMP.

Phylum Echinodermata**Family Asterinidae**

Meridiastra occidentis (O'Loughlin, Waters & Roy, 2003).

CAAB Code: 25 140042.

Distribution: Southern Australia, from Kalbarri (WA) to Port Fairy in Victoria (Edgar 2008).

Prevalence: Abundant.

Notes: This species was widespread across shoreline and offshore reefs at MMP and SIMP, but occurred at higher densities at shoreline than at offshore reefs and was more abundant at SIMP than at MMP. While densities ranging from 20–80 m⁻² were frequently recorded at SIMP shoreline reefs, densities of >20 m⁻² occurred only occasionally at MMP shoreline reefs. At offshore reefs, densities at SIMP and MMP rarely exceeded 15 and 10 m⁻², respectively. This species was often found adhering to the rock surface in hollows or amongst low algae.

Meridiastra calcar (Lamarck, 1816).

CAAB Code: 25 140028.

Distribution: Southern Australia including Tasmania, from Albany (WA) to Currumbin in Queensland (Edgar 2008).

Prevalence: Frequent.

Notes: This species was recorded mostly at shoreline reefs in SIMP and MMP, while a small number were also recorded at SIMP offshore reefs. This species was less abundant than *M. occidentis* and densities of >2 m⁻² occurred only occasionally, and only at SIMP.

Meridiastra gunnii (Gray, 1840).

CAAB Code: 25 140027.

Distribution: Southern Australia, including Tasmania, from the Houtman Abrolhos (WA) to eastern Victoria (Edgar 2008).

Prevalence: Frequent.

Notes: This species was mostly recorded at the inner and outer areas at Penguin Island south (SIMP) with additional single records at Cape Peron south and Shag Rock (SIMP) and Iluka (MMP). This species was less common than *M. occidentis* and *M. calcar*.

Coscinasterias muricata Verrill, 1867.

CAAB Code: 25 154011.

Distribution: Southern Australia, including Tasmania, from the Houtman Abrolhos (WA) to southern Queensland (Edgar 2008).

Prevalence: Common.

Notes: This relatively large (up to ca. 250 mm) sea-star occurred widely across shoreline and offshore reefs in MMP and SIMP, but typically occurred in relatively low densities of 1–2 m⁻² when it was present. Higher densities (i.e. >10 m⁻²) of smaller individuals were recorded in some instances, mainly at SIMP shoreline reefs.

Family Echinometridae

Helicoidaris erythrogramma (Valenciennes, 1846).

CAAB Code: 25 247001.

Distribution: Southern Australia, including Tasmania, from Shark Bay (WA) to Caloundra in Queensland (Edgar 2008).

Prevalence: Abundant.

Notes: This species was widespread across shoreline and offshore reefs at MMP and SIMP, but was particularly abundant only at Cape Peron north and south (SIMP) and, to a lesser extent, at Iluka (MMP). Densities ranging from 10 to ca. 130 m⁻² were frequently recorded at the inner and outer areas at Cape Peron north and south, while densities of 10–43 m⁻² were occasionally recorded at the inner area at Iluka. In contrast, densities of >3 m⁻² were rare at all other sites. This species was typically found in rock hollows.

Family Toxopneustidae

Nudechinus scotiopremnus HL Clark, 1912.

CAAB Code: 25 242007.

Distribution: Indian Ocean and Red Sea, from Yallingup to Broome in WA (Miskelly 2002; Coleman 2007).

Prevalence: Frequent.

Notes: This small urchin was recorded on both shoreline and offshore reefs at MMP and SIMP, but usually occurred at relatively low densities of 1–3 m⁻² when it was present. This species was most commonly concealed in reef hollows or amongst turf algae, but was occasionally found amongst the fronds of branched algae.

Family Temnopleuridae

Holopneustes porosissimus L Agassiz, 1846.

CAAB Code: 25 241011.

Distribution: Southern Australia, including northern Tasmania, from the Houtman Abrolhos (WA) to Waratah Bay (Vic) (Edgar 2008).

Prevalence: Frequent.

Notes: This species occurred widely across shoreline and offshore reefs at MMP and SIMP at relatively low densities that rarely exceeded 3 m⁻². They were most commonly found amongst the fronds of tall branched algae such as *Sargassum*.

Amblypneustes leucoglobus Döderlein, 1914.

CAAB Code: 25 241004.

Distribution: Endemic to WA, from Geraldton to Eucla (Edgar 2008).

Prevalence: Occasional.

Notes: Several specimens of this species were recorded at Wreck Rock (MMP).

Family Cidaridae

Phyllacanthus irregularis Mortensen, 1928.

CAAB Code: 25 202012.

Distribution: Southern Australia, from the Houtman Abrolhos (WA) to the Gulf of St Vincent in South Australia (Edgar 2008).

Prevalence: Rare.

Notes: A single small individual was recorded in a reef pothole at Gull Rock (SIMP).