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REPORT

# The short spined crown-of-thorns starfish *Acanthaster brevispinus* is a corallivore too

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**Abstract** The short spined crown-of-thorns starfish *Acanthaster brevispinus* inhabits deeper water soft bottom habitats, in contrast to the more infamous Indo-Pacific *Acanthaster* species complex of which population outbreaks have been responsible for widespread coral mortality throughout the Indo-West Pacific region. *Acanthaster brevispinus* has not previously been regarded as a threat to corals or coral reefs. Here, we report *A. brevispinus* occurring on mesophotic off-reef or inter-reef habitats in 20–70-m depths dominated by solitary corals off both the western and eastern coasts of Australia. On Ningaloo Reef, *A. brevispinus* were found on mushroom coral (*Cycloseris distorta*) beds using an underwater towed camera and further exploration using a remotely operated vehicle (ROV) confirmed predation by *A. brevispinus* on *C. distorta*. On the southern Great Barrier Reef, *A. brevispinus* in large numbers were found in habitat dominated by the dendrophylliid *Heteropsammia* cf. *cochlea.* Predation on *H.* cf. *cochlea* was also directly observed. This is the first confirmed report of predation on hard corals by *A. brevispinus,* and while there are yet to be any records of population outbreaks of this species, such outbreaks could have a significant effect on mesophotic solitary coral assemblages.

**Keywords** Corallivory · Mesophotic · *Acanthaster* · Great Barrier Reef · Ningaloo · Solitary corals

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## Introduction

The crown-of-thorns starfish Indo-Pacific *Acanthaster* unresolved species complex (Haszprunar and Spies 2014; Haszprunar et al. 2017) (hereafter referred to as *Acanthaster planci* sensu lato) are specialist coral predators and have achieved notoriety as a result of population outbreaks which have caused widespread coral mortality on shallow water coral reefs throughout the Indo-West Pacific since the 1960s (see reviews by Moran 1986; Pratchett et al. 2014). The more uncommon and much lesser-known short spined crown-of-thorns starfish *Acanthaster brevispinus* (Fisher 1917) also has a widespread Indo-Pacific distribution from the Seychelles in the west (Jangoux and Aziz 1984) through Japan (Yuasa et al. 2017) and the Philippines (Fisher 1917) to the northern and southern Great Barrier Reef in Australia (Endean 1961; Birkeland and Lucas 1990) and as far south as Moreton Bay (Endean 1973). Most records of *A. brevispinus* are from deeper (up to 63 m) off-reef soft sediment or muddy habitats (Endean 1961; Birkeland and Lucas 1990; Jangoux and Aziz 1984). *Acanthaster brevispinus* are not known to undergo population outbreaks (Moran 1986; Birkeland and Lucas 1990), and the very few records of this species suggested it was rare until Yuasa et al. (2017) found a localised aggregation of 20 *A. brevispinus* within an area of 100 m$^2$ well-exceeding the defined outbreak density for western Pacific crown-of-thorns starfish on the Great Barrier Reef (Keesing and Lucas 1992). The Yuasa et al. (2017)

study represents the shallowest record for *A. brevispinus* (20 m) and the first on reef substrate. Their observation was also notable in being the first record of *A. planci* sensu lato and *A. brevispinus* living in sympatry.

In the absence of any field observations, Moran (1986) noted that *Acanthaster brevispinus* were thought to be omnivores. However, published observations suggest they are predators. In captivity, they have been found to trap and consume live scallops (Lucas and Jones 1976), and more recently, Yuasa et al. (2017) found them feeding exclusively on soft corals (octocorals) and principally on *Dendronephthya* spp. on a low-latitude reef in Japan. The first record of the species on Australia's west coast was off Ningaloo Reef in 58-m depth when a specimen was collected by one of us (AH) in 2006 and lodged at the Western Australian Museum (registration number Z23359). Subsequent towed video imagery of mushroom coral beds in 40-m depth off Ningaloo made by another of us (RB) in 2015 revealed *A. brevispinus* in this habitat. The objective of this paper is to record further observations of *A. brevispinus* on both Ningaloo Reef and the southern Great Barrier Reef, report on novel feeding observations of *A. brevispinus* on hard corals and discuss the potential importance of this to mesophotic coral reef habitats.

## Materials and methods

Ningaloo Reef, Western Australia—Surveys of mesophotic habitats were undertaken in February and March 2022 off the Ningaloo Reef coast between Helby Bank (21.910317°S, 113.837144°E) and Mandu (22.172081°S, 113.837144°E) using an Oceanbotics SRV-8 remotely operated vehicle (ROV) with geolocation monitored using a Subsonus Ultra-Short Baseline positioning system (USBL) system. ROV transects were conducted at 0.3–0.5 m above the seafloor following specific habitat contours if possible, with −7 to −10° degrees pitch to observe the benthic habitat (Schramm et al. 2020). A suite of different, previously defined and located mesophotic habitats (Turner et al. 2018) were selected for survey; they are mesophotic hard coral habitat (20–30 m), macroalgae-dominated habitat (18–40 m), rhodolith rubble habitat (35–40 m), sand habitat (35–40 m), sponge dominated habitat (35–40 m) and mushroom coral *Cycloseris distorta* beds (35–40 m).

A minimum of four sites per habitat were surveyed. Between 2.46 and 6.38 total hours in each habitat type were searched using the ROV with the video watched in real time, and any *A. brevispinus* were noted and their position was recorded. All ROV imagery was saved and backed up to a hard disc for later review.

One individual of *A. brevispinus* located during the ROV surveys was subsequently retrieved to the surface for examination using a small landing net attached to the ROV manipulator arm.

Historical imagery from the Australian Institute of Marine Science collected off north-western Australia using towed underwater video known to include observations of *A. brevispinus* was also re-examined.

Capricorn Bunker group, southern Great Barrier Reef—During routine management and control activities of the western Pacific crown-of-thorns starfish on the Great Barrier Reef, a survey at Fairfax Islands Reef revealed the presence of a large number of *A. brevispinus* in 21-m water depth at a site located at 23.856917° S, 152.361717° E. A survey of the site was carried out in February 2020 using the Reef Health and Impact Surveys (RHIS) methodology (Beeden et al. 2014) which involves a detailed search of a site 5 m in radius (78 $m^2$). The predominant habitat type of the survey locality was sand (90%) followed by live coral (5%) and macroalgae (5%).

## Results

Ningaloo Reef, Western Australia—Just two *Acanthaster brevispinus* were detected from a total of 23.00 h of ROV surveys at 35 sites. Both starfish were found on *Cycloseris distorta* beds with a total of 6.38 h spent searching this habitat type. The two *A. brevispinus* were found within 11 m of each other about two weeks apart. One had 14 arms of even length (Fig. 1) and the other 13 arms of which two were much shorter than the others and regenerating (Fig. 3).

One *A. brevispinus* was tipped over, using the manipulator arm of the ROV (Fig. 2), and *C. distorta* was observed attached to the mouth region of the *A. brevispinus*. However, but it was not possible to determine if the starfish was feeding on the coral. The day following this, what is believed

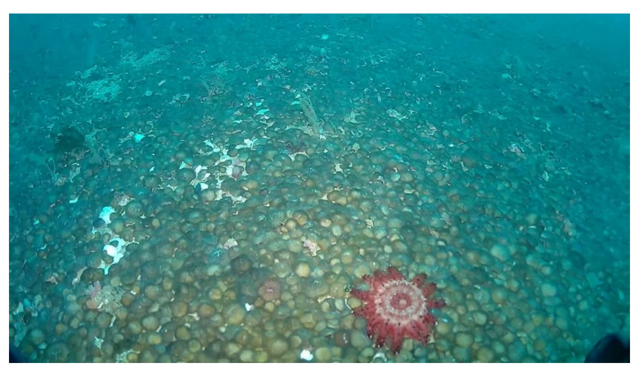

**Fig. 1** *Acanthaster brevispinus* photographed on a bed of mushroom corals (*Cycloseris distorta*) off Ningaloo Reef in 38-m depth in February 2022 (21.80319411°S, 114.0230529°E). Scale not shown as frame width is narrower at bottom than top. Starfish shown is 17–20 cm in diameter. Photograph N. Mortimer

**Fig. 2** *Acanthaster brevispinus* photographed on a bed of mushroom corals (*Cycloseris distorta*) off Ningaloo Reef in 38.1-m depth in March 2022 (21.80327535°S 114.0231096°E. Note that the white *C. distorta* have not necessarily been predated on by the starfish. It is more likely they were flipped over when the bottom was disturbed by the ROV. The underside of these corals is white when alive. Scale not shown as frame width is narrower at bottom than top. Starfish shown is 17.5 cm in diameter.). Photograph L. Hellmrich

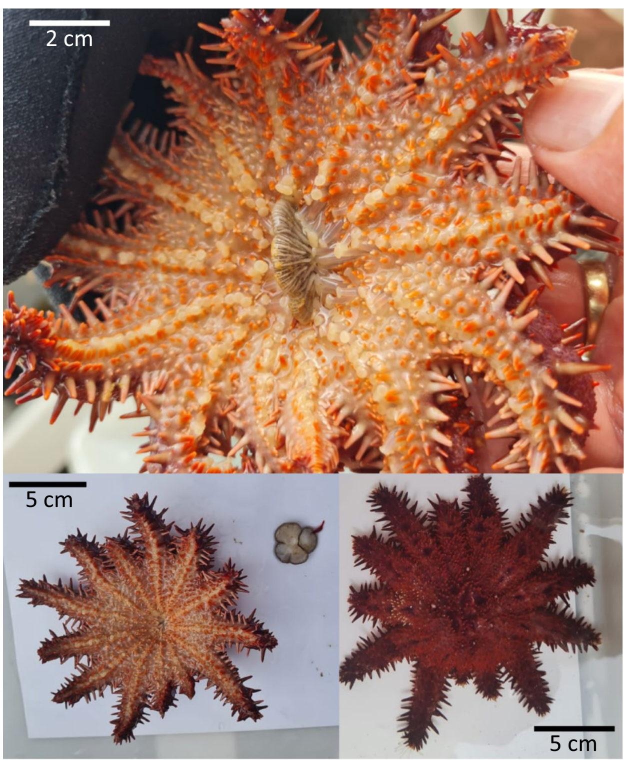


**Fig. 3** Upper panel, oral side of a *Acanthaster brevispinus* (diameter = 17.5 cm) captured with a net from a bed of mushroom corals off Ningaloo Reef from 38-m depth. An individual *Cycloseris distorta* is in its mouth. Moments before this photograph was taken the stomach of the starfish was everted with the coral enveloped within it; lower left panel, *C. distorta* prey at right after being removed from mouth of *A. brevispinus*; lower right panel, aboral surface of *A. brevispinus* (photographs L. Hellmrich and B. De Groot)

to be the same starfish (greatest diameter = 175 mm) was collected at the same site. This starfish was found to have its stomach everted and enveloping at least three *C. distorta* corals with one of these remaining clearly lodged in the mouth of the starfish after the stomach had been retracted (Fig. 3).

Further evidence of *A. brevispinus* living in association with *C. distorta* mushroom coral beds was found when historical tow video imagery from surveys of mesophotic habitats associated with shoals off north-western Australia in 2013 was examined. This revealed as many as six *A. brevispinus* aggregated on rubble habitat among *C. distorta* corals (Fig. 4) in 70-m water depth on Rankin Bank (19.75°S, 115.58°E). The white corals in the photograph (Fig. 4) may be dead corals eaten by the *A. brevispinus*; however, *C. distorta* is white on the underside and is often observed tipped over when alive. Thus, it is not possible to conclude these are feeding scars.

Capricorn Bunker group, southern Great Barrier Reef—At the RHIS survey site at Fairfax Islands reef, six *A. brevispinus* were detected, constituting a density equivalent to 7.6 starfish per 100 m$^2$. It was noted there were several hundred *A. brevispinus* observed in the broader area, mostly 15–25 cm in diameter (Fig. 5). However, two adjacent survey sites in the same sand habitat and depth contour (80 m NW and 80 m SE) did not observe the presence of *A. brevispinus* or coral. Hence, the *A. brevispinus* appeared to be confined to patches of coarse sand substrate dominated by solitary dendrophylliid corals (*Heteropsammia* cf. *cochlea*), and predation by the starfish on the coral was confirmed through observation of stomach eversion around the coral. We also observed the western Pacific crown-of-thorns starfish on

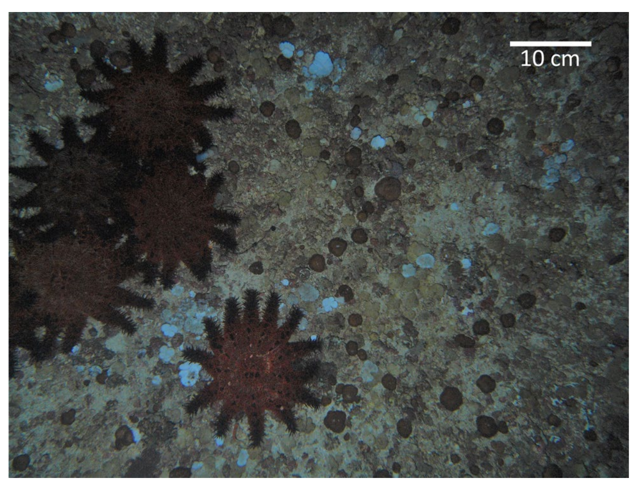


**Fig. 4** An aggregation of six *Acanthaster brevispinus* among *Cycloseris distorta* mushroom corals in 70-m water depth on Rankin Bank off north-western Australia in 2013. Scale is approximate. (photograph A. Heyward)

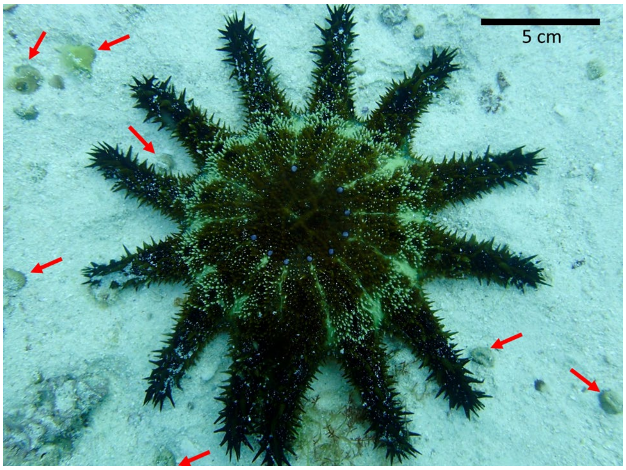


**Fig. 5** *Acanthaster brevispinus* (diameter = 20 cm) on reef habitat in 21-m depth at Fairfax Islands reef. Red arrows point out solitary corals (*Heteropsammia* cf. *cochlea*) on which the starfish were feeding (photograph D. Godoy)

other parts of Fairfax Islands reef on shallower reef habitats during the same survey in February 2020.

## Discussion

This study provides the first confirmed observation that *A. brevispinus* preys on hard corals. Earlier authors have suggested that *A. brevispinus* was an omnivore (Moran 1986) and/or a molluscan predator (Lucas and Jones 1976). Since then, it has been confirmed as feeding on soft corals in the field (Yuasa et al. 2017) and now hard corals (this study). Lucas and Jones (1976) hypothesised that *Acanthaster planci* had evolved from an *A. brevispinus* like ancestor with a generalist diet to become a specialised coral predator. However, there is no evidence that *A. brevispinus* is an omnivore, and our observations suggest that both species are predators, and that at a minimum, *A. brevispinus* is a facultative predator of hard corals. It is worthwhile noting that although crown-of-thorns starfish *A. planci* sensu lato are regarded as specialist, hard coral predators, they have been recorded consuming soft corals, particularly when hard coral availability is scarce (e.g. Chesher 1969). The western Pacific crown-of-thorns starfish has been recorded from depths of 0 to 65 m (Rowe and Gates 1995). Our observations of *A. brevispinus* at 21-m depth on the Great Barrier Reef and those of Yuasa et al. (2017) at 20-m depth in Japan are the shallowest records for *A. brevispinus* which has been recorded to 63 m (see Introduction). Both these recent observations place *A. brevispinus* in sympatric depths and habitats of the western Pacific crown-of-thorns starfish. Indeed, Yuasa et al. (2017) observed both species living in sympatry but with *A. brevispinus* only consuming soft corals. Despite several field studies on feeding preferences of the western Pacific crown-of-thorns starfish on the Great Barrier Reef (e.g. De'Ath and Moran 1998, Keesing 2021) and in Western Australia (Keesing et al. 2019), we are unaware of any records of predation on *Heteropsammia* or *Cycloseris*. Thus, despite living in sympatry, there is as yet no evidence that the western Pacific crown-of-thorns starfish and *A. brevispinus* share the same primary food resource. The observation of regenerating arms on the *A. brevispinus* collected off Ningaloo is suggestive of sublethal predation (McCallum et al. 1989) and indicates that as well as being predators that *A. brevispinus* are themselves predated upon.

The paucity of observations of *A. brevispinus* off the western coast of Australia and our low rate of observations from ROV surveys indicates the species is uncommon there. However, the observations recorded here made elsewhere during shoal surveys on the northwest shelf (e.g. Figure 3) and those made on the southern Great Barrier Reef indicate that the species maybe be locally more abundant. Moran (1986) stated that *A. brevispinus* was not known to undergo population outbreaks. If that is so, then the species would be of little threat to mesophotic coral communities. However, our confirmation that *A. brevispinus* is a corallivore, and our observations of small aggregations of *A. brevispinus* in situations where they are feeding or likely to be feeding on fungiid and dendrophylliid coral beds suggest that the species can occur at higher densities than previously considered. It is therefore possible that *A. brevispinus* might represent a threat to mesophotic solitary coral assemblages. Assemblages of solitary corals are an important component of reef communities elsewhere off north-western Australia (Heyward and Radford 2019) and Indonesia (Hoeksema 2012) and on the Great Barrier Reef where *C. distorta* exist in beds of more than 1000 per $m^2$ (Goreau and Yonge 1968), and *Heteropsammia cochlea* occur at densities of up to 158 per $m^2$ (Fisk 1983). Fine et al. (2013) found that *H. cochlea* at Wistari Reef, nearby to our site on the southern Great Barrier Reef, prefer coarse coral sand habitats similar to the inter-reefal habitat at our study site and are absent in very fine sand habitats. Often occurring on unconsolidated substrata adjacent to coral reef habitats, solitary corals may exist as monospecific or multi-species assemblages and extend as banks more than a kilometre long and on some shoals in the Timor Sea and Browse Basin where they can constitute a high proportion of the benthic habitat cover (Heyward et al. 2012, 2017). These mesophotic mushroom coral beds and those comprised of other solitary corals form an important habitat for a large range of invertebrate and fish taxa (Hoeksema et al. 2012). These habitats are likely to represent a specific niche of environmental conditions which favour the solitary corals. These factors along with specialised adaptations (e.g. light harvesting from reflections off coarse sand, Fine et al. 2013) allow the corals to outcompete algae and other habitat forming invertebrate biota such as sponges and soft corals.

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**Declarations**

**Competing interests** The authors have no competing interests to declare.



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