

Status of the coral reefs of North Keeling Island and new records of fishes within Pulu Keeling National Park, 2010



Stegastes insularis, a damselfish previously thought to be endemic to Christmas Island, is a significant new record for North Keeling Island, Pulu Keeling National Park.

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EXECUTIVE SUMMARY

Pulu Keeling National Park encompasses North Keeling Island and is situated 24 km north of the South Keeling Atoll. Together the northern and southern islands comprise the Cocos (Keeling) Islands and support one of the most remote coral reef communities in the world. Underwater visual surveys were conducted on March 4 2010 at “The Landing” on the west coast of North Keeling Island to determine: 1) the health of the coral reefs, and 2) new records of marine fishes, occurring within Pulu Keeling National Park. Eight fish species observed during the surveys represent new records for the Park increasing the number of recorded marine fishes to 201 from 41 families. The new records are: *Caracanthus maculatus*, *Cephalopholis urodeta*, *Lutjanus kasmira*, *Forcipiger longirostris*, *Stegastes insularis*, *Cirripectes stigmaticus*, *Ptereleotris zebra* and *Acanthurus mata*. The most notable new record was *S. insularis*, which was previously thought to be endemic to Christmas Island (Indian Ocean) and Marcus Island (Pacific Ocean). Several individuals of the following hybrid combination were also observed: *Naso lituratus* x *N. elegans*, *Acanthurus nigricans* x *A. leucosternon*, and *Melichthys indicus* x *M. vidua*. Within the survey area there was no sign of coral bleaching, white syndrome coral disease or crown-of-thorns starfish. These 3 impacts have previously caused significant coral mortality in the Cocos-Christmas region and still pose a significant future threat to marine biodiversity within the Pulu Keeling National Park. Management of Pulu Keeling National Park should continue to minimise the effect of local stressors (e.g. pollution, fishing of herbivorous fishes) to ensure the reefs within the Park have the best chance of coping with global threats and maximise the recovery from any impacts.

INTRODUCTION

Pulu Keeling National Park is part of the Cocos (Keeling) Islands and lies 24 km north of the southern atoll, and approximately 900 km west of Christmas Island. The National Park includes North Keeling Island and the surrounding waters out to 1.5 km from the shore. Within these waters lies a thin margin (50 -200 m) of coral reef. Coral reefs worldwide are under threat, with remote reefs in Indian Ocean being among the worst affected. In 1998, a mass coral bleaching event resulted in 90-99% mortality of corals on many Indian Ocean reefs (Goreau *et al.*, 2000), and remote locations proved particularly vulnerable to these disturbances because isolation has limited their recovery (Graham *et al.*, 2006). Coral bleaching, crown-of-thorns starfish and coral disease has also affected reefs in the Cocos-Christmas region. In 1970's, significant coral loss occurred on the southern atoll of the Cocos Islands due to an outbreak of crown-of-thorns starfish (COTS) (Colin, 1977). COTS have also been recorded at North Keeling Island in 2002 but not in outbreak densities (Hobbs et al. 2005). In the 1980's and 1990's, coral bleaching caused major coral mortality at both Cocos and Christmas Island (Goreau *et al.*, 2000; Wells and Berry, 2000). More recently, an outbreak of white syndrome coral disease resulted in widespread mortality of plate corals at Christmas Island in 2008 (Hobbs and Frisch, 2010). White syndrome disease was also present in 2008 on a small number of plate corals at the southern atoll of the Cocos Islands, but no disease was recorded on plate corals at North Keeling Island (Hobbs and Frisch, 2010). It is not known whether this disease has now spread to North Keeling Islands, or whether there has been any recent mortality of corals from bleaching and COTS. Given the recent history of disturbances to coral reefs in the Cocos-Christmas region, and the vulnerability of isolated islands, it is important to determine what impacts are affecting North Keeling Island and what the consequences have been.

Coral reefs are important ecosystems because they support some of the highest diversity communities on earth, including thousands of reef fishes. So far, 193 species of fish (from 40 families) have been recorded at North Keeling Island (Hobbs, 2009). This number will increase with additional surveys given that approximately 550 species have been recorded from the South Keeling Atoll (Allen and Smith-Vaniz,

1994). However, it is not possible to assume all species present on the southern atoll occur at North Keeling Island and vice versa (Hobbs, 2009). Therefore, specific surveys at North Keeling Island are required to construct a species list of fishes present in Pulu Keeling National Park.

The aims of this present study were to: 1) determine the health of the coral reefs within Pulu Keeling National Park by examining corals for bleaching, white syndrome disease and COTS; and 2), identify new records of fishes to be added to the species list for Pulu Keeling National Park.

METHODS

On the 4th of March 2010, Parks Australia visited North Keeling Island and i was able to undertake underwater visual surveys of coral reef health and the fish fauna present at “The Landing” on the western side of North Keeling Island. Surveys were conducted whilst snorkelling and freediving between the shoreline and 15 m depth. The survey area extended 100 m north and south of the boat (RJ Hawke) anchored in the sandy area at “The Landing”. The fringing reef in this area extends about 80 m from the shoreline to the outer reef dropoff, which begins at 15 m depth. Fishes and corals on the outer reef dropoff (below 15 m) were not able to surveyed whilst snorkelling.

To build on the list of fish species present in Pulu Keeling National Park, fishes in the survey area were identified to species level and their names recorded on underwater paper where identification was certain. Where species identity was uncertain, underwater photographs were taken and the identity was later confirmed using fish guides (Allen *et al.*, 2007; Froese and Pauly, 2007). Only species whose identity was certain were added to the North Keeling Island fish list.

To determine the health of the coral reef within the survey area I examined corals for evidence of bleaching, COTS feeding scars and white syndrome coral disease. These three impacts can be identified by white areas on the coral, indicative of a loss of symbiotic algae (bleaching), or tissue loss and exposure of the white underlying skeleton (disease and COTS). Following tissue death, areas of bare skeleton are

usually colonised by filamentous algae. The survey area was also searched for COTS by freediving and inspecting under corals and ledges where COTS often hide. Because white syndrome mainly affects *Acropora* plate corals (Hobbs and Frisch, 2010), every one of these corals in the survey area was closely inspected for the presence of disease (as defined in Hobbs and Frisch, 2010).

RESULTS

Eight fish species observed during the surveys were new records for Pulu Keeling National Park (Appendix 1). This increases the total number of fishes recorded in the Park to 201. *Cirripectes stigmaticus* represents the first member of the Bleniidae family recorded at North Keeling Island, thereby increasing the number of families present in Pulu Keeling National Park to 41. The most noteworthy new record is the Island Gregory (*Stegastes insularis*). This damselfish was thought to be endemic to Christmas Island (there is also a separate population or sub-species on Marcus Island in the Pacific Ocean). Eight individuals were observed in the survey area at Pulu Keeling National Park.

There were also a number of hybrid fishes observed from the three following combinations: *Naso lituratus* x *N. elegans* (Acanthuridae), *Acanthurus nigricans* x *A. leucosternon*, and *Melichthys indicus* x *M. vidua* (Balistidae). In two of these cases, one of the parent species (listed second) is rare at North Keeling Island. The abundances of the *Melichthys* species were not recorded.

There were no signs of recent coral mortality within the survey area at “The Landing” on the western side of North Keeling Island. There were no bleached corals, no COTS and no recent feeding scars. There was no evidence of white syndrome coral disease on any of the 62 *Acropora* plate corals, on any other coral taxa examined at the survey site.

DISCUSSION

The fish surveys revealed 8 new records for Pulu Keeling National Park, bringing the total number of recorded fish species in the Park to 201. This number will increase

particularly for cryptic groups, such as blennies and gobies, which are severely underrepresented in the current list. These cryptic groups are best surveyed using ichthyocides and anaesthetics. Due to the smaller size, greater isolation, and lower diversity of habitats, Pulu Keeling National Park is likely to have less fish species than the southern atoll. However, the fishes in the Park may not necessarily represent a subset of the 550 species recorded in the southern atoll, as already evident by the occurrence of species in the Park that have not been found on the southern atoll (Hobbs, 2009).

The most notable new record from the 2010 surveys was the occurrence of *Stegastes insularis* in Pulu Keeling National Park. Although only eight individuals were seen, they probably occur outside of the survey and the North Keeling population is probably much larger. This species was previously thought to be endemic to Christmas Island (Allen *et al.*, 2007) where it is the most abundant damselfish in the shallows (Hobbs unpublished data). A population also occurs at Marcus Island in the Pacific Ocean (Allen *et al.*, 2007). However due to the great distance between the Indian and Pacific Ocean populations (> 3000 km), these isolated populations are likely to be speciating and may already represent different sub-species or species. Five individuals were also seen on the southern side of South Keeling atoll following the 2010 North Keeling surveys. The occurrence of *S. insularis* at the Cocos Islands could represent a recent range expansion of the Christmas Island population, and/or a relict of a once widespread population of this species. Molecular analyses are required to determine the origin of the Cocos Islands population. The occurrence of this Christmas-Cocos endemic species in Pulu Keeling National Park adds to the uniqueness of the marine biodiversity in the Park. The Park now sustains a second population of this species, which may prove critical to avoiding global extinction should the Christmas Island population go extinct.

The occurrence of several hybrids within the Pulu Keeling National Park demonstrates that the Park lies within the Indo-Pacific suture zone (Hobbs *et al.*, 2009). This zone includes Christmas Island and South Keeling atoll and represents the mixing of Indian and Pacific Ocean species (Hobbs and Salmond, 2008). This mixing has resulted in extensive hybridisation and there are more reef fish hybrids recorded in this zone than any other coral reef location in the world (Hobbs *et al.*, 2009). The

evolutionary consequences of this hybridisation have not yet been explored, however, hybridisation has played a significant role in the speciation of freshwater fishes (Seehausen, 2004). It is important that the Park continue to protect the habitat and processes that facilitate this natural hybridisation, because the Park and surrounding islands may prove to be an important evolutionary arena for fishes and other reef organisms.

Coral bleaching is considered the major threat to reefs worldwide, particularly remote reefs which appear slow to recovery from mass bleaching events (Graham *et al.*, 2006). At the time of the 2010 survey, the water in the Cocos region was warm (29°C – author’s dive computer readings at 5 m depth at 5 outer reef locations on the southern atoll at the time of surveys), and bleaching was occurring at Christmas Island (M. Gant pers. comm.). However, there was no sign of current coral bleaching or recent (last 6 months) coral mortality within the survey area at Pulu Keeling National Park during the 2010 survey. There was also no evidence of coral bleaching in 2002 and 2004 censuses within the survey area (Hobbs *et al.*, 2005). There was also no sign of bleaching in surveys conducted on South Keeling atoll in March 2010. This indicates that water temperatures during the hottest part of the year (December to March) were not high enough at the Cocos Islands in 2010 to cause corals to bleach.

In 2008, coral disease surveys revealed an outbreak of white syndrome on *Acropora* plate corals at Christmas Island, low levels of white syndrome at the South Keeling Atoll, and no sign of white syndrome at Pulu Keeling National Park (Hobbs and Frisch, 2010). In 2010, white syndrome coral disease remains absent in *Acropora* plate corals within the survey area at Pulu Keeling National Park. Previous surveys in 2002 and 2004 at North Keeling Island did not find any sign of coral disease (Hobbs *et al.*, 2005). There was some white syndrome (<0.5% of *Acropora* plate corals affected) on the South Keeling atoll in 2010 surveys, which was similar to the levels of disease recorded at these survey sites in 2008 (Hobbs and Frisch, 2010). White syndrome coral disease was also present at Christmas Island in February and March 2010, but was not as prevalent as levels recorded during the outbreak that occurred in February 2008 (Hobbs and Frisch, 2010). The presence of white syndrome on the South Keeling Atoll, and the 2008 outbreak of this disease and subsequent mass mortality of plate corals at Christmas Island, means that corals at North Keeling

Island may be affected by white syndrome in the future. If an outbreak of white syndrome did occur at North Keeling Island, recovery is likely to be slow due to the remoteness of the location (Graham *et al.*, 2006). Developing management strategies to prevent an outbreak of white syndrome in Pulu Keeling National Park is limited at this stage because the cause and transmission of white syndrome at Christmas and South Keeling Atoll have not been investigated. Increasing sea temperatures and pollution may promote disease by compromising the host (coral) immune system (Harvell *et al.*, 1999).

There was no sign of crown-of-thorns (COTS) within the survey area at North Keeling Island. There have been outbreaks of COTS in the South Keeling Atoll before, causing significant coral mortality (Colin, 1977; Hobbs *et al.*, 2005). Three COTS individuals were observed in the survey area at North Keeling Island in 2002 but not in 2004 (Hobbs *et al.* 2005). In 2010, only found 4 COTS were recorded at 6 sites on the southern atoll. However, the southern side of the atoll was not surveyed which was an area where a dense aggregation was observed below 30 m depth during 2008 surveys (Hobbs *et al.* unpublished data). Only one COTS was recorded in surveys in 2010 at Christmas Island, although there is no evidence from previous surveys or reports that COTS have ever been abundant at this island (Gilligan *et al.*, 2008; Hobbs unpublished data). While COTS may be absent in the survey area at North Keeling Island in 2010, they may be present at other locations or depths around the island. The presence of COTS at the southern atoll, the history of outbreaks at the southern atoll, and past records of COTS at North Keeling Island indicate that COTS may pose a future threat to the coral reef system within Pulu Keeling National Park. The cause of COTS outbreaks has not yet been determined.

North Keeling Island lies in a unique bioregion for Indo-Pacific marine organisms. It is important that Pulu Keeling National Park protects both the biodiversity of this region and the processes that make this area unique. Future threats to the coral reefs within the Park include COTS, coral bleaching and corals diseases. While threats such as coral bleaching and coral disease have been linked to global scale issues (e.g. rising sea temperatures due to global warming), local impacts (e.g. pollution) can increase the susceptibility of corals to disease and reduce the thermal tolerance of corals to bleaching (Harvell *et al.*, 1999; Carilli *et al.*. 2009). Management of Pulu Keeling

National Park should continue to minimise the effect of local stressors (e.g. pollution, fishing of herbivorous fishes) to ensure the reef has the best chance of coping with global threats and maximise its recovery from such impacts.

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Appendix 1: New records of fish species occurring at North Keeling Island based on underwater observations and photographs taken on March 4, 2010. The list follows the format and nomenclature used by Allen and Smith-Vaniz 1994, although Ptereleotridae is now classed as a family. The geographic distribution of listed species follows that of Allen and Smith-Vaniz, 1994 “Asterisk or numbers preceding species names indicate the following distributional data: * = also known from Christmas Island (Allen et al. 2007); 1 = widespread Indo-Pacific or Indo-west Pacific; 2 = West Pacific species that reach their western distributional limit at Cocos (Keeling); 3 = Indian Ocean species (may include western extremity of west Pacific); 4 = Circumtropical or cosmopolitan”. Species that are new records for the Cocos Islands are listed in bold.

Caracanthidae – Orbicular velvetfishes

2* *Caracanthus maculatus* (Gray, 1831)

Serranidae – Sea basses

1 *Cephalopholis urodeta* (Forster, 1801)

Lutjanidae – Snappers

1* *Lutjanus kasmira* (Forsskål, 1775)

Chaetodontidae – Butterflyfishes

1* *Forcipiger longirostris* (Broussonet, 1782)

Pomacentridae – Damselfishes

* ***Stegastes insularis* Allen and Emery, 1985** **new record for Cocos Islands**

Blenniidae - Blennies

1* *Cirripectes stigmaticus* Strasburg & Schultz, 1953

Ptereleotridae – Dartfishes

1* *Ptereleotris zebra* (Fowler, 1938)

Acanthuridae – Surgeonfishes

1* *Acanthurus mata* (Cuvier, 1829)