



## New records of Angelfishes (Pomacanthidae) and Butterflyfishes (Chaetodontidae) from Christmas and Cocos (Keeling) Islands, Indian Ocean

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**Abstract.** Extensive underwater surveys of marine fishes were conducted on the outer reef slope at Christmas Island and the Cocos (Keeling) Islands in the northeastern Indian Ocean from May to September 2005. Seven species of angelfishes and butterflyfishes were found to be new records. *Chaetodon adiergastos*, *C. collare*, *C. decussatus*, *C. rafflesii* and *Genicanthus bellus* were new records for Christmas Island, and *Centropyge bicolor* and *C. flavicauda* were new records for the Cocos (Keeling) Islands. Details on the depth, location, number of individuals and body size are presented.

**Key words:** Christmas Island, Cocos (Keeling) Islands, marine fish, coral reefs, Chaetodontidae, Pomacanthidae

### Introduction

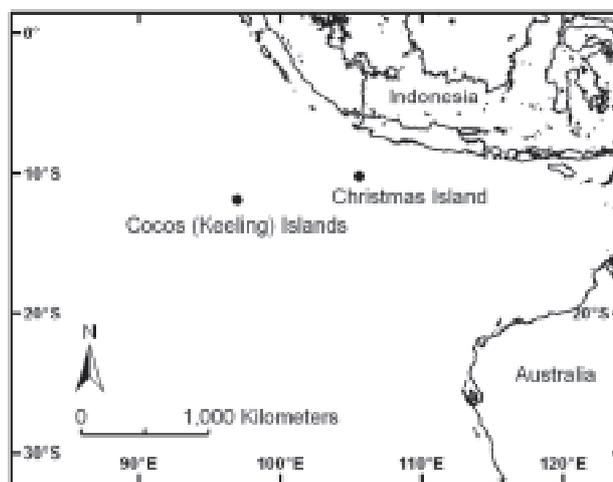
Christmas Island (10°30'S 105°40'E) and the Cocos (Keeling) Islands (12°12'S 96°54'E) are isolated oceanic islands situated in the northeast Indian Ocean approximately 300 km south and 1000 km southwest of Java (Indonesia), respectively. Although these Islands are located in the Indian Ocean, they represent the western edge of the Western Pacific marine biogeographic region, resulting in a marine faunal assemblage that is typical of that found in the tropical Indo-West Pacific (Woodroffe and Berry, 1994). The coral reefs that fringe these Islands harbour a diverse community of species, some of which are endemic. However, detailed studies of this marine fauna have been limited by the remoteness of these Islands.

Approximately 575 and 550 species of fish have been recorded at Christmas Island and the Cocos Islands, respectively (Allen and Steene, 1988; Allen and Smith-Vaniz, 1994). These numbers are relatively low compared to other tropical islands and this is probably due to the small size and isolation of these Islands as well as undersampling (Allen and Smith-Vaniz, 1994). Sampling of fishes at these Islands has primarily been through the

use of chemical ichthyocides and spears, however, easily recognised species (e.g., angelfishes and butterflyfishes) were not collected because they could be accurately identified by sight (Allen and Steene, 1988). Angelfishes (family Pomacanthidae) and butterflyfishes (family Chaetodontidae) are distributed throughout the tropics and are most commonly found on coral reefs where they form discrete adult populations that are linked by a dispersive larval phase. The aim of this study was to identify new records of angelfishes and butterflyfishes at Christmas Island and the Cocos Islands using underwater visual surveys.

### Materials and Methods

To document the occurrence of angelfishes and butterflyfishes, underwater surveys were conducted from May to September 2005, at a total of 12 sites on the outer reef slope of the eastern, northern and western sides of both Christmas Island and the Cocos Islands. The southern (exposed) side of the Islands could not be surveyed due to unsuitable weather conditions. Surveys were conducted by 2 or 3 SCUBA divers experienced in underwater visual identification of angelfishes and butterflyfishes. At least two dives were completed at each site and observations were made at depths of 0 to 40 m or more (depending on the site). For each new record, we noted the geographic location, depth, approximate size (Total Length: TL) and the number of individuals. Species were only recorded where visual identification was certain. Visual identification is an accurate and commonly used method for identifying angelfishes and butterflyfishes because of their distinct and well-known colour patterns (Allen and Steene, 1988). To determine if a species was a new record we examined species lists for Christmas (Allen and Steene, 1988) and Cocos Islands (Allen and Smith-Vaniz, 1994) in combination with published geographic ranges for angelfishes and butterflyfishes (Allen *et al.* 1998). All but one of the new records described here were observed during our 2005 surveys. Information on the new record of *Chaetodon decussatus* was provided by G. Allen based on his observations in July 2006.



**Figure 1.** The location of Christmas Island and the Cocos (Keeling) Islands in the northeast Indian Ocean.

## Results

Seven species of fish were identified as new records for either Christmas or Cocos Islands (Table 1). Four butterflyfishes (*Chaetodon adiergastos*, *C. collare*, *C. decussatus* and *C. rafflesi*) and one angelfish (*Genicanthus bellus*) were new records for Christmas Island and two angelfishes (*Centropyge bicolor*, *C. flavicauda*) were new records for the Cocos Islands. One to fifteen individuals of each species were recorded on the outer reef slope at depths of 2–65 m and were generally of adult size (Table 1).

## Discussion

These seven new records increase the number of angelfish species occurring at Christmas and Cocos Islands to 13 and 9, respectively, and increase the number of known butterflyfish species at Christmas Island to 31. The body size, colouration and the depth of water that the individuals were observed at Christmas and Cocos Islands were similar to that reported for these species in other locations (Allen *et al.* 1998).

The seven new records at Christmas and Cocos Islands represent range extensions for these species. The bicolor angelfish, *Centropyge bicolor*, occurs from Indonesia and Christmas Island eastward to Polynesia (Allen *et al.* 1998) and the new Cocos Islands record now represents the most western edge of its range. The other new record from Cocos Islands was *Centropyge flavicauda*, which is widely distributed throughout the Indo-Pacific, ranging from East Africa to the Tuamotu Archipelago in the Pacific Ocean and also occurs at Christmas Island (Allen *et al.* 1998). The closest potential source populations of *C. bicolor* and *C. flavicauda* are at Christmas Island and Indonesia, both of which are approximately 1000 km from the Cocos Islands. The new record of the angelfish *Genicanthus bellus* at Christmas Island is notable because it is known only from scattered locations in the Pacific Ocean such as Tahiti, Philippines, Mariana and Marshall Islands (Allen *et al.* 1998). This new record at Christmas Island is only the second location in the Indian Ocean where this species has been found, the other location being the Cocos Islands.

*Chaetodon adiergastos* was one of four new butterflyfish records from Christmas Island. This species' distribution extends from Japan to Indonesia and northwest Australia (Allen *et al.* 1998), and the new

record from Christmas Island is a southwestern extension of its current range. *Chaetodon rafflesi* is distributed from India to the Tuamotu Archipelago in the Pacific Ocean (Allen *et al.* 1998) and the new record at Christmas Island also represents a southwestern range extension. *Chaetodon decussatus* occurs from Oman to Indonesia (Allen *et al.* 1998), and this new record increases the southern area of its range. *Chaetodon collare* is found from the Arabian Peninsula in the western Indian Ocean eastward to the Philippines (Allen *et al.* 1998), and Christmas Island is now the southernmost known record for this species. All four species of butterflyfish occur in Indonesia and due to its relatively close proximity to Christmas Island (approximately 300 km), Indonesia would be considered the most likely location of the source populations.

Five of the seven species identified as new records can be considered extremely rare as only 1 or 2 individuals were observed during extensive surveys (*Centropyge flavicauda*, *Chaetodon adiergastos*, *Ch. collare*, *Ch. decussatus* and *Ch. rafflesi*). Furthermore, these species were not recorded during previous surveys in 2001 and 2002 (Authors' unpublished data). These four species are conspicuous and usually inhabit shallow water (0–40 m: Allen *et al.* 1998), so it is unlikely that a significant number of individuals went unnoticed. With such a small population, it is most likely that these species are vagrants that have arrived as larvae from distant locations. Without further arrivals it would be difficult for populations of these vagrant species to persist at Christmas and Cocos Islands. However, the adult size of the individuals observed indicates that at least some individuals that arrive as larvae are able to survive and grow to adulthood, raising the potential to establish a viable population. Such appears to be the case with the 12 *Centropyge bicolor* individuals at the Cocos Islands. All 12 individuals were observed in discrete social groups (2–4 individuals), and some contained ripe gonads that released gametes when the abdomen was gently squeezed. This very small reproductive population may potentially increase and become established, especially if facilitated by self-recruitment rather than relying on larvae from distant locations. Although we observed at least 15 *Genicanthus bellus* individuals in 3 discrete social groups, the abundance of this species at Christmas Island is unknown because we were unable to adequately survey the deepwater habitats where it commonly lives (50–100 m: Allen *et al.* 1998). There is potential for some of these rare, vagrant species

**Table 1**

New records of butterflyfish (Chaetodontidae) and angelfish (Pomacanthidae) from Christmas Island (CI) and Cocos (Keeling) Islands (CKI). The size of the individuals was recorded as the Total Length (TL) estimated to the nearest cm. N = total number of individuals observed.

Species	Location	Depth (m)	Size (cm)	N
<i>Centropyge bicolor</i> (Bloch 1787)	Direction Island, CKI (12°5'11"S 96°52'34"E)	8–19	8–11	12
<i>Centropyge flavicauda</i> Fraser-Brunner 1933	Direction Island, CKI (12°5'11"S 96°52'34"E)	35	4–5	2
<i>Chaetodon adiergastos</i> Seale 1910	Boat Cave, CI (10°27'19"S 105°34'10"E)	2	14	2
<i>Chaetodon collare</i> Bloch 1787	Boat Cave, CI (10°27'19"S 105°34'10"E)	2	13	1
<i>Chaetodon decussatus</i> Cuvier 1831	Flying Fish Cove, CI (10°25'44"S 105°40'00"E)	8	13	1
<i>Chaetodon rafflesi</i> Bennett 1830	Police Station, CI (10°25'8"S 105°40'21"E)	3	13	1
<i>Genicanthus bellus</i> Randall 1975	Boat Cave (10°27'19"S 105°34'10"E) and Police Station, CI (10°25'8"S 105°40'21"E)	62–65	8–14	15

to interbreed with closely related species with established populations, thus forming hybrids, as has been reported for a number of angelfishes and butterflyfishes (Allen *et al.* 1998).

Further studies at Christmas and Cocos Islands will ultimately reveal more new records, and possibly new species. These discoveries are likely to occur in areas that have been poorly sampled, such as the southern coastline, deep slopes (>50 m) and cave microhabitats.

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