

# North-eastern range extension of the anemone *Stichodactyla haddoni* to the Marshall Islands represents a new record of host use by the endemic anemonefish *Amphiprion tricinctus*

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*Amphiprion tricinctus* is an anemonefish endemic to the Marshall Islands that was previously reported to inhabit four species of sea anemone. Underwater visual surveys in 2009 and 2010 located five individuals of the anemone *Stichodactyla haddoni* in the shallow lagoon of Majuro Atoll. This is the first record of *S. haddoni* in the Marshall Islands and a significant north-eastern range extension by 2200 km from its nearest record in Chuuk State, Federated States of Micronesia. *Stichodactyla haddoni* was inhabited by juvenile and adult *A. tricinctus*. This report is the first to describe a symbiotic relationship between *A. tricinctus* and *S. haddoni*. The number of host anemone species inhabited by *A. tricinctus* now extends to five.

**Keywords:** *Amphiprion tricinctus*, Majuro Atoll, Marshall Islands, Pomacentridae, *Stichodactyla haddoni*, Stichodactylidae

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## INTRODUCTION

Anemonefish (family Pomacentridae) have an obligate symbiotic relationship with sea anemones. Globally, anemonefish inhabit ten different species of anemones, however each species of anemonefish only associates with certain anemone species (Fautin & Allen, 1997). *Amphiprion tricinctus* (Schultz & Welander, 1953 in Schultz *et al.*, 1953) is a species of anemonefish endemic to the Marshall Islands and reportedly inhabits four species of sea anemones: *Entacmaea quadricolor*; *Heteractis aurora*; *H. crispa*; and *Stichodactyla mertensi* (Fautin & Allen, 1997). *Stichodactyla haddoni* (Saville-Kent, 1893) is an anemone that is distributed from the Red Sea and Indian Ocean to New Caledonia and Japan in the Pacific Ocean (Fautin & Allen, 1997). In various parts of its geographical range, *S. haddoni* is inhabited by six species of anemonefish (*A. akindynos*, *A. chrysogaster*, *A. chrysopterus*, *A. clarkii*, *A. polymnus* and *A. sebae*). In this study we report the first record of *S. haddoni* in the Marshall Islands, and in addition, that it is inhabited by the endemic anemonefish *A. tricinctus*, which represents a newly-described symbiotic relationship.

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## MATERIALS AND METHODS

Underwater visual censuses of anemonefish and their host anemones were conducted on SCUBA at 25 sites across three atolls (Majuro, Rongerik and Rongelap) in the Republic of the Marshall Islands (Central Pacific Ocean). Anemones and anemonefish were identified following the descriptions in Fautin & Allen (1997), and included observations of diagnostic characteristics on the column and underside of the oral disc of anemones. Sites were situated in a range of habitats including lagoons, reef passes and outer reef slopes. At each site, three replicate 250 × 5 m transects were conducted at two depths (3 and 10 m where possible). After completing the surveys, observations of anemonefish were also made during roving swims adjacent to the transect area. The size of any host anemones encountered in, or adjacent to, transects was measured using a ruler (tentacle crown long diameter: Huebner *et al.*, 2012). To determine the sex and maturity of the anemonefish (*Amphiprion tricinctus*) residing on the focal anemone (*Stichodactyla haddoni*), the two largest individuals were caught (by spearfishing) and their gonads dissected and macroscopically examined. The status of the gonads was classified following the criteria described in Mackie *et al.* (2005), with F4 and M3 representing mature females and males, respectively.



**Fig. 1.** A large social group of the endemic anemonefish *Amphiprion tricinctus* occupying the sea anemone *Stichodactyla haddoni* in the lagoon of Majuro Atoll at the Marshall Islands.

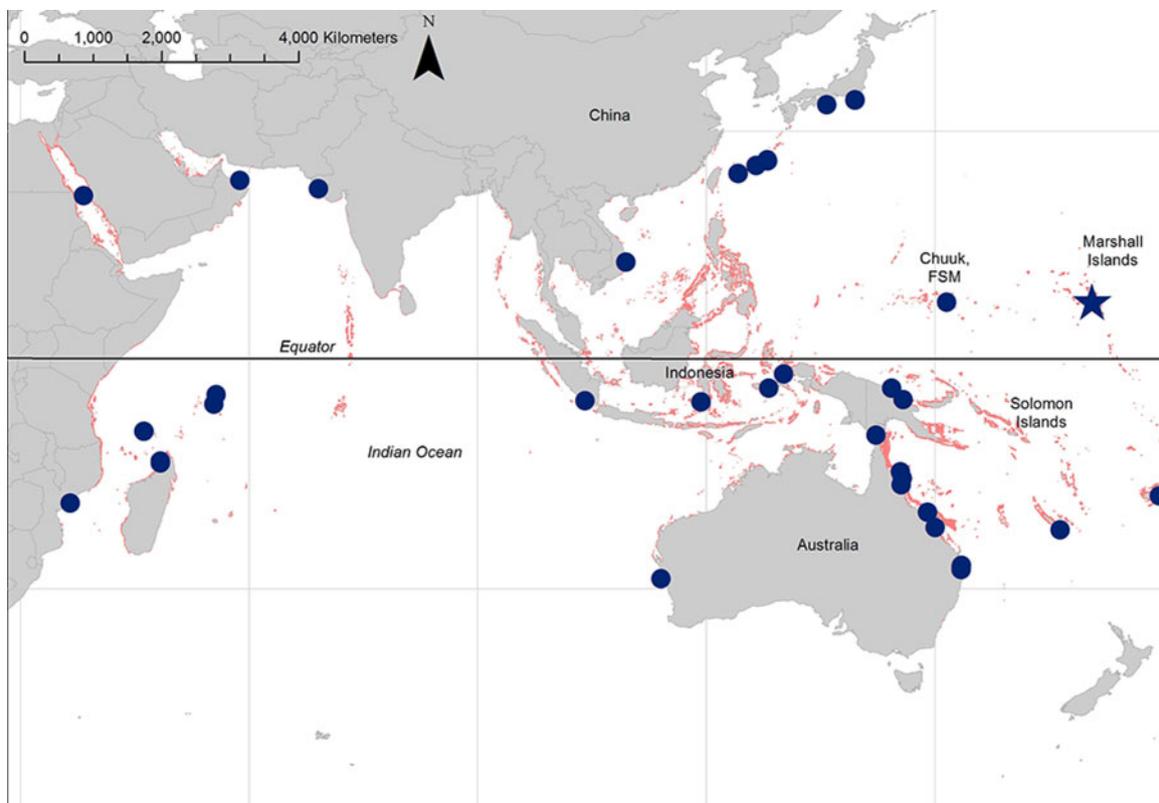
## RESULTS

Four species of anemonefish (*Amphiprion chrysopterus*, *A. melanopus*, *A. perideraion* and *A. tricinctus*) and six species of host anemones (*Entacmaea quadricolor*, *Heteractis aurora*, *H. crispa*, *H. magnifica*, *Stichodactyla haddoni* and *S. mertensi*) were recorded during the underwater surveys. The most notable observation was the new record of *S. haddoni* in the Marshall Islands and its occupation by the anemonefish *A. tricinctus* (Figure 1). *Stichodactyla haddoni*

is now the fifth species of anemone inhabited by *A. tricinctus* and represents a new case of symbiosis between these two species. Five separate *S. haddoni* anemones were observed between 1 and 8 m depth adjacent to the shoreline (and city of Majuro) at a site in the eastern lagoon of Majuro Atoll (N7.106155 E171.37187). The diameter of the anemones was approximately 30 to 50 cm. Each of the anemones was inhabited by *A. tricinctus* (orange-brown morph) and the number of individuals per anemone was 2,2,4,6 and 9. Each anemone contained two large *A. tricinctus* individuals (>7 cm total length), which likely represent adult breeding pairs as the gonads from one *A. tricinctus* pair revealed a mature female (F4) and mature male (M3).

## DISCUSSION

The new record of *Stichodactyla haddoni* at the Marshall Islands is a significant north-eastern extension of its range (Fautin & Allen, 1997) that is more than 2200 km from the nearest Ocean Biogeography Information System record (OBIS, 2014) (Figure 2). It therefore represents a significant range extension. Based on reports of longevity and size of sea anemones (Fautin & Allen, 1997) it would appear that *S. haddoni* has probably been in the Marshall Islands for at least ten years prior to our observations. Given the size and number of atolls in the Marshall Islands, and the vast extent of shallow water habitats that have not yet been surveyed, it is possible that *S. haddoni* has been present in the Marshall Islands for much longer (and is more widespread). Based on its current geographical distribution, *S. haddoni* probably colonized the Marshall Islands from the nearest known



**Fig. 2.** Map of occurrence records for *Stichodactyla haddoni* (indicated by dots) (from OBIS, 2014) and the location of the new record in the Marshall Islands indicated by a star.

extant populations to the west (e.g. Chuuk, Japan, Papua New Guinea and New Caledonia), or from closer locations where populations remain undetected or have gone extinct. The region between the extant populations to the west and where we observed the anemones at Majuro in the Marshall Islands contains many coral reef lagoons that may provide favourable habitat for *S. haddoni*. We did not observe *S. haddoni* during surveys in the lagoons of some locations in this region (Pohnpei, Kosrae, Rongelap Atoll, Bikini Atoll and Mili Atoll, 2007–2012: authors' unpublished data). However, there are many other locations that remain un-surveyed in this region and therefore *S. haddoni* may be present, but undetected.

The presence of juveniles and adult breeding pairs indicates that *S. haddoni* provides suitable recruitment and breeding habitat for *Amphiprion tricinctus*. Flexibility in host preferences enables the endemic *A. tricinctus* to use five of the six host anemone species that occur at the Marshall Islands. While endemic species may have an elevated risk of global extinction, the ability to use a greater diversity of hosts reduces the risk of extinction associated with specialization (Munday, 2004). Being able to inhabit a wide range of anemone species may become increasingly important given that rising sea temperatures associated with climate change are causing bleaching and mortality of anemones relied upon by anemonefish (Hobbs *et al.*, 2013).

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## REFERENCES

- Fautin D.G. and Allen G.R.** (1997) *Field guide to anemonefishes and their host sea anemones*. Revised edition. Perth: Western Australian Museum, 160 pp.
- Hobbs J.-P.A., Frisch A.J., Ford B.M., Thums M., Saenz-Agudelo P., Furby K.A. and Berumen M.L.** (2013) Taxonomic, spatial and temporal patterns of bleaching in anemones inhabited by anemonefishes. *PLoS ONE* 8, e70966. doi:10.1371/journal.pone.0070966.
- Huebner L.K., Dailey B., Titus B.M., Khalaf M. and Chadwick N.E.** (2012) Host preference and habitat segregation among Red Sea anemonefish: effects of sea anemone traits and fish life stages. *Marine Ecology Progress Series* 464, 1–15.
- Mackie M.C., Lewis P.D., Gaughan D.J. and Newman S.J.** (2005) Variability in spawning frequency and reproductive development of the narrow-barred Spanish mackerel (*Scomberomorus commerson*) along the west coast of Australia. *Fishery Bulletin* 103, 344–354.
- Munday P.L.** (2004) Habitat loss, resource specialization, and extinction on coral reefs. *Global Change Biology* 10, 1642–1647.
- OBIS** (2014) Available at: <http://www.iobis.org> (accessed 1 March 2014).
- Saville-Kent W.** (1893) *The Great Barrier Reef of Australia: its products and potentialities*. London: W.H. Allen & Co., 387 pp.
- and
- Schultz L.P., Herald E., Lachner E., Welander A. and Woods L.** (1953) *Fishes of the Marshall and Marianas Islands*. Washington, DC: US Government Printing Office.

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