

Sea Anemones That Harbor Symbiotic Pomacentrid Fishes in the Western Pacific

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The relationship between certain tropical Indo-Pacific sea anemones and pomacentrid fishes (genera *Amphiprion*, *Premnas*, and *Dascyllus*) is a classic example of symbiosis. The systematics of *Amphiprion* and *Premnas*—all 26 species of which are obligate symbionts in nature—has been elucidated (Allen, 1972, 1973; Allen and Springer, 1975), and a mechanism allowing anemonefishes to swim unharmed among the host actinian's tentacles has been proposed (Mariscal, 1970; Schlichter, 1975) although it is not universally accepted (Lubbock, 1980). However, until my research was complete the anemones that act as hosts for the fishes were so poorly known that it was not clear whether all Indo-Pacific members of the family Stichodactylidae (previously called the Stoichactidae and including genera *Stichodactyla* [= *Stoichactis*] and *Heteractis* [= *Radianthus*]) participate in such symbioses nor how many other families contain species that may act as hosts to these fishes in nature. Many early descriptions were based on one or a few preserved specimens, and some were so general as to be nearly worthless for differential diagnosis, partly because they did not provide information on some characteristics which are now considered of great taxonomic value, such as nematocysts. The comparative dearth of research on these animals is partly attributable to their restriction to the tropics, and to the relatively large size of some species (their common name is "giant anemone") which makes them difficult to collect, preserve, and study.

Some 30 nominal species of actinians have been implicated in this symbiosis. The type localities of 10 of the 25 or 26 nominal species of stichodactylids and of 1 non-stichodactylid species that harbor symbiotic pomacentrids are in the eastern Malay Archipelago. One approach to determining which species the original description was intended to define is to collect in the type locality.

¹ For more recent publications, see Daphne Gail Fautin.

To this end, I participated in the Rumphius Expedition III, part of a biennial series sponsored by the Indonesian National Institute of Oceanology (Lembaga Oseanologi Nasional or LON), which was held October 30 to November 14, 1977 (the cruise itself was October 13 to 31). Collections of marine biota were made by 4 foreign and approximately 20 Indonesian scientists, under the leadership of Dr. Subagjo Soemodihardjo of LON headquarters, Jakarta, at seven stations in the Kei and Aru Islands and at several sites in the Banda Island group, all part of the Molucca Islands. Preliminary identification and curation of the specimens were carried out afterward at the LON field station, Poka, Ambon. Specimens collected on the Rumphius Expeditions form the basis for a reference collection of eastern Indonesian marine biota, housed at the Poka field station.

With the valued assistance of my counterpart, Ono Kurnaen Sumadhiharga, who maintains the reference collection, I collected 50 lots. These consisted of 14 species of Actiniaria and one of Corallimorpharia, most of which were procured while scuba diving on coral reefs, at depths as great as 17 m. Before being removed from the substratum by hand, most of the anemones were photographed, and data on live appearance, size, habitat, and symbionts were recorded. About half of the actinian species collected belong to family Stichodactylidae, and were associated with 5 species of anemonefishes, as follows:

ACTINIAN SPECIES

(Nomenclature following Dunn [1981])

Stichodactyla gigantea (Forsskål, 1775)*S. meretensii* Brandt, 1835*Heteractis crispa* (Ehrenberg, 1834)*H. magnifica* (Quoy & Gaimard, 1833)*H. aurora* (Quoy & Gaimard, 1833)*Entacmaea quadricolor*

(Rueppell & Leuckart, 1828)

SYMBIOTIC FISH*Amphiprion ocellaris* Cuvier, 1830*A. clarkii* (Bennett, 1830)*A. sandaracinos* Allen, 1972*A. clarkii* (Bennett, 1830)*A. perideraion* Bleeker, 1855*A. ocellaris* Cuvier, 1830*A. perideraion* Bleeker, 1855*A. clarkii* (Bennett, 1830)*Premnas biaculeatus* (Bloch, 1790)

In addition to *Amphiprion* or *Premnas*, *Dascyllus trimaculatus* occurred as a facultative symbiont in some actinians. Two non-stichodactylid species that have been reported as hosting pomacentrids were also collected, one in association with fish.

The corallimorpharian taken in the Aru Islands was *Amplexidiscus fenestrafer* Dunn & Hamner 1980, which I had not previously seen in situ. It

has an unusual mode of feeding, and may be a mimic of the large actinians that host pomacentrid fishes (Hamner and Dunn, 1980).

Following the Rumphius Expedition III, I spent three days at the LON field station on Pari Island in the Seribu Islands of Jakarta Bay, through the courtesy of its supervisor Malikusworo Hutomo. Pari Island is not far from Onrust Island where Verwey (1930) did most of the research for his classic study of anemonefishes. He did not provide names for the host actinians, identifying them only by number. Fortunately, I was able to collect at least one specimen of each of the five species of sea anemones Verwey discussed, and thereby was able to identify those in his study. This visit also provided comparative data with eastern Indonesia—all symbiotic anemones that I collected in Jakarta Bay had also been collected on the Rumphius Expedition III, but their fish faunas were slightly different, as follows:

VERWEY'S NUMBER	ACTINIAN SPECIES (Nomenclature following Dunn [1981])	SYMBIOTIC FISH ACCORDING TO VERWEY	SYMBIOTIC FISH ACCORDING TO ALLEN
1	<i>Stichodactyla gigantea</i> (Forsskål, 1775)	<i>Amphiprion percula</i>	<i>A. ocellaris</i> Cuvier, 1830
2	<i>S. mertensii</i> Brandt, 1835	<i>A. polymnus</i>	<i>A. clarkii</i> (Bennett, 1830)
3	<i>Heteractis crispa</i> (Ehrenberg, 1834)	<i>A. ephippium</i> <i>A. polymnus</i>	<i>A. ephippium</i> (Bloch, 1790) <i>A. clarkii</i> (Bennett, 1830)
4	<i>H. magnifica</i> (Quoy & Gaimard, 1833)	<i>A. akallopisus</i> <i>A. percula</i>	<i>A. akallopisus</i> Bleeker, 1853 <i>A. ocellaris</i> Cuvier, 1830
5 and 6	<i>Entacmaea quadricolor</i> (Rueppell & Leuckart, 1828)	<i>A. ephippium</i> <i>Premnas biaculeatus</i>	<i>A. ephippium</i> (Bloch, 1790) <i>P. biaculeatus</i> (Bloch, 1790)

En route to Indonesia, I spent two days in Okinawa. During a visit several months previously with Jack T. Moyer (Director of the Tatsuo Tanaka Memorial Biological Station, located on Miyake Island south of Tokyo), we had been unable to locate any specimens of the anemonefish *Amphiprion polymnus* (Linnaeus, 1758) which is known to occur in Okinawan waters. The host anemone of that fish had never been identified. Fortunately, in October we located several specimens of the large, sand-dwelling stichodactylid *Stichodactyla haddoni* (Saville Kent, 1893), each containing *A. polymnus*.

On my return, I spent four days at the Marine Laboratory of the University of Guam. During two dives, I was able to collect specimens of the stichodactylids *S. mertensii* Brandt, 1835 (found with *A. chrysopterus* Cu-

vier, 1830), *Heteractis crispa* (Ehrenberg, 1834) (with *A. chrysopterus* and *A. clarkii*), *H. magnifica* (Quoy & Gaimard, 1833) (with *A. perideraion*), and *H. aurora* (Quoy & Gaimard, 1833) (with *A. chrysopterus*). Some of the anemones harbored the pomacentrid fish *Dascyllus trimaculatus* as well. Also collected were specimens of the non-stichodactylid, cloning sea anemone *Entacmaea quadricolor* (Rueppell & Leuckart, 1828) which harbored *A. melanopus* Bleeker, 1852.

With the support of a grant from the National Science Foundation, I studied specimens collected on this trip, and on previous ones in eastern Indonesia (as a participant in the Rumphius Expedition II), Japan, Malaysia, Papua New Guinea, and Hawaii, in addition to specimens borrowed from several museums and individuals. Contemporary actinian taxonomy is based mainly on features that can be studied in preserved specimens. This is partly because many species, including most of those from the tropics and deep seas, were described from preserved material, and partly because features distinguishable only in living anemones, such as color, may exhibit considerable intraspecific variability (Stephenson, 1928, p. 69). Taxonomic criteria include: Anatomical considerations (e.g., body form—some aspects of which may be altered in the process of preservation—presence or absence of verrucae, and tentacle and mesentery arrangement); histological characters (e.g., form of mesenteric retractor and sphincter muscles); and type, size, and distribution of nematocysts (although they can be studied best in living material). This research culminated in a monograph on the family Stichodactylidae and other sea anemones that harbor symbiotic pomacentrid fishes (Dunn, 1981). Redefinition of the 10 symbiotic and 2 nonsymbiotic species was based upon examination of a series of specimens, in most cases from a variety of localities, and with one exception, including live as well as preserved material. Keys to living and preserved actinians were prepared, as was a chart of which fishes occur with which hosts.

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