

The littoral sea cucumber (Echinodermata: Holothuroidea) fauna of Guam re-assessed – a diversity curve that still does not asymptote

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Holothuriidae

Actinopyga echinites
Actinopyga mauritiana
Actinopyga miliaris?
Actinopyga palauensis
Bohadschia argus
Bohadschia marmorata
Bohadschia koellikeri
Bohadschia vitiensis
Bohadschia ocellata
Holothuria (Cystipus) inhabilis
Holothuria (Cystipus) rigida
Holothuria (Halodeima) atra
Holothuria (Halodeima) edulis
Holothuria (Halodeima) aff. edulis
Holothuria (Halodeima) signata
Holothuria (Lessonothuria) hawaiiensis
Holothuria (Lessonothuria) lineata
Holothuria (Lessonothuria) pardalis
Holothuria (Lessonothuria) verrucosa
Holothuria (Mertensiothuria) coronopertusa
Holothuria (Mertensiothuria) leucospilota
Holothuria (Microthele) fuscogilva
Holothuria (Microthele) fuscopunctata
Holothuria (Microthele) whitmaei
Holothuria (Platyperona) difficilis
Holothuria (Platyperona) excellens
Holothuria (Semperothuria) cinerascens
Holothuria (Semperothuria) flavomaculata
Holothuria (Stauropora) discrepans
Holothuria (Stauropora) fuscocinerea
Holothuria (Stauropora) olivacea
Holothuria (Stauropora) pervicax
Holothuria (Theelothuria) turriscelsa
Holothuria (Thymiosycia) arenicola
Holothuria (Thymiosycia) hilla
Holothuria (Thymiosycia) aff. impatiens 1
Holothuria (Thymiosycia) aff. impatiens 2
Holothuria (Thymiosycia) aff. impatiens 3
Holothuria (n. subg.?) n. sp.
Labidodemas semperianum
Labidodemas pseudosemperianum?
Pearsonothuria graeffei

Stichopodidae

Stichopus chloronotus
Stichopus herrmanni
Stichopus cf. variegatus
Stichopus horrens
Stichopus noctivagus
Thelenota ananas
Thelenota anax
Thelenota rubralineata

Synaptidae

Euapta godeffroyi
Euapta tahitiensis
Opheodesoma grisea?
Patinapta taiwanensis?
Polyplectana sp.
Polyplectana galathea
Synapta maculata
Synaptula sp.

Sclerodactylidae

Afrocucumis africana

Chiridotidae

Chiridota hawaiiensis
Chiridota violacea

Cucumariidae

Thyone okeni

Phyllophoridae

Phyrella n. sp.

Table 1 - Checklist of holothurians recorded from Guam. Species in bold are new records compared to Paulay, 2003

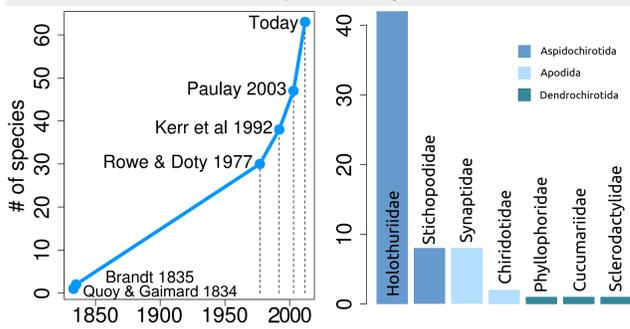


Figure 1 - Diversity curve

Figure 2 - Taxonomic composition

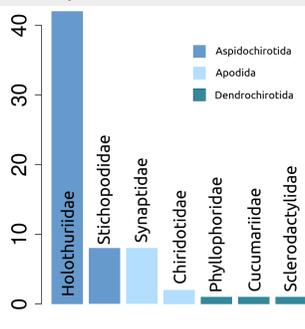


Figure 3 - From top to bottom: *Phyrella n. sp.*, *Stichopus horrens*, *Holothuria arenicola*, *Holothuria n. sp.*, *Holothuria olivacea*, *Euapta tahitiensis*, *Holothuria aff. impatiens*, *Labidodemas semperianum*.

The echinoderms of Guam have become fairly well known over the years, as these large and conspicuous animals have been popular subjects for a variety of biological studies. The first written record is by Quoy & Gaimard (1834), who described *Holothuria guamensis* (now *Actinopyga varians*, Netchy & Paulay in prep.) and noted (but did not name) that five holothurian species are present on the island. Brandt (1835) described *Holothuria maculata* (now *Holothuria fuscogilva*) from Guam soon after. A few echinoderms were recorded from Guam early in the 20th century, although some apparently erroneously, after Guam passed into US hands (Fisher 1919, Clark 1920). Following World War II, Clark (1954) and Cloud (1959) reported on a number of species from Guam and Saipan. Numerous studies followed after the establishment of the University of Guam and the Marine Laboratory, especially in wake of a large outbreak of crown of thorns sea stars that devastated Guam's reefs in 1967. Frank Rowe's visit to Guam led to a review of holothuroid fauna, a paper that served as a popular introduction to holothurian taxonomy in the Pacific for years, by virtue of numerous color plates it offered (Rowe & Doty 1977). The echinoderms of Guam were checklisted in "A working list of marine organisms from Guam" (UOGML 1981), and numerous new records added subsequently by Kerr et al. (1992). The latest published checklist for echinoderms, including holothuroids, for Guam was included in the Micronesia volumes "Marine biodiversity of Guam and the Marianas" (Paulay, 2003). This checklist recorded 47 species with 10 new records. In June 2010, a week-long workshop on holothuroid systematics sponsored by the NSF PEET project included a substantial field work component (using sampling in snorkeling and SCUBA), both during the day and at night, across a variety of habitats, which yielded to more than 40 species, 15 were new records, of which 2 proved new to science. Additional sampling in the last two years has led to the addition of 2 species to the list which now includes 62 species (Table 1).

Recorded species richness on Guam is now higher than in almost any comparable-sized area. It is comparable to the recorded fauna of the Spermonde archipelago in Indonesia (56 species; Massin, 1999). The high richness reflects both the position of Guam close to the W Pacific diversity center, and the intense scrutiny the fauna has received over the years by both resident and visiting holothuroid specialists.

The continuing increase in the known diversity of sea cucumbers on Guam is remarkable given the intensive study the fauna has received, and shows how much remains to be learned about biodiversity of even large and conspicuous marine organisms. Part of the increase in the number of species recorded in Guam since 2003 is related to the increase in taxonomic scrutiny spurred a collaborative taxonomic revision of the reef-associated holothuroids by the NSF PEET project. Since 2006, molecular and morphological examination of fresh material collected across the Indo-Pacific has revealed high levels of cryptic diversity in several species complexes. Integrative taxonomy has revealed species lost in synonymies (e.g., 4 species of *Bohadschia marmorata* complex), not recognized since their description (e.g., distinction of *Euapta tahitiensis* and *Euapta godeffroyi*), and species that were missed because characters traditionally used in species delimitation do not vary among related forms (e.g., the three species in the "*Holothuria impatiens*" complex). Increased sampling efforts focusing on the holothuroid fauna (PEET workshop, Kerr's lab effort) revealed less common (e.g., *H. olivacea*, *H. discrepans*, *H. rigida*) and two new species (*Phyrella n. sp.* and *Holothuria (n. subg.?) n. sp.*), each known from 3 or fewer specimens to date on Guam. Exploration of undersampled habitats, such as the deep reef twilight zone sampled by technical diving, has also added new records (*Holothuria coronopertusa* and *H. aff. edulis*).

The fauna is dominated by the family Holothuriidae (42 species; 68%), followed by the Synaptidae and the Stichopodidae (both 8 species; 13%). Two species of Chiridotidae, and one each of Cucumariidae, Sclerodactylidae, and Phyllophoridae, round out the fauna. The dominance of aspidochirotids (81%) and poor representation of dendrochirotids (5%) is typical of oceanic islands in the tropics. Similarly dendrochirotids comprise 5% (2 of 37 species) of the holothuroids of the oceanic island La Réunion (Conand et al, 2010), while they represent 34% (42 of 122 species) of the fauna on Madagascar, a neighboring microcontinent (Cherbonnier, 1988). Oligotrophic waters and isolation likely both contribute to the underrepresentation of this suspension feeding group with lecithotrophic development.

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