

Note

Key to field identification of shallow water brachycnemic zoanthids (Order Zoantharia: Suborder Brachycnemina) present in Okinawa

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Abstract Okinawa zoanthids have only recently begun to be investigated intensively. Recent research has confirmed the presence of several previously unknown species in the shallow coral reef waters surrounding Okinawa. Here, to aid zoanthid researchers in field identification, a dichotomous key of brachycnemic zoanthids (families Sphenopidae, Zoanthidae, Neozoanthidae) is provided, with characters almost exclusively based on ecology and morphology, although all taxa listed have also been examined using molecular phylogeny. With this key, five species of *Palythoa*, four species of *Zoanthus*, and one taxon each of *Sphenopus*, *Isaurus*, *Neozoanthus*, as well as an undescribed zoanthid genus are identifiable. Although not common, other as of yet undescribed brachycnemic zoanthids are likely to exist in Okinawa waters, and it is hoped this key will help spur further research into their biodiversity.

Keywords zoanthid, dichotomous key, Brachycnemina, Okinawa, biodiversity

Introduction

Zoanthids (Hexacorallia: Zoantharia) are an Order of benthic cnidarians found worldwide and are particularly common in coral reef environments. Despite their commonality, a lack of confirmed morphological diagnostic characteristics combined with large intraspecific variation and their often somewhat cryptic ecology led to the general abandonment of zoanthid taxonomic research for the large part of the twentieth century. However, zoanthid research in Japan, aided by the combination of molecular and morphological data, has recently made progress in understanding the true levels of species diversity in this region (e.g. Ono et al. 2008). In particular, zoanthids belonging to the suborder Brachycnemina, which are often zooxanthellate and increasingly popular as both biochemical research materials (Behenna et al. 2008) and in the pet trade, have undergone much phylogenetic investigation and subsequent taxonomic revision, resulting in the combination of some taxa (Reimer et al. 2006b,c), and the description of other, new species (Reimer et al. 2006b). Although this revision is by no means complete, such taxonomic research can allow researchers to more

clearly understand the relationships between different zoanthid species, and estimate their biodiversity.

Okinawa, as the southernmost prefecture of Japan, has the overall average warmest ocean waters found in Japan, and also the largest amounts of coral reef environment. The shallow waters surrounding Okinawa are home to at least 13 species of brachycnemic zoanthids, with several undescribed or undiscovered species likely to be present (author, personal observation). Although preliminary, here we present a dichotomous key to aid in field identification of these 13 species with the hope that this will make this notoriously taxonomically difficult group more accessible to researchers. A combination of characteristics is given in many parts of our key, as often these characteristics are utilized collectively to reach a decision, similar as in sea anemones (Häussermann 2004). Additionally, occasionally specimens that do not fit within this key may yet appear (e.g. undescribed species), and collectors are urged to contact the author or other zoanthid researchers when such specimens appear.

It should be noted that this key is only for zoanthids of the suborder Brachycnemina, as opposed to the suborder Macrocnemina, which can be distinguished by their fifth mesentery from the dorsal directive being incomplete as

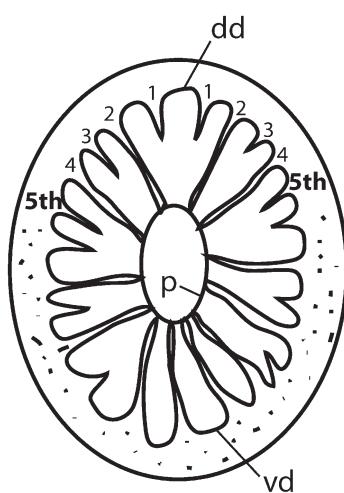


Fig. 1 A simplified drawing of a cross-section of a zoanthid from suborder Brachycnemina showing the status of the fifth mesentery (5th) from the dorsal directive (dd) as incomplete (not reaching the pharynx {p}). Note mesenteries 2 and 4 are complete (reaching pharynx). If the fifth mesentery were complete, the specimen would belong to suborder Macrocnemina. vd=ventral directive

opposed to complete in Macrocnemina (Fig. 1). Additionally, Macrocnemina are often but not always epizoic on other living organisms (e.g. molluscs, sponges, crabs, antipatharians, red coral), while Brachycnemina are generally not¹.

Dichotomous key

1. Encrusted with sand, particles often visible upon close examination, outer column surface feels rough to the touch – families Sphenopidae and Neozoanthidae, unknown zoanthid genus 1 -----3.
2. Not encrusted with sand, feels smooth to the touch – family Zoanthidae -----17.
3. Polyps unitary, unattached to substrate ----- *Sphenopus marsupialis* Gmelin 1791 or unknown *Sphenopus* species² sensu Soong et al. 1999.
4. Polyps generally colonial, attached to substrate – *Palythoa*, *Neozoanthus*, and unknown zoanthid genus 1 -----5.
5. Most polyps have oral disks with diameter greater than >0.5 cm, heavy amounts of very fine encrustation – genus *Palythoa* -----7.
6. Polyps have oral disk diameters much smaller than 0.5 cm, may be almost impossible to see details with the naked eye, encrusted with relatively large particles of sand that may be visible to the naked eye – *Neozoanthus* spp. and unknown zoanthid genus 1 -----15.
7. Polyps embedded in a well-developed coenenchyme (“immersae”) ----- *Palythoa tuberculosa* Esper 1791 (Fig. 2).
8. Polyps free and clear of a coenenchyme (“intermediae” or “liberae”), and/or connected by stolons -----9.
9. Colonies found in caves or areas of no light, polyps recumbent or bent, azooxanthellate ----- *Palythoa* sp. *tokashiki* (Fig. 3). (First informal description).
10. Colonies not found in caves, zooxanthellate -----11.
11. Colonies not found intertidally, usually at depths >5 m, in areas with low light. Stoloniferous, large oral disk with visible septae, generally very short tentacles >60 in number ----- *Palythoa heliodiscus* Ryland & Lancaster 2003 (Fig. 4).

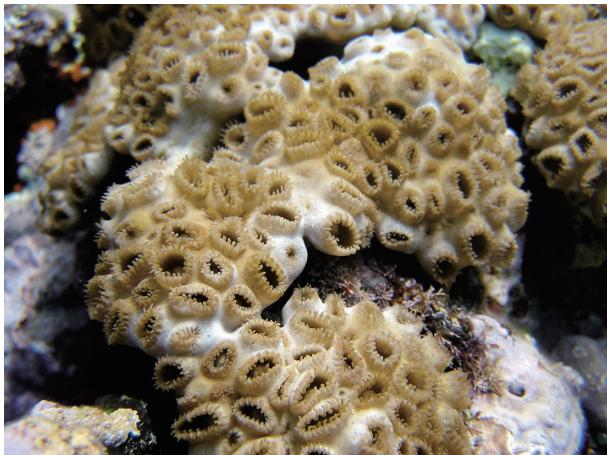


Fig. 2 *Palythoa tuberculosa* in situ at Odo, Itoman, Okinawa. Image taken May 16, 2007. Depth=intertidal



Fig. 3 *Palythoa* sp. *tokashiki* in situ at Mizugama, Kadena, Okinawa. Image taken April 12, 2009. Depth=8.0 m

12. Colonies often found intertidally -----13.
13. Colonies always consist of <10 polyps, rarely open in daytime -----***Palythoa* sp. *yoron*³ *sensu* Shiroma & Reimer 2009** (Fig. 5).
14. Colonies often consist of >10 polyps, polyps often open in daytime, oral disk brown or green, thicker than *P. heliodiscus* -----***Palythoa mutuki*** Haddon & Shackleton 1891 (Fig. 6).
15. Polyps often very small, often unitary, generally found under dead coral rubble or rocks, azooxanthellate – unknown zoanthid genus 1⁴. (First informal description) (Fig. 7).
16. Colonies found in areas exposed to light, with high



Fig. 4 *Palythoa heliodiscus* in situ at Ishigaki, Okinawa. Image taken May 9, 2008. Depth=approximately 10 m



Fig. 5 *Palythoa* sp. *yoron* in situ at Odo, Itoman, Okinawa. Image taken May 16, 2007. Depth=intertidal

- amounts of current, zooxanthellate -----***Neozoanthus*** Herberts 1972.⁵ (*Neozoanthus* sp. *okinawa* – first informal description) (Fig. 8).
17. Polyps recumbent and often bumpy, rarely open in daytime -----***Isaurus tuberculatus*** Gray 1828 (Fig. 9).



Fig. 6 *Palythoa mutuki* in situ at Odo, Itoman, Okinawa. Image taken May 15, 2008. Depth=intertidal (tidepool)



Fig. 8 *Neozoanthus* sp. *okinawa* in situ at Korijima, Nakijin, Okinawa. Image taken December 28, 2008. Depth=23.1 m

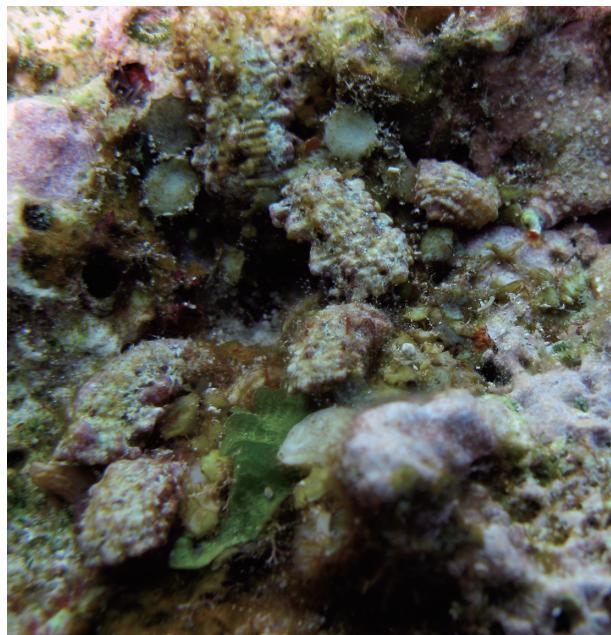


Fig. 9 *Isaurus tuberculatus* in situ at Cape Maeda-misaki, Onna, Okinawa. Image taken July 12, 2007. Depth=approximately 5 m



Fig. 7 Unknown zoanthid genus 1 in situ at Odo, Itoman, Okinawa. Image taken January 13, 2008. Depth=intertidal

18. Polyps erect and smooth, often open in daytime – genus *Zoanthus* -----19.
19. Polyps with obvious markings (usually white stripes) around outside of oral disk, oral disk diameter often >1.0 cm -----*Zoanthus gigantus* Reimer & Tsuka-

hara 2006 (Fig. 10).

20. Polyps do not have obvious markings on outside of oral disk -----21.
21. Polyps embedded (“immersae”) in well-developed coenenchyme, oral disks pink, white, or light purple or green in color -----*Zoanthus kuroshio*^s Reimer & Ono 2006 (Fig. 11).
22. Polyps not embedded (“intermediae” or “liberae”) in coenenchyme -----23.
23. Oral disks always purple or pink, often with white



Fig. 10 *Zoanthus gigantus* in situ near Ginanzaki, Higashi, Okinawa. Image taken November 20, 2007. Depth=approximately 2 m



Fig. 12 *Zoanthus* aff. *vietnamensis* in situ at Jinoiso, Otsuki, Kochi (no good images exist for Okinawan specimens) from Reimer (2007). Depth=1.5 m



Fig. 11 *Zoanthus kurushio* in situ at Zampa, Yomitan, Okinawa. Image taken November 17, 2007. Depth=5.0 m



Fig. 13 *Zoanthus sansibaricus* in situ at Convention Center, Ginowan, Okinawa. Image take March 27, 2009. Depth=approximately 3 m

oral opening, outer surface of polyps somewhat lighter in color than *Z. sansibaricus*. Contain zooxanthellae of *Symbiodinium* clade C15 or related types
-----***Zoanthus* aff. *vietnamensis***⁶ Pax & Mueller 1957 (Fig. 12).

24. Oral disks may be a variety of colors (red, orange, yellow, green, blue, white, brown) sometimes with elaborate patterns, outer surface of polyps somewhat darker in color than *Z. kuroshio*. Contain *Symbiodinium* related to clade C1/C3 or A -----***Zoanthus sansibaricus*** Carlgren 1900 (Fig. 13).

Discussion

Examination of zoanthid species diversity in Okinawa demonstrates the overall lack of knowledge on this order. Of the 13 taxonomic groups described by the key above, there are at least four (*Palythoa* sp. tokashiki, *Palythoa* sp. yoron, *Neozoanthus* sp. okinawa, and unknown zoanthid genus 1) taxa that are likely new species, and a further two (*Sphenopus*, *Zoanthus* aff. *vietnamensis/kuroshio*) that require further taxonomic investigation. Furthermore, unknown zoanthid genus 1 may include more than one

species. Thus, approximately half of the species here have a somewhat unclear status.

Additionally, aside from the 13 species described in this key, investigations in Okinawa have pointed to the existence of other, undescribed species of *Palythoa* and *Zoanthus*, particularly at deeper depths (>10 m) (author, unpublished data). Therefore, the exact number of brachycnemic zoanthid species present in the shallow waters of Okinawa remains unknown. However, from the above data, it would not be unexpected that at least 20 brachycnemic zoanthid species are present.

Macrocnemic zoanthids are also quite common in Okinawa, and a dichotomous key for their identification will be created in the near future.

Future zoanthid research utilizing a combined molecular and morphological/ecological approach should help us obtain a clearer understanding of zoanthid evolution and phylogeny. It is hoped that this key will aid in field identification of zoanthids, and help widen interest in this diverse and important component of Okinawan coral reef biodiversity. Additionally, this key is likely applicable to not only Okinawa, but also the surrounding regions, including the southeast coastline of Japan north of Okinawa (Nansei Islands to Wakayama and the Izu Islands), and Taiwan.

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Notes

¹ There is one monospecific genus (*Acrozoanthus*) within Brachycnemina that is epizoic on eunicid tube worms currently known from Australia (Ryland et al. 2003) Indonesia (Sinniger et al. 2005), and southern Taiwan (author, unpublished data). Additionally, a minority of

Macrocnemina species are not epizoic.

² Based on data from Soong and co-workers (1999), it is very likely there are at least two *Sphenopus* species in Taiwan, including one undescribed species. Distribution data from Okinawa are not yet known for this genus, but it is very likely present.

³ It is not ascertained yet if *P. sp. yoron* is truly a species or simply a hybrid of *P. tuberculosa* and *P. mutuki*. See Reimer et al. (2007) and Shiroma and Reimer (2009) for details.

⁴ Specimens of this putative new genus have been collected from several locations in Okinawa (author and T. Fujii, personal collections). Molecular data indicate these zoanthids are only distantly related to all known zoanthids, and it is unknown as to what suborder they will belong to. Thus, although this group may not be part of Brachycnemina, it is included here as it is not epizoic, and often found in similar environments as the species listed in this key.

⁵ Not yet formally described specimens from Okinawa morphologically fit the description of *Neozoanthus* (Herberts 1972), originally described from Madagascar and not reported since then. Initial phylogenetic analyses indicate Okinawan specimens are related to Sphenopidae and Zoanthidae, making this classification here preliminary but likely correct.

⁶ It is unknown if *Z. kuroshio* and *Z. aff. vietnamensis* are valid separate species or morphotypes of one species. See Reimer et al. (2006a) for details.

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