

Mass occurrence of the cubomedusa *Copula sivickisi* (Cnidaria: Cubozoa) at Seto Harbor, Shirahama, Wakayama, Japan in summer of 2013; a possible recent example of global warming

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Abstract More than 200 very young medusae of *Copula sivickisi* (Stiasny) were collected within totally 60 minutes at two nights in June, 2013 at the Seto Harbor, Shirahama, Wakayama, Japan. This mass occurrence might be related to recent global warming at Shirahama, known as the northernmost distributional locality of this cubozoan species. It is assumed that the polyp stage of this species may live in the surrounding areas, because there jellyfish were small size (most are less than 1.6 mm height) that was conceivable as the newly released one from the polyp.

Keywords: box jellyfish, medusa, plankton, polyp, global warming

Introduction

Species of the Cubomedusae (Cnidaria: Cubozoa) are known as one of the most feared coastal marine animals due to the powerful stings caused by many species (Bentlage et al. 2010). Most of the species are of medium to large sized jellyfishes (5 - 20 cm in bell height), but also a few small species have been known. One of such small species is *Copula sivickisi*, described by Stiasny (1926) as *Charybdea sivickisi*, based on animals from the Philippines. The species, like other members of the family Tripedaliidae, presents sexual dimorphism (Straehler-Pohl et al. in press) and exhibit complex copulatory behaviour (Lewis & Long 2005; Lewis et al. 2008). But their unique features are adhesive pads on the exumbrella that enable them to attach and rest in any substrate (Hartwick 1991). In the present paper, mass occurrence of very young medusae of this species, that is an outstanding phenomenon, is reported at the northernmost distributional place, *i.e.*, Shirahama, Wakayama Prefecture, Japan.

Materials and Methods

On the nights of 13th and 14th June 2013, we mounted a light spot (torch) near the pillars of a fishing dock at Shirahama (Seto Harbor, 33°41'19.07"N, 135°20'39.5"E) . Few minutes after the setting of the light spot, we noticed many small medusae of the present species swimming near the light focus, being attracted to plankton aggregations. The weather was warm and no wind, with sea surface very calm. Using small hand nets, these medusae were collected from the water, put into a bucket with clean seawater and transported to the laboratory. The morphology was observed and photographed in the living state.

Results and Discussion

Copula sivickisi was found at Shirahama, Wakayama, Japan, only a few times for a century (1929, 2006, 2008) and in very small numbers (Uchida 1929; Lewis et al. 2008; Kubota unpublished data). Shirahama, affected by the warm current Kuroshio, is the northernmost distribution locality in the world of this species (Lewis et al. 2008). During each night of the two days in early summer, we sampled more than 100 specimens in 30 minutes. We observed that most of the collected specimens were very tiny specimens, and only a few showing the beginning stage of gonad formation. The specimens ranged from 1.2 - 3.2 mm height and 0.8 - 1.8 mm in diameter (at velarium aperture), but most were less than 1.6 mm height (Fig. 1) that is conceivable as the newly released medusa from the polyp (viz. Werner 1975; Yamaguchi & Hartwick 1980; Straehler-Pohl & Jarms 2011).

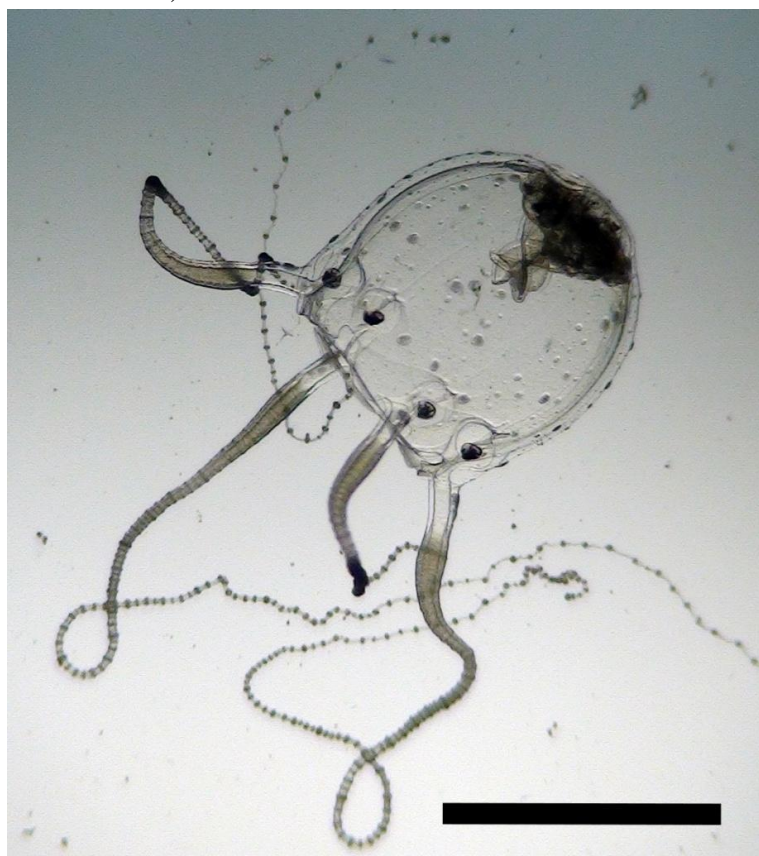


Figure 1. Side view of very young medusa of *Copula sivickisi* (Stiasny, 1926) collected from Shirahama, Wakayama, Japan. The specimen was anesthetized. Scale bar = 1 mm.

During the following mornings, most of the specimens were attached to the sides of the bucket or any substrate put inside it (Fig. 2). Therefore, this cubomedusa takes a rest in the daytime in contrast to the active behavior at night.

Abundance data, even without identical sampling methods, is noticeable, because it demonstrates some relevant biological aspects of the species. Kingsford et al. (2012) stated that they took three years (summers) in a number of sites in Australia to obtain less than 200 specimens of the present species, *C. sivickisi*. In contrast, we obtained more than that number in less than totally 60 minutes at Shirahama this time, then the population size of this young specimens there is now very impressive. It is surmised that such a mass occurrence of tropical *C. sivickisi* at Shirahama may be related to recent global warming, according with the well-established phenomenon exemplified for a green mussel, *Perna viridis* (Linnaeus, 1758) and tropical animals (Kubota 2011).

Due to the small size of the specimens found and high concentration, we assume that the species can reproduce in the area, and the polyp stage may occur in the surrounding areas. Based on this, we emphasize the need of studies focusing on the biology and ecology of cubozoans, like Acevedo et al. (2013), Colins et al.

(2013), Courtney & Seymour (2013), and Toshino et al. (2013).



Figure 2. Side view of very young medusa of *Copula sivickisi* (Stiasny, 1926) from Shirahama, Wakayama, Japan attached to a piece of marine angiosperm. Note tentacles contracted inside the bell. Scale bar = 1 mm.

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Literatures cited

- Acevedo, M. J., Fuentes, V. L., Olariaga, A., Canepa, A., Belmar, M. B., Bordehore, C., et al. 2013. Maintenance, feeding and growth of *Carybdea marsupialis* (Cnidaria: Cubozoa) in the laboratory. *Journal of Experimental Marine Biology and Ecology*, 439, 84–91.
- Bentlage, B., Cartwright, P., Yanagihara, A. A., Lewis, C., Richards, G. S. & Collins, A. G. 2010. Evolution of box jellyfish (Cnidaria: Cubozoa), a group of highly toxic invertebrates. *Proceeding of the Royal Society B*, 277, 493–501.
- Colin, S. P., Costello, J. H., Katija, K., Seymour, J. & Kiefer, K. 2013. Propulsion in Cubomedusae: mechanisms and utility. *PLoS ONE*, 8, e56393.
- Courtney, R. & Seymour, J. 2013. Seasonality in polyps of a tropical cubozoan: *A latina* nr *mordens*. *PloS ONE*, 8, e69369.

- Hartwick, R. F. 1991. Observations on the anatomy, behaviour, reproduction and life cycle of the cubozoan *Carybdea sivickisi*. *Hydrobiologia*, 216/217, 171–179.
- Kingsford, M. J., Seymour, J. E. & O’Callaghan, M. D. 2012. Abundance patterns of cubozoans on and near the Great Barrier Reef. *Hydrobiologia*, 690, 257–268.
- Kubota, S. 2011. Sharp population decrease of *Mytilus galloprovincialis* and a marked population increase of *Perna viridis* in Tanabe Bay and its adjacent waters, Wakayama Prefecture, Japan. *Bulletin of the Biogeographic Society of Japan*, 66, 75–78 (In Japanese with English abstract).
- Lewis, C., Kubota, S., Migotto, A. E. & Collins, A. G. 2008. Sexually dimorphic cubomedusa *Carybdea sivickisi* (Cnidaria: Cubozoa) in Seto, Wakayama, Japan. *Publications of the Seto Marine Biological Laboratory*, 40, 1–8.
- Lewis, C. & Long, T. A. F. 2005. Courtship and reproduction in *Carybdea sivickisi* (Cnidaria: Cubozoa). *Marine Biology*, 147, 477–483.
- Stiasny, G. 1926. XII. Über einige scyphomedusen von Puerto Galera. Mindoro (Philippinen). *Zoologische Mededeelingen*, 9, 239–248.
- Straehler-Pohl, I., Garm, A. & Morandini, A.C. (*in press*) The sexual dimorphism in Tripedaliidae (Conant, 1897) (Cnidaria, Cubozoa, Carybdeida). *Zootaxa*.
- Straehler-Pohl, I. & Jarms, G. 2011. Morphology and life cycle of *Carybdea morandinii*, sp. nov. (Cnidaria), a cubozoan with zooxanthellae and peculiar polyp anatomy. *Zootaxa*, 2755, 36–56.
- Toshino, S., Miyake, H., Ohtsuka, S., Okuizumi, K., Adachi, A., Hamatsu, Y., et al. 2013. Development and polyp formation of the giant box jellyfish *Morbakka virulenta* (Kishinouye, 1910) (Cnidaria: Cubozoa) collected from the Seto Inland Sea, western Japan. *Plankton & Benthos Research*, 8, 1–8.
- Uchida, T. 1929. Studies on the Stauromedusae and Cubomedusae, with special reference to their metamorphosis. *Japanese Journal of Zoology*, 2, 103–196.
- Werner, B. 1975. Bau und Lebensgeschichte des Polypen von *Tripedalia cystophora* (Cubozoa, class. nov., Carybdeidae) und seine Bedeutung für die Evolution der Cnidaria. *Helgoländer wissenschaftliche Meeresuntersuchungen*, 27, 461–504.
- Yamaguchi, M., Hartwick, R. 1980. Early life history of the sea wasp, *Chironex fleckeri* (Class Cubozoa). In: P. Tardent, R. Tardent (Ed), *Developmental and cellular biology of coelenterates*. Elsevier/North-Holland Biomedical Press, pp. 11–16.