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A *Goniopora stokesi* community at Tatsugasako, Otsuki, Kochi, Japan: a new northernmost specimen-based record

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Abstract: The zooxanthellate scleractinian species *Goniopora stokesi* is widely distributed across the Indo-Pacific Ocean, and in Japan the northernmost records of this species are from Tatsukushi, Kochi on Shikoku, although these records are not associated with specimens deposited in museums. The species is unique among *Goniopora* in that it lives on soft bottom sediment, forming free-living colonies, and produces asexual daughter colonies, or ‘polyp balls,’ via budding from parent colonies. Here we report on a large *G. stokesi* community from Otsuki, Kochi, Japan, representing the northernmost specimen-based record of the species. Specimen-based records are important as verifiable baseline data in light of global warming and climate change, which is expected to drastically effect the marine flora and fauna of Kochi and surrounding areas.

Key words: Anthozoa, Scleractinia, temperate region, hard coral, free-living

Goniopora stokesi Milne Edwards & Haime, 1851 is known to form large communities on soft substrates such as sandy bottoms, and is widely distributed in the Indo-Pacific Ocean (Veron 2000), including reports in Japan from Yaeyama Islands, Okinawa Islands, Tanegashima Island, Amakusa Islands, Miyakejima Island, and Tatsukushi, Kochi, based on photographs in Veron (1992), as well as from Iriomotejima Island and Okinawajima Island (Kitano et al. 2013), and Amami-oshima Island (Uyeno et al. 2016) based on specimens. The species is categorized as near-threatened in the IUCN Red List, and is commercially important in the aquarium trade (Sheppard et al. 2008). From an ecological point of view, *G. stokesi* communities can add complexity and rugosity to an otherwise flat sea bottom, and provide habitat for numerous associated organisms. Individual *G. stokesi* colonies form large free-living “balls” that are unattached to any hard substrate, and are instead found on sandy bottoms. In large stands, new colonies appear to primarily be clones generated asexually via budding/bail-out, a reproductive method unique

to this species among Scleractinia (Scheer 1960; Rosen & Taylor 1969; Kitano et al. 2013), although similar strategies are known from the order Zoantharia (Acosta et al. 2005; Gonzalez-Munoz et al. 2019). Although similar *Goniopora* communities have been reported from subtropical Japan, the numbers of colonies reported has been small and across only a few known locations, and molecular analyses have shown these communities to consist of species other than *G. stokesi* (Kitano et al. 2013). As well, some previous records are unclear about what exactly they are based on (e.g. specimens in a private collection, or field observations, etc., see Veron 1992), making confirmation of these data often difficult given the complexity of accurate species identifications.

The presence of an aggregation of *Goniopora stokesi* at Tatsugasako (also known as Ba-hama), Otsuki, Kochi, Japan (32°51'N, 132°39'E) had been known for several years by local divers (Figs. 1, 2). Species identification was confirmed via the presence of asexual daughter colonies (‘polyp balls’) visible in situ and on collected specimens (Fig. 3). Assessments of the size and density of the community were carried out on September 1, 2019 and December 13, 2019 by the authors, with in situ photographs and a rough estimate of the

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Fig. 1. Map of the Tatsugasako (Ba-hama) dive site including the relative location and size of the *Goniopora stokesi* community.

size of the community acquired via underwater measurement (Fig. 1). Specimens of *G. stokesi* from this study are deposited in the Kagoshima University Museum under the collection number KAUM-CN-15. For more detailed location information, please contact the corresponding author.

Colonies of *G. stokesi* were observed at Ba-hama at depths between 25 to 30 m, with no colonies either deeper or shallower. The density of colonies averaged 40% and reached close to 80% coverage of the sandy bottom (Fig. 2), with colonies ranging in size from small daughter colonies approximately one cm in diameter to large colonies approximately 6–10 cm in diameter (Fig. 3). Almost no other anthozoans were observed among the *G. stokesi* colonies except for a single bleached *Goniopora tenuidens* (Quelch, 1886) colony. The total area covered by the community was estimated at approximately 120 by 90 m, or 10,800 m².

Although it does not appear on dive location guide maps (e.g. <https://livedoor.blogimg.jp/johnny74656/imgs/a/2/a2d27bf4.jpg>), it is not thought that this community is a recent appearance to the area. The location of this large community far north from most previously known specimen-based, confirmed records in the Ryukyu Islands (Kitano et al. 2013; Uyeno et al. 2016) is somewhat surprising. However, this current site is only slightly north of previous records from Unohae and Hirabae, Tosashimizu, Kochi (Veron 1992), although no specimens in museums, or exact latitude and longitude coordinates exist for these previous records. More recent examinations of soft-bottom *Goniopora* in Japan have shown other communities to not consist of *G. stokesi*, but instead of other *Goniopora* species (Kitano et al. 2013).

While the current report is simply a new specimen-based

Fig. 2. *Goniopora stokesi* community in situ at the Tatsugasako (Ba-hama) dive site.

record of a species, this kind of data is becoming increasingly important given that the temperate Kuroshio region in Japanese waters is already undergoing drastic marine faunal changes due to ongoing global warming (e.g. Tanaka et al. 2012). Establishing firm records of the expanding range limits of species allows researchers to track the migration of species under climate change (Thomas et al. 2001). While such work is challenging for terrestrial species, it requires even more effort for marine species. Additionally, while many surveys have focused on shallow water zooxanthellate coral communities in the temperate regions of Japan, there is much knowledge to be gained from surveys in understudied areas such as sandy bottoms, rubble zones, mesophotic areas, and inner

Fig. 3. *Goniopora stokesi* specimen KAUM-CN-15 showing a) mother and daughter colonies (top-side view), b) mother and daughter colonies (bottom-side view) and c) daughter colonies. Rulers in mm and cm.

bays (Obuchi et al. 2009). A full understanding of the marine benthic fauna of the temperate region of Japan requires more of such research.

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