ユウレイフタゴウミサボテンモドキCalibelemnon hinoenma Kushida & Reimerの琉球列島沖縄島東海岸での初報告

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New observation of the sea pen *Calibelemnon hinoenma* Kushida & Reimer from the east coast of Okinawa Island, the Ryukyus, Japan

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Abstract. We conducted a biosurvey in the mesophotic zone of Oura Bay, Nago, on the east coast of Okinawa Island, the Ryukyus, Japan, since fauna in this zone is not well been known. We found the sea pen species *Calibelemnon hinoenma* Kushida & Reimer (Cnidaria: Anthozoa: Octocorallia: Scleralcyonacea: Pennatuloidea: Scleroptilidae) on the sand and mud sea bottom of this bay at 55-60 m depth. This is the first report of this sea pen from the east coast of Okinawa Island and the second report after its discovery in Amami Oshima and from the west coast of Okinawa Island. This report strongly suggests that Oura Bay has unique fauna in the mesophotic zone in addition to previously found rare organisms in the shallower waters.

Introduction

Sea pens (phylum Cnidaria: class Anthozoa: subclass Octocorallia: order Scleralcyonacea: superfamily Pennatuloidea) are divided into 16 families (containing one epifamily) including ~300 species (McFadden et al., 2022; McFadden et al. (ed.), WoRMS, 2022). They are distributed world-wide from shallow waters down to depths of at least 6,200 m (Williams, 2011, 2019). Sixty eight species and 4 subspecies have been recorded in Japan (reviewed by Kushida & Reimer, 2019). In the Ryukyu Islands, at least 18 species have so far been found and more discoveries are expected (Imahara, 1991; Imahara, 1996; Imahara & Ogawa, 2006; Kushida & Reimer, 2019). Recently, the genus *Calibelemnon* (family: Scleroptilidae) has been found from the Ryukyu Islands in the course of molecular phylogenetic analyses (Kushida & Reimer 2019). Subsequently, the new species *Calibelemnon hinoenma* has been described in detail from waters of Amami Oshima, Kagoshima and Maeda, Onna, on the west coast of Okinawa Island (30-38 m and 80 m in depth, respectively) (Kushida & Reimer, 2020). However, its habitat range has not yet been well established.

Bathymetric distributions of sea pens tell us that depth preference varies among sea pen genera (Williams, 2011; Kushida et al. 2022). Their geographical habitat may also differ among species. Moreover, preferences of light intensity, water temperature, pressure, dissolved oxygen concentration, substratum, preys, etc. are not known for any species. To elucidate these differences by genera or species, it is necessary to obtain more ecological information on various species.

It is known that the ecosystems in the shallow waters of less than 30-35 m depth at Oura Bay located in the east coast of Okinawa Island are rich with diverse marine organisms including many endangered species (Obuchi et al., 2010; Diving Team Snack-Sunufkin (ed.), 2015; Okinawa Defense Bureau, 2020; Mission Blue, 2019). As for sea pens, four species, i.e. *Virgularia* sp. (family Virgularidae), *Pteroeides* sp. (family Pennatulidae), *Kophobelemnon* sp. (family Kophobellemnidae), and *Cavernulina* sp. (family Veretillidae), respectively, have been found in these shallow waters (Diving Team Snack-Sunufkin (ed.), 2015). However, little is known about the ecosystems deeper than 30-35 m of Oura Bay. A nautical chart used in the report of the Okinawa Defense Bureau (2020) has indicated presence of such a deeper zone of more than 40 m depth on the west side of this bay.

Based on the above background information, we investigated fauna on the seabed in this zone in order to record ecologically important species. Here, we report the presence of *Calibelemnon hinoenma* in Oura Bay as the first observation of this sea pen species from the east coast of Okinawa Island.

Material and methods

We conducted a survey for marine organisms on sandy and muddy sea beds at a depth below 40 m in

Oura Bay, Nago, on the east coast of Okinawa Island by using a remotely operated vehicle (BlueROV2, Blue Robotics, Torrance, U.S.A.) on June 26-27, 2022. A Paralenz Dive Camera (Paralenz, Copenhagen, Denmark) with 2.7K resolution was used to capture in situ images of live organisms.

Results and Discussion

Five colonies of *C. hinoenma* were found at 55-60 m depth in the waters around N26°31'26" and E128°3'50-54". These colonies were found in a small submarine canyon on the west side of Oura Bay. With depths ranging from 50 to 69 m, this small canyon seems to form the deepest point of the bay. The seawater temperature measured during the survey was between 24.4 and 24.6°C.

Morphological characters of the colonies, such as slender shape, white/translucent color, and autozooid pairs projecting from the rachis, matched well with *C. hinoenma* (Fig. 1) on the basis of the original descriptions of *C. hinoenma* (Kushida & Reimer, 2020). While the average number of autozooid pairs was 10, additional small immature autozooids could be found in the lower part of the rachis, which were however difficult to confirm from our pictures of live specimens because their lower parts were not clearly visible. Four colonies had a single autozooid near the top of the rachis (Fig. 1a, c, d) but one colony lacked this autozooid (Fig. 1b) for unknown reasons. The ground heights of colonies with a top autozooid were 9-11 cm similar to the previously reported body length of *C. hinoenma* (Kushida & Reimer, 2020).

Though the colonies were located sparsely, we found these five colonies within 25 minutes of survey time. Thus, *C. hinoenma* may not be rare in these waters. The habitat of this species in Oura Bay, however, seems to be limited to the areas of very gentle slope and the bottom of the small submarine canyon, both of which were a sandy-muddy bed. The area of the seabed below 50 m depth in the submarine canyon is roughly estimated from a nautical chart (ODB, 2020) to be approximately 0.26 km2.

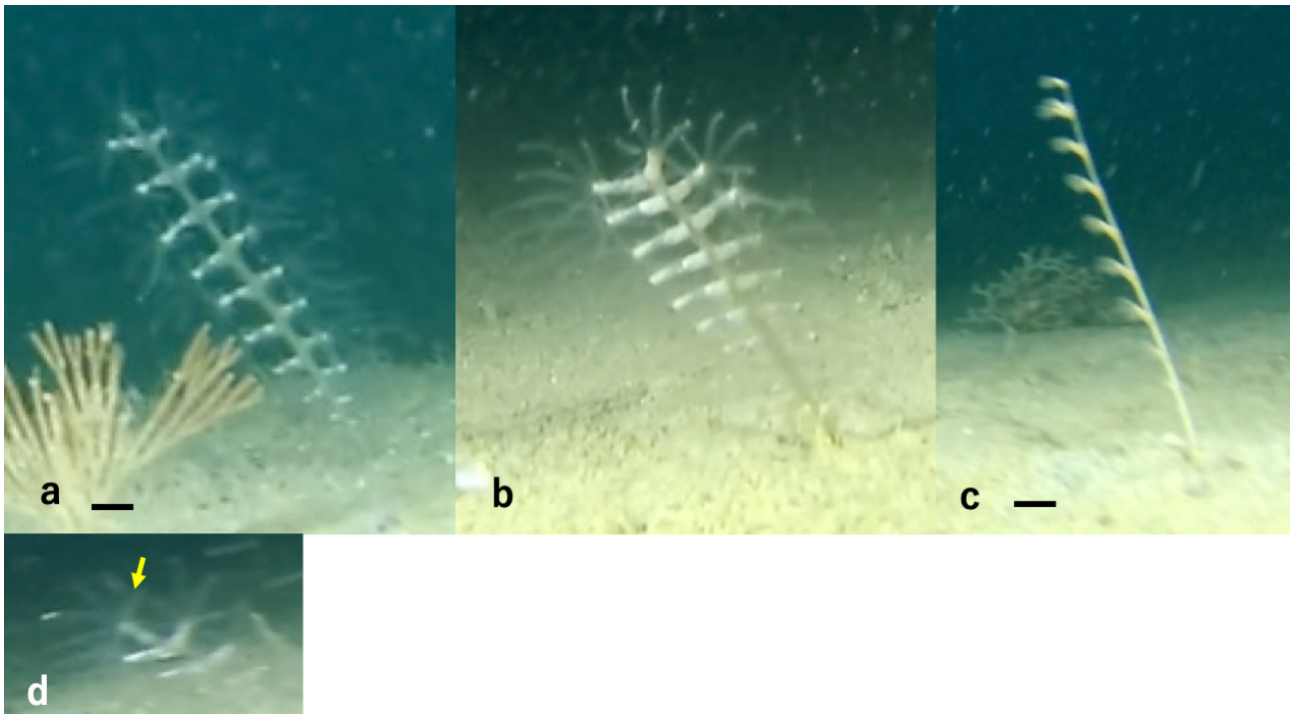

図 1. 大浦湾の海底谷で撮影されたユウレイフタゴウミサボテンモドキ *Calibelemnon hinoenma*. これらの画像は mp 4 動画から取得した . a. 代表的な *C. hinoenma* コロニー . 深さ 57.9 m. Scale bar, 約 1 cm. b. コロニー先端の通常個虫を欠落したもの . 深さ 59.1 m. このコロニーは手前に傾いているため Scale bar を示していない . c. *C. hinoenma* コロニーを横から見た画像 . 深さ 57.9 m. Scale bar, 約 1 cm. d. コロニー先端の通常個虫を示す（矢印）画像。深さ 59.2 m. このコロニーは手前に傾いているため Scale bar を示していない .

Fig. 1. Images of *Calibelemnon hinoenma* colonies found in the submarine canyon of Oura Bay. These images were captured by an mp4 movie camera. a. A typical colony of *C. hinoenma* at 57.9 m depth. Scale bar, approximately 1 cm. b. A colony lacking a top autozooid at 59.1 m depth. No scale bar as this colony was leaning towards the camera. c. Side view of a colony at 57.9 m depth. Scale bar, approximately 1 cm. d. Region of a colony showing an autozooid at the top of the colony (arrow) at 59.2 m depth. No scale bar as this colony was leaning towards the camera.

Other organisms we found in this area were other Octocorallia species such as those in Ellisellidae and Clavulariidae, Bryozoa, sponges, tunicates, and some fish of the family Pinguipedidae, all of which were inconspicuous in the shallow waters of less than 30-35 m depth.

The tropical marine environment is conventionally divided into the altiphotic zone (less than ~40 m depth), mesophotic zone (~40-130 m; 10-1% light intensity of the altiphotic zone in Okinawa, Lesser et al., 2018), and rariphotic zone (~130-300 m) (Baldwin et al., 2018; Stefanoudis et al., 2019). It has been discussed that the ecosystems of these respective zones are unique and vulnerable even though there may be some overlap of species, and thus each of these zones must be protected from human activities and abiotic effects (Baldwin et al., 2018; Lesser et al., 2018; Rocha et al., 2018; Stephanoudis et al., 2019; Soares et al., 2020).

The sea canyon where *C. hinoenma* and other organisms inhabit belongs to the mesophotic zone, and, in addition, it is close to land. Therefore, fauna there can be expected to be susceptible to human activities and abiotic effects such as inflowing soil from rivers and land reclamation, and thus preservation of this area should be encouraged.

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ユウレイフタゴウミサボテンモドキ *Calibelemnon hinoenma* Kushida & Reimer の琉球列島沖縄島東海岸での初報告

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要旨 . ユウレイフタゴウミサボテンモドキ *Calibelemnon hinoenma* Kushida & Reimer (刺胞動物門 : 八放サンゴ亜綱 : Scleralcyonacea 目 : Pennatuloidea 上科 : ホソジクウミサボテン科 : フタゴウミサボテンモドキ属) が沖縄島東海岸 (大浦湾海底 , 名護) において初めて確認された . この種は 2020 年に奄美大島と沖縄島西海岸 (真栄田 , 恩納) において新発見されたものである (Kushida & Reimer, Marine Biodiversity 50: 107).

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