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Gigantic Anemone Species in the Deep 'Churaumi'—Description of a New Species of the Genus *Telmatactis* (Cnidaria: Anthozoa: Actiniaria: Metridioidea), *Telmatactis profundigigantica* sp. nov.

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Although the members of the genus *Telmatactis* Gravier, 1916 have been reported from broad area of the world including Japanese waters, the localities of the species have been limited to shallow areas. In this study, we report a new species in this genus, *Telmatactis profundigigantica* sp. nov., collected from the deeper area than 200 m of the East China Sea off Okinawa Island, discovered by ROV, and taken care of in Okinawa Churaumi Aquarium. This new species is chiefly characterized by its comparatively huge size of its body, over 10 cm in diameter and height, far larger than the other known species of this genus. Moreover, this species has characteristic multiple-headed tentacles and large cnidae in its acrospheres. In the present article, we also discuss the severe toxicity of this species and touch on the ecology of deep-sea anemones.

Key Words: sea anemone, Andvakiidae, Okinawa Churaumi Aquarium, deep sea, capitate, multiple-headed, hemolytic toxin, sting, taxonomy.

Introduction

In this article, we describe a new species from the sea off Okinawa Island. Since the establishment of the genus *Telmatactis* Gravier, 1916, several species have been described and the genus currently contains around 30 species as results (Rodríguez et al. 2022). Almost all *Telmatactis* species, however, were described in the 19th to early 20th centuries; and there have been few recent descriptions: after the description of *T. carlgreni* Doumenc, Chintiroglou, and Foubert, 1989 (Doumenc et al. 1989), no new species have been described in the world over 30 years (Rodríguez et al. 2022). In addition to the lack of recent descriptions, recent studies that have treated this genus are also rare. In particular, there have been no studies of *Telmatactis* in the Pacific recently, in contrast to the most recent study on this genus, which conducted a comprehensive revision of the species of *Telmatactis* in the Atlantic (den Hartog 1995).

This general lack of studies on *Telmatactis* has resulted in difficulties in the identification or taxonomic revision of this genus due to the insufficiency of morphological information needed for current taxonomic studies, and thus the taxonomy of this genus can be considered confused. This situation also affects the study of phylogeny of sea anemones: the only species with publicly available sequences in GenBank is tagged as "*Telmatactis* sp." (Gusmão et al. 2020), a provisional name not identified at the species-level. From Japan, only a single species of this genus, *T. clavata* (Stimpson, 1856), has been recorded officially, although there are potentially several more species in Japanese waters (Uchida and Soyama 2001). Therefore, the taxonomic knowledge of Japanese *Telmatactis* has not been advanced over 150 years from Stimpson (1856).

The present new species of *Telmatactis*, the first-described species in the 21st century, was recently collected from the deep sea near Okinawa Island, Ryukyu Islands, Japan. This species is characterized by a far larger body size than other *Telmatactis* species and has numerous tentacles including strange multiple-headed ones. In addition, we also report the collection of this species of anemone pictured with in-situ images taken by a remotely operated vehicle (ROV).

Materials and Methods

Sample collection, preservation, and ecological observation. Sample collections and observations were performed in the same method as described by Izumi et al. (2019): anemones were found by remotely operated vehicles (ROV) to the east off Ishigaki and Okinawa Islands, Okinawa Prefecture (Fig. 1), on 5 April 2006, 19 July 2017, and 7 January 2019. Movies of the anemones in situ were taken by LEO (ROV of Kowa Corporation) operated by the

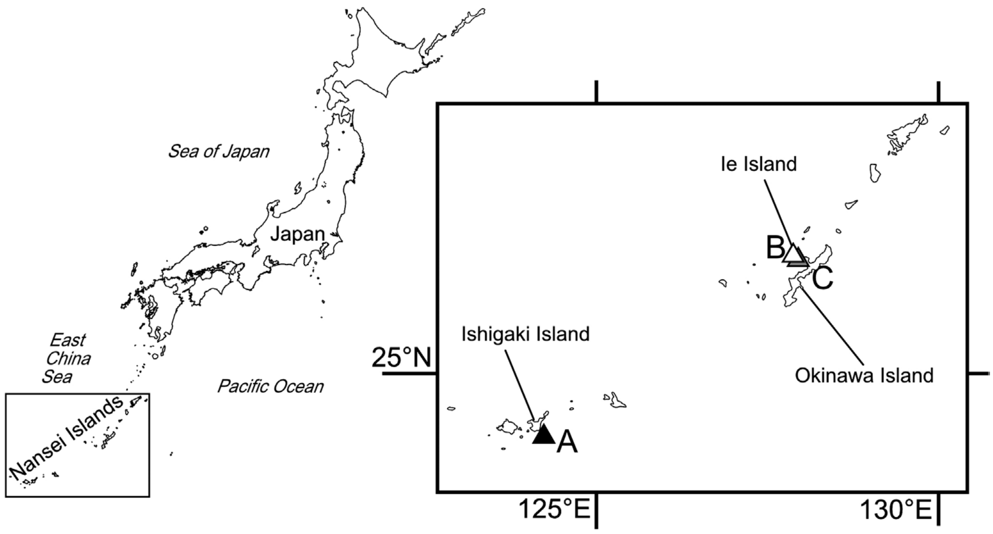

Fig. 1. Sampling locality of *Telmatactis profundigigantica* sp. nov. Holotype (NSMT-Co 1820) and paratype (CMNH-ZG 10156) of *T. profundigigantica* sp. nov. were collected from off Ishigaki Island (A). Living images were acquired in situ off Okinawa and Ie Island (B, C).

R/V Dai-2 Kuroshio-Maru. Two polyps of *Telmatactis* used in this study as specimens were collected from off Ishigaki Island and were kept alive in aquarium tanks at Okinawa Churaumi Aquarium (Okinawa, Japan) before fixation. For these specimens, in vitro images of living polyps were taken prior to fixation to record the external form of the oral disc, as well as the color and size of the polyps. Tentacle tissues were dissected by scissors and preserved in 99% ethanol, and the remaining whole polyps were fixed in approximately 10% v/v formalin sea water solution after approximately half a day of anesthetization using magnesium chloride solution.

One of the specimens examined (holotype) has been deposited in the National Museum of Nature and Science, Tokyo (NSMT), and the other in the Coastal Branch of Natural History Museum and Institute, Chiba (CMNH).

Morphological examination. One specimen of the new species (NSMT-Co 1820) was dissected to examine various tissues. During this dissection, we obtained external and internal morphology data and took photographs. Because the new species was too large to be mounted on slide glasses, the specimen was cut into blocks including some mesenteries before embedding. Tissues were dehydrated by ethanol and cleared in xylene, embedded in paraffin, sliced into serial sections (10 μm thick) using a microtome (HistoCore AUTOCUT R; Leica), mounted on glass slides, and stained with hematoxylin and eosin [referred to Presnell and Schreibman (1997)] or Masson's trichrome method (Masson 1929) with the series of reagents (MUTO PURE CHEMICALS CO., LTD. 2022).

Cnidae Observation. Cnidae were observed from the acrosphere, tentacle (base), actinopharynx, column, limbus, filament, and acontium of the holotype. Tissue from each organ was placed on slide glasses and mounted using 50% (v/v) glycerin sea water solution. Images of the cnidae were obtained by differential interference contrast microscopy (Zeiss Axio Imager; Zeiss), following the ordinary method (Yanagi 2017). The length and width were measured using the software ImageJ ver. 1.49 (Rasband 1997–2012). Cnidae nomenclature follows Mariscal (1974). Size distributions were processed, and values of means and standard deviations were calculated using Microsoft Excel 2016.

Taxonomy

Order **Actiniaria** Hertwig, 1882
Suborder **Enthemonae**
Rodríguez and Daly in Rodríguez et al., 2014
Superfamily **Metridioidea** Carlgren, 1893
Family **Andvakiidae** Danielssen, 1890
Genus ***Telmatactis*** Gravier, 1916
[Japanese common name: Mamire-isoginchaku-zoku]
Telmatactis profundigigantica sp. nov.
[Japanese name: Ryugu-no-goten]
(Figs 2–5)

Material examined. *Holotype*. NSMT-Co 1820: dissected specimen, tissues embedded in paraffin, histological sections prepared, nematocysts prepared; collected on 5 April 2006, collected at southeast off Ishigaki Island (24°18.41′N, 124°16.49′E; Fig. 1A), at 206 m depth, using ROV in survey by Okinawa Churaumi Aquarium by Keiichi Sato, kept alive in aquarium of Okinawa Churaumi Aquarium, and fixed by Takato Izumi on 10 September 2018. *Paratype*. CMNH-ZG10156: whole specimen (smaller polyp than holotype); collected on 5 April 2006, at 203 m depth, using ROV in the survey of Okinawa Churaumi Aquarium by Keiichi Sato, kept alive in aquarium of Okinawa Churaumi Aquarium, and fixed by Takato Izumi from the aquarium tank on 30 November 2021.

The other materials (only living aspects in video without specimens). [Polyp no.1]: living images in a movie; captured on 19 September 2017, at a depth of 205 m, northeast off Ie island (26°44.78′N, 127°45.44′E; Fig. 1B), using ROV in the survey of Okinawa Churaumi Aquarium by Takuo Higashiji; [Polyp no.2]: living images in a movie; captured

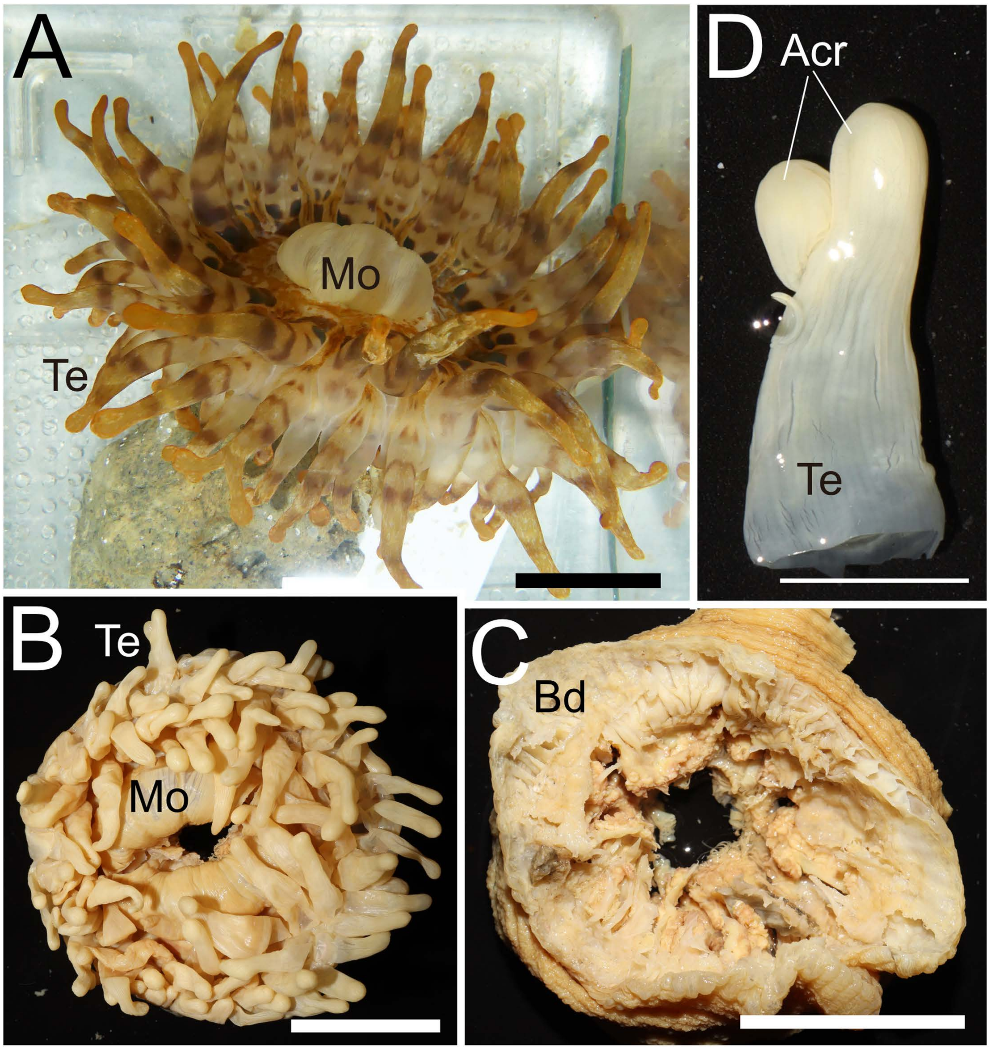

Fig. 2. External morphology of the holotype (NSMT-Co 1820) of *Telmatactis profundigigantica* sp. nov. A, Living polyp of *T. profundigigantica* sp. nov.; B, oral view of the specimen; C, aboral view (basal disc is damaged); D, enlarged view of a double-headed tentacle. Bold scale bars indicate 5 cm and a narrow bar 1 cm. Abbreviations: Acr, acrosphere; Bd, basal disc; Mo, mouth; Te, tentacle.

on 7 January 2019, at a depth of 262 m, off Motobu Town (26°38.82′N,127°47.36′E; Fig. 1C), Okinawa Island, using ROV in the survey of Okinawa Churaumi Aquarium by Takuo Higashiji.

Description (sizes of the holotype specimen). *External feature*: column barrel-like shape, not differentiated into parts, flexible with high degree of expansibility, height approximately 100–120 mm, diameter ca. 100 mm in the widest part and ca. 80–90 mm in basal disc of the live specimens, and height 90 mm, diameter 95 mm in the widest part and 60 mm in basal disc of preserved specimens. Body pale brownish or reddish orange (Fig. 2A); surface of body with transversal wrinkles but without papillae, apertures or mesenterial insertions. Aboral end basal disc, flattened and slightly wider than the diameter of column, apparently sticky and strongly adheres to substrate thus hard to detach from substrate without damage (Fig. 2C). Oral disc with 96 tentacles in five cycles: 6-6-12-24-48 tentacles (Fig. 2A, B). No morphological differences between the tentacles in each cycle; tentacles in first to forth cycle slightly longer (ca. 40–50 mm in length) than tentacles in fifth cycle (ca. 25–30 mm in length) when fully expanded. Tentacles apparently capitate with large robust acrosphere-like knobs on the tips (Fig. 2A, B). Some tentacles particularly double-or triple-headed: two or three acrospheres on the tip of one axis of tentacle (Fig. 2D). Approximately 5–10% of tentacles double- or triple-headed. Except for these tentacles, the other tentacles mostly uniform with one acrosphere on the tip (Fig. 2A). Surface of tentacle axis smooth, with obscure longitudinal wrinkles but without any other remarkable structures. Surface of acrosphere smooth and without any structures. Coloration of tentacles slightly pale orange, some parts translucent, with dark brown or red stripes or patches in living specimens (Fig. 2A). Acrospheres same color or comparatively dark orange in living. Tentacles, especially acrospheres, very sticky due to presence of dense nematocysts (see internal anatomy). Oral disc diameter ca. 70–80 mm, uniformly brownish orange, in live specimens. Mouth at the center of oral disc, strongly swollen; conchula absent (Fig. 2A, B).

Internal anatomy: ninety-six mesenteries: 48 pairs in four cycles (6-6-12-24). Six pairs of perfect mesenteries in first cycle, and the other imperfect. 12 mesenteries in the first

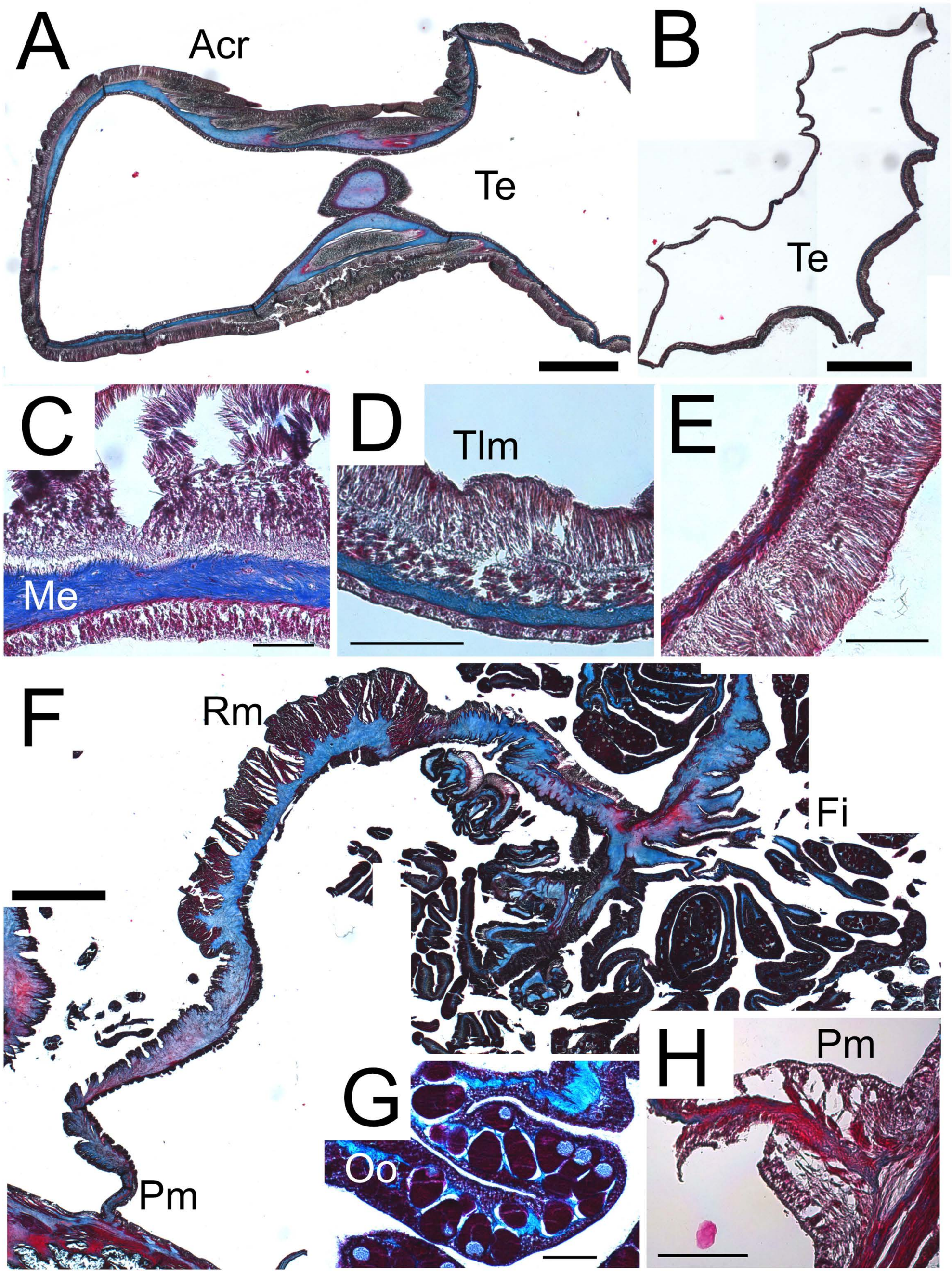

Fig. 3. Internal anatomy (histological sections) of the holotype of *Telmatactis profundigigantica* sp. nov. A, Longitudinal section of a tentacle with acrosphere of *T. profundigigantica* sp. nov.; B, transversal section of tentacle axis; C, enlarged view of longitudinal section of acrosphere; D, enlarged view of transversal section of tentacle axis; E, enlarged view of longitudinal section of tentacle axis; F, transversal section of a perfect mesentery and acontia; G, enlarged view of oocytes; H, transversal section of a parietal muscle. Bold scale bars indicate 1 mm and narrow bar 0.1 mm. Abbreviations: Acr, acrosphere; Fi, filament; Me, mesoglea; Oo, oocyte; Pm, parietal muscle; Rm, retractor muscle; Te, tentacle; Tlm, tentacle longitudinal muscle.

cycle macrocnemes with parietal muscles, retractor muscles, reproductive tissues, filaments and acontia (Fig. 3F). The other imperfect macrocnemes, without distinct retractors but with some reproductive tissues, filaments and acontia. All mesenteries continuing along the whole-body length (Fig. 2C). All tentacles arise from each endocoel and exocoel. Tentacular longitudinal muscles ectodermal, distinct (Fig. 3B, D); tentacular circular muscles indistinct (Fig. 3A, E). Acrosphere on tentacle tips apparently thickened, with densely arranged several rows of large basitrichs (Fig. 3A, C; Table 1). Retractor muscles restricted, limited at the center of each macrocneme, with approximately 40–55 simple to slightly-branched muscular processes (Fig. 3F); parietal muscles of macrocnemes distinct but comparatively weak, triangular shape, with 7–12 multiply-branched muscular processes on each side (Fig. 3H). Mesoglea in the body wall thicker than the ectoderm and the endoderm of body wall, actinopharynx and mesenteries (Fig. 3F), but thinner than ectoderm of the tentacle (Fig. 3B–E). Actinopharynx smooth, grooved, approximately 2/3 of the column length.

Table 1. Cnidom of *Telmatactis profundigigantica* sp. nov. (NSMT-Co 1820). When two types of nematocysts are present, the size range of smaller type is summarized in the "S" line and the larger one is in the "L" line.

		Telmatactis profondogigantica sp. nov. NSMT-Co 1820 (holotype)				
		Length × Width (μm)	Mean (μm)	SD (μm)	n	frequency
Acrosphere						
Spirocysts		23.7–25.1 × 3.1–3.2	24.4 × 3.2	0.71 × 0.06	2	rare
Basitrichs	S	27.2–32.2 × 2.5–2.9	29.2 × 2.7	1.69 × 0.13	5	rare
	L	73.5–100.5 × 2.8–4.3	86.1 × 3.6	4.75 × 0.34	41	numerous
Microbasic p-mastigophores		44.9–57.7 × 4.8–6.9	51.4 × 5.5	3.56 × 0.50	16	numerous
Tentacle						
Spirocysts		29.1–43.6 × 2.5–4.9	37.3 × 3.2	4.31 × 0.52	21	numerous
Basitrichs		40.5–72.1 × 2.7–4.2	58.7 × 3.4	7.72 × 0.36	41	numerous
Microbasic p-mastigophores		34.7–45.8 × 5.4–5.7	40.2 × 5.5	5.53 × 0.14	2	rare
Actinopharynx						
Spirocysts		28.3–36.7 × 4.1–5.6	32.8 × 4.8	3.06 × 0.40	14	few
Basitrichs		33.3–38.1 × 2.3–4.0	35.7 × 3.2	2.37 × 0.87	2	rare
Microbasic p-mastigophores	S	31.6–39.3 × 4.6–7.3	35.3 × 6.0	1.83 × 0.57	21	numerous
	L	53.4 × 8.0	-	-	1	rare
Column						
Basitrichs	S	16.4–21.6 × 2.3–3.9	19.2 × 3.1	1.58 × 0.48	17	numerous
	L	20.5–27.2 × 4.9–6.5	24.4 × 5.7	1.54 × 0.46	19	numerous
Filament						
Basitrichs		13.1–19.0 × 2.7–4.6	15.7 × 3.5	1.29 × 0.43	39	numerous
Microbasic p-mastigophores		52.4–60.8 × 6.8–9.4	56.6 × 8.0	2.40 × 0.65	16	few
Acontia						
Basitrichs		28.6–34.8 × 2.1–3.6	31.7 × 2.7	1.56 × 0.31	48	numerous
Microbasic p-mastigophores		60.7–66.3 × 8.6–10.6	63.2 × 9.8	1.55 × 0.56	17	numerous
Limbus						
Basitrichs		21.1–26.4 × 2.6–4.3	24.4 × 3.4	1.38 × 0.50	12	few
Microbasic *p*-mastigophores		24.7–31.2 × 4.8–7.5	27.5 × 6.1	1.71 × 0.63	19	numerous

Two indistinct siphonoglyph both on the dorsal and ventral side of actinopharynx, always connected to actinopharynx and sustained by the dorsal and ventral pairs of directive mesenteries. Sphincter muscle mesogleal, strongly developed. Filaments limited near the aboral end. Dioecious; mature reproductive tissue contains several oocytes in the mesoglea of each mesentery in holotype (Fig. 3F, G).

Cnidom: spirosysts, basitrichs, microbasic *p*-mastigophores (or microbasic amastigophores). See Fig. 4 and Table 1 for size and distribution.

Ecological remarks. Living images of this species were captured several times by ROV during surveys of Okinawa Churaumi Aquarium. *Telmatactis profundigigantica* sp. nov. inhabits on the rocks spattered on sandy bottoms and sometimes buried in demosponges (Fig. 5A). This species could be the strong predator in the deep sea: we observed *T. profundigigantica* sp. nov. directly preyed on a Pomacentridae fish in the aquarium. It is observed that many shrimps of *Plesionika* sp. are crowded around this anemone (Fig. 5B): they could live symbiotically to be protected from the enemies by this strong predator.

Not only are the basitrichs of the tentacles of this species comparatively large and robust (Table 1), but the toxin of this species can also cause serious stings to humans. In one case, a staff member of Okinawa Churaumi Aquarium was stung by the tentacle tip of this species, and the tissue of the lesion became hollowed out with leucocytes being destroyed, and several days of hospitalization were needed. Based on these symptoms, the toxin of this species is likely severe hemolysin enough to harm human health, which is known from some sea anemones (Gimenez et al. 2014; Jouiaei et al. 2015). Also in Japanese waters, there are a few anemones known to have hemolytic venom: e.g., *Phyllodiscus semoni* Kwietniewski, 1897 is known to have hemolytic peptide venom in addition to inflaming one (Nagai et al. 2002) and several cases of sting injury from *P. senomi* were reported from the south area of Japan (Uchida and Soyama 2001). In addition, some anemones like *Anthopleura* Duchassaing de Fonbressin and Michelotti, 1860 and *Actinia* Linnaeus, 1767 are known to have hemolytic venom in Japan (Shiomi 1997; Kohno et al. 2009). However, all anemones with hemolytic venom known to date are living in the shallow zone, and thus it is a rare case that a deep-sea anemone has such severe venom enough to harm human health. Overall, there still have been few case studies of the venoms and stings of anemones in Japan (e.g., Nagai et al. 2002; Kohno et al. 2009) although some information on stings is also found in field guides (e.g., Uchida and Soyama 2001). Thus, we believe the severe hemolytic symptoms observed here and this species will be important in future further analyses of the toxicity of anemones in Japan.

Etymology. This new species is characterized by its comparatively far larger size and its deep-sea habitat. Thus, the species epithet is an adjective, composed of "profund-" (Latin *profundus* = deep) + "gigantica" [latinized Ancient Greek *giganticus* (*gigantikos*) = huge].

Derivation of Japanese name. Ryugu (= castle under the deep sea) + no (= of) + goten (= palace). Associated the reddish color to the palaces of Okinawa covered with red roof tiles.

Distribution. Off Okinawa Island and Ishigaki Island, Nansei Islands.

Taxonomic remarks. The morphological features of this anemone are corresponded to the latest diagnosis of *Telmatactis* in den Hartog (1995) as below: body wall without any structures; clavate 96 tentacles; mesogleal sphincter; two siphonoglyphs on actinopharynx; and presence of acontia. In this genus, *Telmatactis profundigigantica* sp. nov. is characterized by three characters: (1) enormously large body sizes (Fig. 2A–C); (2) numerous tentacles (Fig. 2A) with some peculiar multiple-headed ones (Fig. 2D); and (3) large tentacle basitrichs (Fig. 3C). As mentioned below, *Telmatactis* is distributed across a broad area of the world, and thus in this study we have mainly compared with the species of *Telmatactis* living in the western Pacific.

(1) *Telmatactis profundigigantica* sp. nov. is much far larger than the other species from the Pacific. The height of this species is at least 90 mm even when formalin-fixed, and this is approximately two times larger than the maximum size of any other *Telmatactis* species from the Pacific, with the next largest species, *T. allantoides* (Bourne, 1918) or *T. ambonensis* (Kwietniewski, 1898): these species 55 mm in height (Kwietniewski 1898; Bourne 1918). Of course, living polyps of *T. profundigigantica* sp. nov. is far larger than formalin-fixed specimen (see description part), thus the size of this species is significant in this genus.

(2) Among the species of *Telmatactis* in the Pacific, the maximum tentacle number reported until now is 74 for *T. stephensoni* Carlgren, 1950, and *T. ambonensis* with 70 tentacles following (Kwietniewski 1898; Carlgren 1950). Therefore, the number of tentacles of *T. profundigigantica* sp. nov. (= 96) is higher. In addition, until now, there have been no records of such double-headed tentacles in this species (Fig. 2D) among this genus. Not only the double-headed tentacles in the type specimens, but there are also observed a few tentacles (one or two in 96 tentacles) with triple-capitated heads in living polyps kept living in Oki-

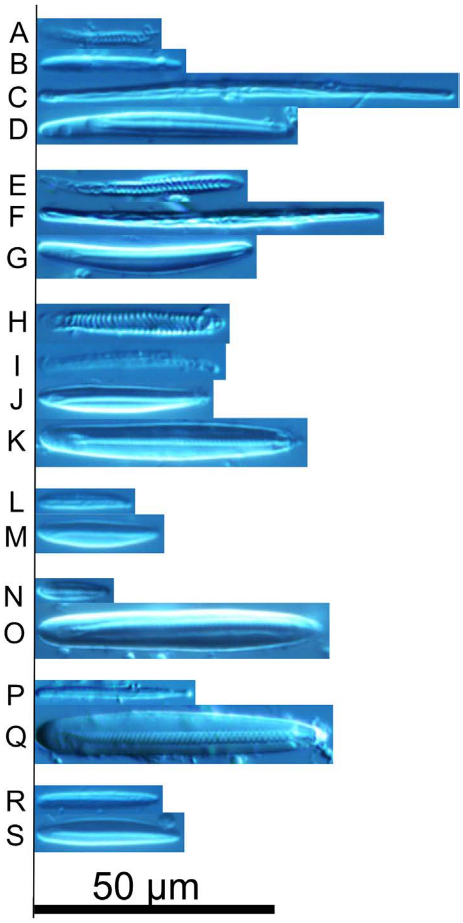

Fig. 4. Cnidom of *Telmatactis profundigigantica* sp. nov. A–D, Acrosphere: A, spirocyst; B, C, small and large types of basitrichs; D, microbasic *p*-mastigophore. E–G, Tentacle axis: E, spirocyst; F, basitrichs; G, microbasic *p*-mastigophore. H–K, Actinopharynx: H, spirocyst; I, basitrichs; J–K, two small and large of microbasic *p*-mastigophores. L, M, Small and large types of basitrichs of column. N, O, Filament: N, basitrich; O, microbasic *p*-mastigophore. P, Q, Acontia: P, basitrich; Q, microbasic *p*-mastigophore. R, S, Limbus: R, basitrich; S, microbasic *p*-mastigophore.

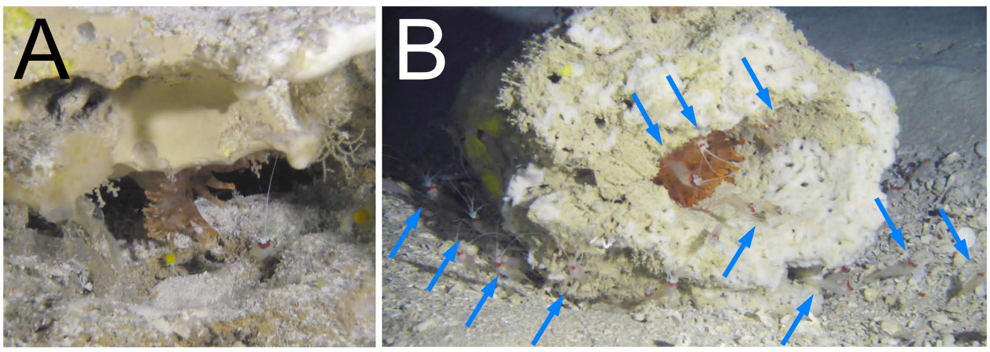

Fig. 5. Living images of *Telmatactis profundigigantica* sp. nov. in situ. A, A polyp adhering to a rock; B, a polyp buried in sponge. In both pictures, many shrimps of *Plesionika* sp. are observed around the anemones (arrows). Dates and Localities: A, [polyp no. 1], 19 September 2017, northeast off Ie island, Okinawa Pref.; B, [polyp no. 2], 7 January 2019, off Motobu-cho Town, Okinawa Island.*profundigigantica*.

nawa Churaumi Aquarium. Considering that the number of tentacles is almost fixed, it is not possible that the strange tentacle is the half-way condition during the fission of the tentacle. Thus, these multiple-headed tentacles should be also a characteristic feature of *T. profundigigantica* sp. nov.

(3) The basitrichs on the acrosphere of this species are significantly large on this genus: the largest record as far as known of the size of basitrichs on tentacle tip was 77.4 μm, observed in *T. cricoides* (Duchassaing, 1850) [den Hartog (1995); though the name of the cnidae is described as spirulae, the picture of cnidae (fig. 7) is same as basitrichs in the nomenclature we use]. Even the mean of large basitrichs in acrospheres (86.1 μm; Table 1) is larger than the largest record, it can be therefore said that the significant size of cnidae is also the diagnostic character of *T. profundigigantica* sp. nov. It is known that capitated tentacle tips of sea anemones including acrospheres often contain extremely large sizes of nematocysts in several groups. For example, *Haloclava hercules* Izumi, 2021, a species of Haloclavidae, has very gigantic nematocysts almost reaching 300 μm in its clavate tentacle tips (Izumi 2021). Among actiniarians, therefore, it can be said that basitrichs in the actinopharynx of *T. profundigigantica* sp. nov. are not so extraordinarily large even though the sizes are apparently large among members of the genus *Telematics*.

In addition, almost all records of *Telmatactis* until now are from comparatively shallow waters. For example, all records in den Hartog (1995) are shallower than 10 m, and there are no records deeper than 30 m in the other descriptions [including field guides; Uchida and Soyama (2001)]. Thus, the habitat of *T. profundigigantica* sp. nov., 203–262 m in depth, is exceptionally the deepest record of this genus.

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Authors Contributions

Takato Izumi: Conceptualization; Resources; Investigation; Writing—original draft; Writing—review & editing; Funding acquisition. Takuo Higashiji: Resources; Writing—review & editing.

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Declarations

Competing interests. The authors declare no conflicts of interest.

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