ASED http://e-ASED.org
Animal Systematics, Evolution and Diversity

Anim. Syst. Evol. Divers. Vol. 41, No. 1: 70-74, January 2025
https://doi.org/10.5635/ASED.2025.41.1.033

A New Species of Solitary Orange Cup Coral, *Paracyathus aurantius* n. sp. (Anthozoa: Scleractinia: Caryophylliidae), from Korea

Sung-Jin Hwang[1,2,*]

[1]Department of Life Science, Woosuk University, Jincheon 27841, Korea
[2]Cnidaria Bioresources Bank of Korea, Jincheon 27841, Korea

ABSTRACT

Through a taxonomic study of solitary corals collected from the subtidal zone of the Navarone Cliffs in Chujado—located in the northern part of Jeju Island, Korea—at a depth of 10 to 15 meters in 2021, a new species, *Paracyathus aurantius* n. sp., has been described and added to the anthozoan fauna. As a result of this study, a total of 27 species within the genus *Paracyathus* have now been reported. This new species is characterized by its bright orange color, cylindrical and robust corallum shape, five cycles of septa, a septal formula of S1 = S2 > S3 > S4 > S5, up to 3rd pali, and a columella composed of approximately 30 papillae.

Keywords: new species, *Paracyathus aurantius*, solitary caryophyllid, taxonomy, Korea

INTRODUCTION

The Caryophylliidae, one of the largest and most diverse family of stony corals, comprises over 300 species from 41 extant and 27 extinct genera, including *Paracyathus* Milne Edwards and Haime, 1848 (see Milne Edwards and Haime, 1848; Reyes et al., 2009; Hoeksema and Cairns, 2024a). In Korea, eight species and seven genera have been identified: *Caryophyllia* Lamarck, 1801; *Crispatotrochus* Tenison-Woods, 1878; *Goniocorella* Yabe and Eguchi, 1932; *Heterocyathus* Milne Edwards and Haime, 1848; *Paracyathus* Milne Edwards and Haime, 1848; *Phyllangia* Milne Edwards and Haime, 1848; and *Stephanocyathus* Seguenza, 1864 (see Song, 1982, 1991; Choi and Song, 2015; Sim et al., 2023). Among these genera, *Stephanocyathus* has recently been transferred to the newly formed family Stephanocyathidae Vaga, Cairns and Kitahara, 2024 (Hoeksema and Cairns, 2024a).

Paracyathus, an azooxanthellate genus, has been discovered in the Atlantic, Indian, and Pacific Oceans at various depths, ranging from shallow waters to the deep sea, with some species found as deep as 1,260 m (Verrill, 1866; Duncan, 1876, 1889; Lindström, 1877; Alcock, 1893; Cairns, 1994, 2004; Cairns and Chapman, 2001; Altuna and Ríos, 2014; Singarayan and Rethnaraj, 2016; Kitahara and Cairns, 2021). Most of the 26 valid species of *Paracyathus*—with the exception of 28 extinct species—are reported to be found in the Pacific and Indian Oceans. Some of these species are endemic or eurythermic, meaning they range from tropical to temperate regions (Verrill, 1869; Lindström, 1877; Alcock, 1902; Cairns, 1994, 2004; Cairns and Chapman, 2001; Hoeksema and Cairns, 2024b).

Only one species of the genus *Paracyathus*—*P. rotundatus*—was previously known to exist in Korea's East, Southwest, and South Seas (Sim et al., 2023). However, based on morphological differences from 26 previously recorded species, a new species, *Paracyathus aurantius* n. sp., has been discovered through analysis of solitary coral specimens collected from Chujado, Jeju Island. As a result of this study, two species of *Paracyathus* have now been identified in Korea's anthozoan fauna.

MATERIALS AND METHODS

In 2021, specimens were collected by scuba diving in the subtidal zone of the Navarone Cliffs in Chujado, located in the northern part of Jeju Island, Korea, at a depth of 10 to

*To whom correspondence should be addressed
Tel: 82-43-531-2892, Fax: 82-43-531-2862
E-mail: buteo2@woosuk.ac.kr, buteo2@gmail.com

eISSN 2234-8190

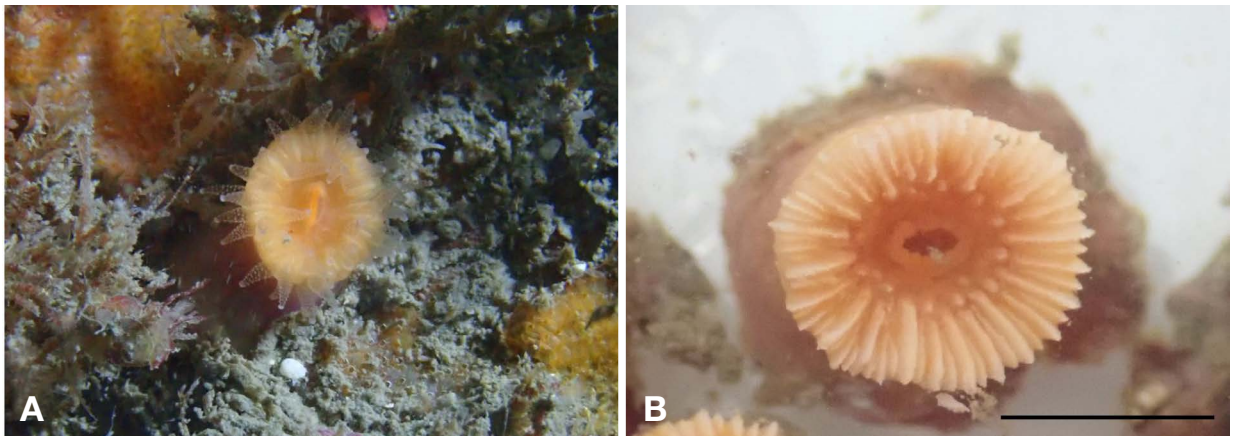

Fig. 1. *Paracyathus aurantius* n. sp., holotype, MABIK CN00081561. A, Light orange-colored solitary coral firmly attaching on rock slope; B, Collected specimen before fixation. Scale bar: B = 5 mm.

15 meters. To document their morphological and ecological characteristics prior to fixation, solitary orange cup corals firmly attached to the rock surfaces were photographed using a Tough TG-5 digital camera (Olympus Digital Solution Corporation, Tokyo, Japan). The corals were then sampled with a diving knife and immediately preserved in 99% alcohol (v/v) for further morphological examination.

To identify the species, the corallite, costae, septa, pali, columella, and detailed morphological characteristics were examined using a stereomicroscope (SteREO Discovery. V8; Carl Zeiss, Jena, Germany). Measurements of calicular diameter, septal breadth and thickness, costae width, and other dimensions were taken using a ruler and an image analyzer (OptiView; Korea Lab Tech, Seongnam, Korea). Images obtained during the examinations were captured with a digital camera (KCS-2000SS; Korea Lab Tech) equipped with a CMOS sensor microscope.

One holotype (entire corallite) and one paratype (broken corallum), were each deposited in the National Marine Biodiversity Institute of Korea, Seocheon and Cnidaria Bioresources Bank of Korea, Jincheon, respectively.

SYSTEMATIC ACCOUNTS

Phylum Cnidaria Hatschek, 1888
Class Anthozoa Ehrenberg, 1834
Subclass Hexacorallia Haeckel, 1896
Order Scleractinia Bourne, 1900
Family Caryophylliidae Dana, 1846
Genus *Paracyathus* Milne Edwards and Haime, 1848

Key to 11 species of the genus *Paracyathus* found in the Indo-Pacific and Western Pacific Oceans

1. Septa arranged decamerally··· *Paracyathus montereyensis*
– Septa arranged hexamerally ····· 2
2. Septa developed over 5 cycles ····· 3
– Septa do not developed up to 5 cycles ····· 6
3. Columella loosely papillose ····· *P. porcellanus*
– Columella crowded, composed over 20 slender papillose ····· 4
4. P1 larger than P2 ····· ***P. rotundatus***
– P3 higher than P1, P2 ····· 5
5. PD : GCD more than 8.0 ····· ***P. aurantius* n. sp.**
– PD : GCD less than 8.0 ····· *P. darwinensis*
6. S3 larger or same than S4 ····· 7
– S3 not larger than S4 ····· 10
7. Septal face meniane-like structures ····· *P. milleri*
– Septal face not meniane-like structures ····· 8
8. Columella composed less than 20 papillose··· *P. parvulus*
– Columella composed over 20 papillose ····· 9
9. Calice circular to slightly elliptical ····· *P. lifuensis*
– Calice subcircular, hexagonal outline ····· *P. ebonensis*
10. With well-developed epitheca ····· *P. durhami*
– Without well -developed epitheca ····· *P. peysonneli*

[1]****Paracyathus aurantius* n. sp. (Figs. 1, 2)**

ZooBank LSID: urn:lsid:zoobank.org act:2C9F0ED1-C1AA-4B38-BDEC-8BEA8D3BD8C2.

Type locality. Jeju-do, Jeju-si, Chuja-myeon, Daeseo-ri, Navarone Cliffs (33°57′29.77″N, 126°17′18.56″E), 10–15 m.
Material examined. Korea: holotype (MABIK CN000

Korean name: [1]*주황측컵돌산호

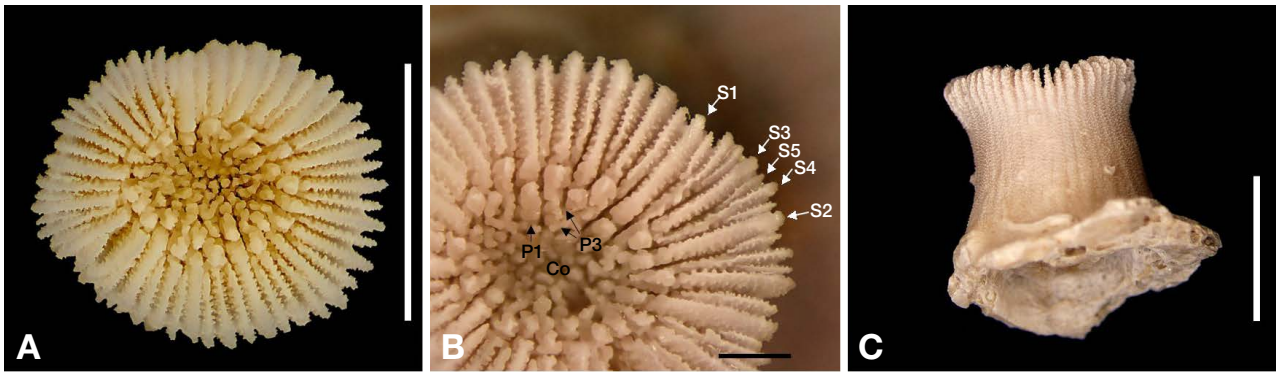

Fig. 2. *Paracyathus aurantius* n. sp., holotype, MABIK CN00081561. A, Stereo calicular view; B, Calicular view; C, Lateral view. Co, columellae; P1, pali associated with S1; P3, pali associated with S3; S1, primary septa; S2, secondary septa; S3, third septa; S4, fourth septa; S5, fifth septa. Scale bars: A, C = 5 mm, B = 1 mm.

81561), one entire corallite, and paratype (CBB21CnAn E432), one broken corallum from type locality, 12 Sep 2021, Jeong SC, 10–15 m, by SCUBA diving.

Description. Azooxanthellate. Corallum (holotype) cylindrical and quite robust with slightly narrow pedicel and broad base, firmly fixed by robust pedicel, calice slightly elliptical; 7.3 mm in greater calicular diameter (GCD), 6.3 mm in lesser calicular diameter (LCD), and ratio of GCD : LCD 1.16; pedicel diameter 6.2 mm in diameter with ratio of PD (pedicel diameter) : GCD 0.85, base diameter in 9.6 mm; height 7.8 mm from base to calicular, 6.5 mm from pedicel to calicular (Fig. 2). Costae well developed from calicular margin to base, 0.24–0.39 (average 0.32) mm in width, covered with tiny spinous granules, separated by intercostal striae with 0.07–0.14 (average 0.10) mm wide (Fig. 2C). Septa hexamerally arranged up to 5 cycles, but 5th incomplete in holotype with 58 septa (Fig. 2A). All septa unequally protrude above thecal wall. Septal face granulation, with small spiny and hump-shaped protuberances on upper side and lower side, respectively. Septal formula S1 = S2 > S3 > S4 > S5. Primary septa (S1) and secondary septa (S2) 1.72–2.11 mm in width with average of 1.87 mm, and 0.13–0.18 (average 0.15) mm thick. Third septa (S3) slightly shorter than S1 and S2, 1.50–1.81 mm in width with average of 1.65 mm, and 0.09–0.14 mm thick. Fourth septa (S4) and fifth septa (S5) 1.27–1.7 (average 1.55) mm and 0.73–0.93 (average 0.83) mm in width, respectively. S4 with 0.06–0.12 mm thick, and S5 thinnest with 0.04–0.08 mm thick. Pali well developed in front of S1 to S3, sometimes indistinct at border with columella (Fig. 2B). Pali (P1 and P2) associated with S1 and S2 usually single lobe, and P3 divided into 2 lobes, lobes on septal side large and high, lobes on columella side small and low. P1 slightly higher than P2, and P3 distinctly higher than P1 and P2. Fossa deep. Columella concave, composed of about 30 papillae (Fig. 2B).

Color. While alive, the tentacles are somewhat transparent with opaque white tips and have tiny granules on their surfaces (Fig. 1A). The corallum is bright orange, slightly darker at the oral part. When preserved in alcohol, the color fades and turns white (Fig. 2).

Ecology and habitat. Corals are firmly attached to gently sloping rock surfaces within 15 m of subtidal water (Fig. 1A). Sessile benthic invertebrates, such as bryozoans and hydroids, inhabit the surrounding rocks.

Distribution. Pacific Ocean: Korea (Chujado).

Etymology. The specific name, *aurantius*, is derived from the Latin word meaning “orange-colored,” which refers to the light orange color of the corallum.

Remarks. *Paracyathus* is characterized by its solitary and firmly affixed form, with pali those are not arranged in crowns. These pali usually consist of several lobes located in front of the lower septa and are often found before all septa except the last cycle (Cairns and Kitahara, 2012; Kitahara and Carins, 2021). The genus *Paracyathus* currently includes 26 valid species (excluding 28 extinct species) (Hoeksema and Cairns, 2024b). Within this genus, only one species, *P. rotundatus* Semper, 1872, has been recorded in Korea to date. This species differs morphologically from the new species in the following ways: (1) corallum size and GCD : LCD ratio (1.16 in *P. aurantius* n. sp. vs. 1.11–1.50 in *P. rotundatus*), (2) order of the pali and the number of paliform lobes, and (3) corallum color (light orange in *P. aurantius* n. sp. vs. brown, light sky-blue, or blue-green in *P. rotundatus*) (Sim et al., 2023).

The new species has five septa, making it similar to *Paracyathus andersoni* Duncan, 1889, *P. darwinensis* Cairns, 2004, *P. indicus* Duncan, 1889, and *P. porcellanus* Verrill, 1866. Among these four species, the new species differs from *P. andersoni* by having a septal formula of S1 = S2 > S3 > S4 > S5

(vs. S1 = S2 = S3 in *P. andersoni*). It also differs from *P. indicus* in that S4 and S5 are not fused to S1 at the calice margins (Duncan, 1889). Furthermore, the new species differs from *P. porcellanus* in the number of lobes forming the pali and density of papillose columella (dense in *P. aurantius* n. sp. vs. loose in *P. porcellanus*), and from *P. darwinensis* in the size of the pali (in *P. aurantius* n. sp., P2 smaller than P1 and similar in height vs. P2 larger and higher than P1 in *P. porcellanus*) (Verill, 1866; Carins, 1994, 2004).

Thus, the materials collected from Jeju Island (Chujado) are reported here as a new species based on this morphological comparison with recorded species.

ORCID

Sung-Jin Hwang: https://orcid.org/0000-0002-1259-6775

CONFLICTS OF INTEREST

Sung-Jin Hwang, a contributing editor of the Animal Systematics, Evolution and Diversity, was not involved in the editorial evaluation or decision to publish this article.

ACKNOWLEDGMENTS

This work was supported by the management of Marine Fishery Bio-resources Center (2024) funded by the National Marine Biodiversity Institute of Korea (MABIK).

REFERENCES

Alcock A, 1893. On some newly-recorded corals from the Indian Seas. Journal of the Asiatic Society of Bengal (Natural History), 62:138-149.

Alcock A, 1902. Report on the deep-sea Madreporaria of the Siboga-expedition. Siboga Expeditie, 16a:1-52. https://doi.org/10.5962/bhl.title.11383

Altuna A, Ríos P, 2014. Scleractinia (Cnidaria: Anthozoa) from INDEMARES 2010-2012 expeditions to the Avilés Canyon System (Bay of Biscay, Spain, northeast Atlantic). Helgoland Marine Research, 68:399-430. https://doi.org/10.1007/s10152-014-0398-z

Cairns SD, 1994. Scleractinia of the temperate North Pacific. Smithsonian Contributions to Zoology, 557:1-150. https://doi.org/10.5479/si.00810282.557.i

Cairns SD, 2004. The Azooxanthellate Scleractinia (Coelenterata: Anthozoa) of Australia. Records of the Australian Museum, 56:259-329. https://doi.org/10.3853/j.0067-1975.56.2004.1434

Cairns SD, Chapman RE, 2001. Biogeographic affinities of the North Atlantic deep-water Scleractinia. In: Proceedings of the First International Symposium on Deep-Sea Corals, Ecology Action Centre and Nova Scotia Museum, Halifax, pp. 30-57.

Cairns SD, Kitahara MV, 2012. An illustrated key to the genera and subgenera of the recent azooxanthellate Scleractinia (Cnidaria, Anthozoa), with an attached glossary. ZooKeys, 227:1-47. https://doi.org/10.3897/zookeys.227.3612

Choi E, Song JI, 2015. New records of two genera *Leptoseris* and *Phyllangia* (Anthozoa: Hexacorallia: Scleractinia) from Korea. Animal Systematics, Evolution and Diversity, 31:146-152. https://doi.org/10.5635/ASED.2015.31.3.146

Duncan PM, 1876. Notices of some deep-sea and littoral corals from the Atlantic Ocean, Caribbean, Indian, New-Zealand, Persian Gulf, and Japanese Seas. Proceedings of the Zoological Society of London, 44:428-442. https://doi.org/10.1111/j.1096-3642.1876.tb02582.x

Duncan PM, 1889. On the Madreporaria of the Mergui Archipelago collected for the Trustees of the Indian Museum, Calcutta by Dr. John Anderson, F.R.S., Superintendent of the Museum. Zoological Journal of the Linnaean Society, 21:1-25. https://doi.org/10.1111/j.1096-3642.1886.tb00967.x

Hoeksema BW, Cairns S, 2024a. World List of Scleractinia. Caryophylliidae Dana, 1846 [Internet]. World Register of Marine Species, Accessed 2 Dec 2024, <https://www.marinespecies.org/aphia.php?p=taxdetails&id=135073>.

Hoeksema BW, Cairns S, 2024b. World List of Scleractinia. *Paracyathus* Milne Edwards and Haime, 1848 [Internet]. World Register of Marine Species, Accessed 2 Dec 2024, <https://marinespecies.org/aphia.php?p=taxdetails&id=135096>.

Kitahara MV, Cairns SD, 2021. Tropical Deep-Sea Benthos, Vol. 32. Azooxanthellate Scleractinia (Cnidaria, Anthozoa) from New Caledonia. Mémoires du Muséum National d'Histoire Naturelle. Publications Scientifiques du Muséum, Paris, pp. 1-722.

Lindström G, 1877. Contributions to the actinology of the Atlantic Ocean. Kongliga Svenska Vetenskaps-Akademiens Handlingar, 14:1-26.

Milne Edwards H, Haime J, 1848. Recherches sur les polypiers. Mémoire 2. Monographie des turbinolides. Annales des Sciences Naturelles, Zoologie, Series 3, 9:211-344.

Reyes J, Santodomingo N, Cairns S, 2009. Caryophylliidae (Scleractinia) from the Colombian Caribbean. Zootaxa, 2262:1-39. https://doi.org/10.11646/zootaxa.2262.1.1

Semper C, 1872. Uber Generationswechsel bei steinkorallen und über das M.-Edwards'sche wachstumgesetz der polypen. Zeitschrift fur Wissenschaftliche Zoologie, 22:235-280.

Sim SH, Yu HJ, Park SH, Cho IY, Min WG, Hwang SJ, 2023. A new record of solitary coral, *Paracyathus rotundatus* (Anthozoa: Scleractinia: Caryophylliidae), from Korea. Animal Systematics, Evolution and Diversity, 39:61-66. https://doi.org/10.5635/ASED.2023.39.2.060

Singarayan L, Rethnaraj C, 2016. Occurrence of azooxanthellate scleractinian corals off Goa, mid-west coast of India. Marine Biodiversity Records, 9:78. https://doi.org/10.1186/s41200-016-0080-z

Song JI, 1982. A study on the classification of the Korean Anthozoa: 7. Scleractinia (Hexacorallia). The Korean Journal of Zoology, 25:131-148.

Song JI, 1991. A systematic study on the Korean Anthozoa: 12. Order Scleractinia. The Korean Journal of Systematic Zoology, 7:127-150.

Verrill AE, 1866. Synopsis of the polyps and corals of the North Pacific exploring expedition, under Commodore C. Ringgold and captain John Rodgers, U.S.N., from 1853 to 1856. Collected by Dr. Wm. Stimpson, naturalist to the expedition. With descriptions of some additional species from the west coast of North America. Part III. Madreporaria. Communications of the Essex Institute, 5:17-50.

Verrill AE, 1869. On new and imperfectly known Echinoderms and Corals. Proceedings of the Boston Society of Natural History, 12:381-396.

Received December 6, 2024
Revised December 16, 2024
Accepted December 24, 2024