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First report of sand-dwelling dinoflagellate, *Ceratocorys malayensis* (Dinophyceae), from the central south coast of Viet Nam

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Short communication

Abstract

In this study, marine sand samples were collected from the shallow intertidal zone of Nha Trang Bay, Viet Nam. Identification and taxonomic observations were conducted on the sand-dwelling dinoflagellates using light and scanning electron microscopy. Morphology characterizations of the species *Ceratocorys malayensis* suggested it was a new record in Vietnamese coastal waters. Taxonomic descriptions and photographs of this species are provided.

Keywords: *Ceratocorys malayensis, marine sand-dwelling dinoflagellate, Viet Nam*

Introduction

Benthic dinoflagellates (including epiphytic and sand-dwelling species) consist of many potentially toxic species, which can produce toxins such as ciguatera fish poisoning (CFP) (Lehane and Lewis, 2000; Hoppenrath *et al*., 2014; Trick *et al*., 2020; Wang, 2021). They are associated with sandy bottoms, dead corals, seagrasses, macroalgae, detrital aggregates and even artificial substrate in tropical and subtropical waters (Faust, 1995; Tester *et al*., 2014; Xu *et al*., 2021). Over the past decades in Viet Nam, surveys of the benthic dinoflagellates have mostly focused on epiphytic toxic species (Nguyen and Larsen, 2004; Ho *et al*., 2010; Ho and Nguyen, 2014; Ho and Niê Bing, 2019), whereas there are too few studies on sand-dwelling dinoflagellates (Ho and Niê Bing, 2021). More and more studies on sand-dwelling dinoflagellate have been carried out worldwide. In particular, the classification and geographical distribution of sand-dwelling dinoflagellates have also become a hot research issue. Though much work has been done in the Western Pacific region, there still exist gaps in the basic taxonomy and biodiversity of sand-dwelling dinoflagellate in the region. This study aims to document the occurrence of marine sand-dwelling dinoflagellates from the intertidal zone of Nha Trang Bay contributing to a basis for a better understanding of their global distribution and habitat. Cells of *Ceratocorys* are angular, shorter epitheca to hypotheca, small to large spines on the hypotheca, and thecae heavily reticulated (Carbonell-Moore, 1996). At present, twelve *Ceratocorys* species have been identified and described, *e.g. Ceratocorys anacantha* M. C. Carbonell-Moore, *C. armata* (Schutt) Kofoid, *C. horrida* Stein, *Ceratocorys mariaovidiorum* (Salgado *et al*., 2018). All of them are marine species and are found in tropical and subtropical waters (Carbonell-Moore, 1996; Graham, 1942). Here we reported the first record of *Ceratocorys malayensis* (Dinophyceae) from sandy sediment samples in Vietnamese coastal waters.

Material and methods

Samples were collected from the shallow intertidal zone of Nha Trang Bay, Khanh Hoa province, Viet Nam (109° 13.218' E, 12° 12.75' N). Surface sandy samples were collected by snorkelling divers using plastic bags from a depth of 1–1.5 m. Water temperature (°C) and salinity (psu) were measured from the water column during sample collections. In the laboratory, the sand samples were mixed and lightly shaken with filtered seawater collected from the same site. The materials were filtered through a series of consecutive meshes with sieve sizes 125 μm, 64 μm, 32 μm and 20 μm to remove large particles. Material on the 64 μm, 32 μm and 20 μm sieves were examined under a Leica MZ 12 stereo microscopic microscope. Cells of dinoflagellates were sought and isolated by pipette. The wild cells were observed alive using light microscopy (LM). Photographs were recorded with a digital camera. For scanning electron microscopy (SEM), fixed specimens were isolated and placed on

a 5 μm polycarbonate membrane in a filter-holder (Millipore), rinsed three times with distilled water and dehydrated through an ethanol series of 15%, 30%, 50%, 70%, 90% and 99.99%, and then air dried. The filter was mounted on an aluminium stub with carbon tape and coated with gold in a vacuum sputter coater. Specimens were observed using a JEOL JSM-5410 LV scanning electron microscope.

Results and discussion

Based on the examination of cell size, shape, cell surface morphology

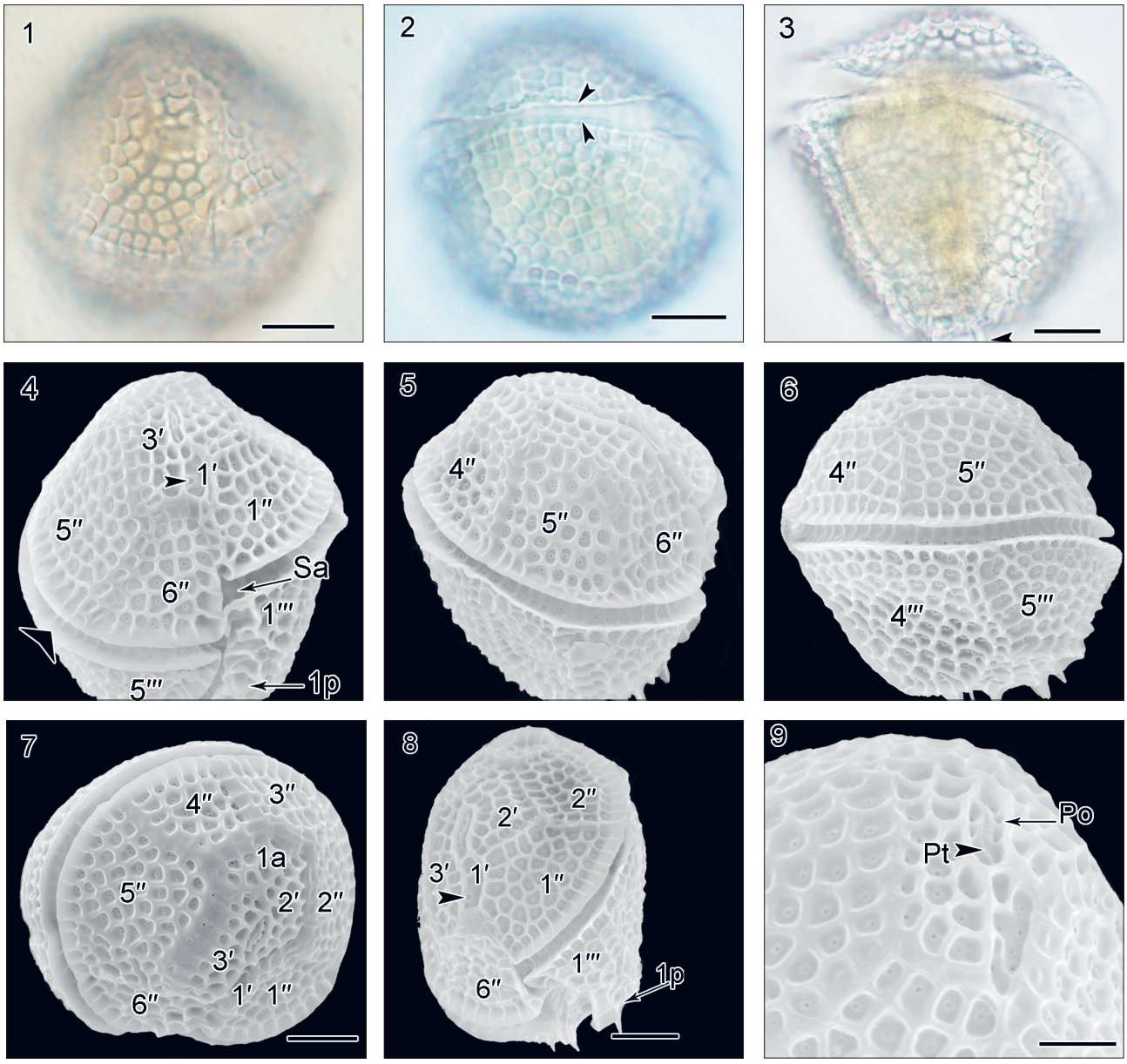

Fig. 1. LM and SEM micrographs of *Ceratocorys malayensis*. (1) Ventral view showing heavily reticulated thecae, (2) Lateral view showing cingulum (arrowheads), (3) Dorsal view showing several spines (arrowheads), (4) Ventral view showing the deep cingulum (wide arrowhead), narrow sulcus (arrow), posterior intercalary plate 1p (long arrow) and ventral pore (arrowhead), (5 and 6) Lateral view showing three precingular plates (4″, 5″ and 6″), (7) Apical view showing three apical (1′, 2′ and 3′), anterior intercalary (1a) and six precingular plates (1″, 2″, 3″, 4″, 5″ and 6″), (8) Right lateral view of the left of the epitheca and hypotheca showing the plate 1′ with ventral pore inside (arrowhead) and posterior intercalary plate 1p (long arrow), (9) Apical view showing the detailed apical pore plate Po with round pores (arrow) and a λ-shaped cover plate Pt (arrowhead). Scale bars: 10 μm, except 9: 5 μm

and architecture of thecal plates, by light and SEM, the marine sand-dwelling dinoflagellate *Ceratocorys malayensis* was described and documented with description. The species is described as

Class : Dinophyceae
Order : Gonyaulacales
Family : Ceratocoryaceae
Genus : *Ceratocorys*
Species : *Ceratocorys malayensis* Z. Luo, P.T. Lim and H. Gu.

The locality of the collection was Nha Trang Bay, Khanh Hoa province, Viet Nam. Previously, this species has only been described in Malaysia, *Ceratocorys malayensis* was sourced from surface sand in Sarawak, Rawa Island, Malaysia (Luo *et al*., 2020). This is the first record of *Ceratocorys malayensis* in Viet Nam and even it was also uncommon species in the coastal waters of Viet Nam. The habitat of occurrence was marine and benthic and at the collection site, seawater temperature ranged between 25 and 29 °C and the salinity ranged from 32.5 to 33 psu. Morphology of the cells showed brown-yellow chloroplasts (Fig. 1, 1 to 3). Cells are round, as illustrated in apical and antapical view, varying from 40.8–54.8 μm long and 38.8–53.6 μm wide (n = 10). Several short spines of 1.5–4.0 μm long emerge at the antapex end (Fig. 1, 3 to 6). The epitheca is smaller than the hypotheca. Measurements resembled those reported in the literature for *Ceratocorys malayensis* (Luo *et al*., 2020) at 40.2–58.0 μm long (49.2 ± 4.9 μm, n = 30), 40.9–54.6 μm wide (46.6 ± 3.9 μm, n = 30). The thecal surface is heavily reticulated, with one round pore, ranging 0.35–0.5 μm in diameter inside each reticulation

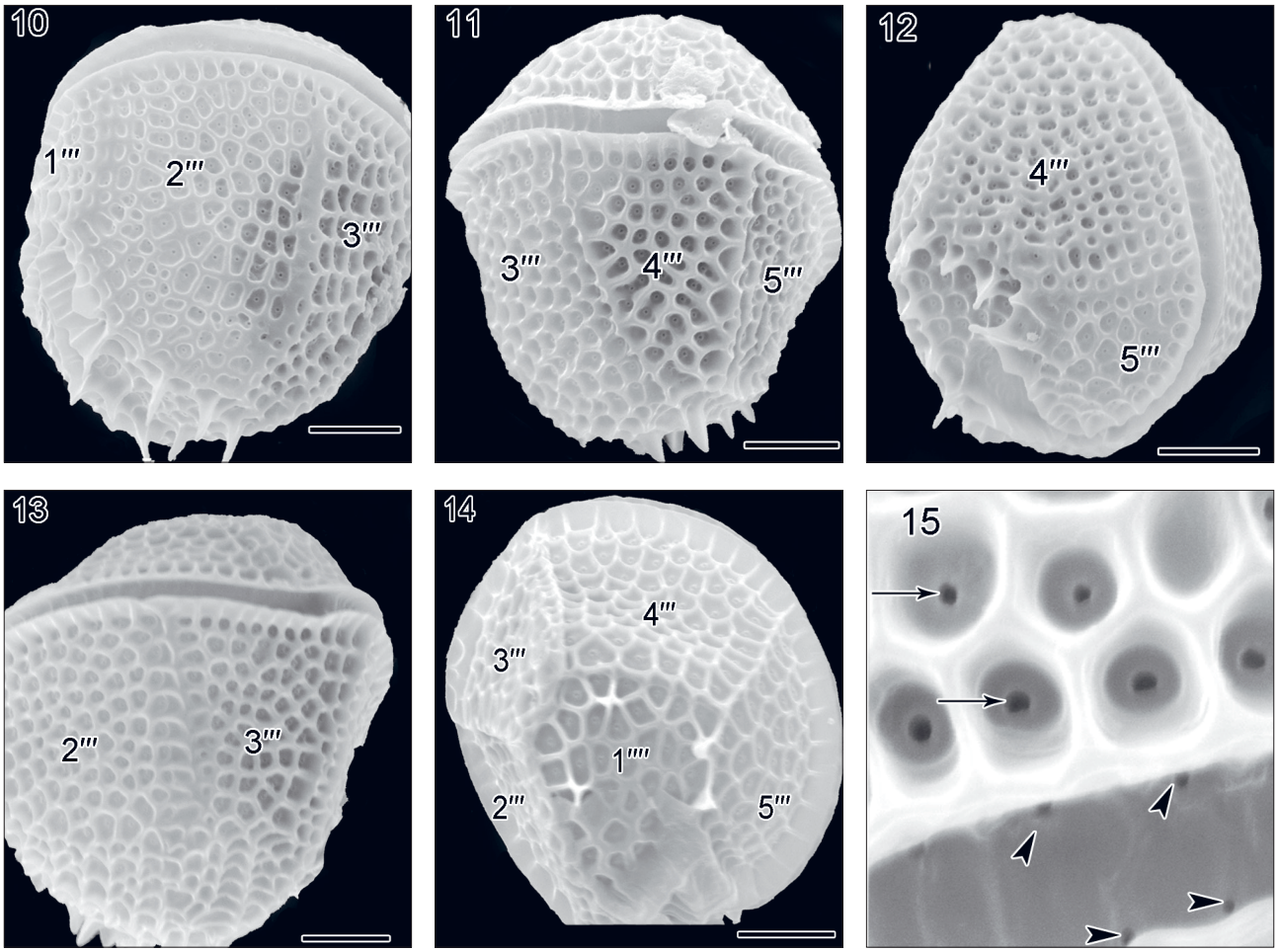

Fig. 2. SEM micrographs of *Ceratocorys malayensis*. (10, 13) Right lateral view of the left half of the hypotheca showing three postcingular plates (1‴, 2‴ and 3‴), (11) Dorsal view of the hypotheca showing three postcingular plates (3‴, 4‴ and 5‴), (12) Left lateral view of the right of the hypotheca showing two postcingular plates (4‴ and 5‴), (14) Antapical view showing four postcingular plates (2‴, 3‴, 4‴ and 5‴) and antapical plate (1⁗), (15) Detailed thecal surface showing thecae heavily reticulated with one pore inside (arrows) and deep cingulum with two rows of marginal pores (arrowheads). Scale bars: 10 μm, except 15: 2 μm.

(Fig. 2, 15). The reticulation was distinguishable under light and scanning electron microscope (Fig. 1, 1 to 3).

Thecal plate arrangement is Po, Pt, 3′, 1a, 6′′, 5′′′, 1p and 1′′′, the cingulum (c) and sulcus (s) plates were not visible in the specimens of this study. The epitheca of *C. malayensis* composed of eleven plates (Fig. 1, 7). The apical pore plate (Po) is oval, 5.8 μm long with a λ-shaped cover plate (Pt) surrounded by a row of evenly distributed 9–10 pores (Fig. 1, 9). The apical plates contain three plates (1′, 2′ and 3′). The first apical plate is short and narrow with a ventral pore at the border with plate 3′ (Fig. 1, 8) and does not contact anterior sulcus plate Sa (Fig. 1, 4). The second and third apical plates are nearly equal in size. The anterior intercalary plate 1a is small and pentagonal without contacting plate Po (Fig. 1, 7). The precingular plates comprise six plates. The cingulum is deeply excavated, equatorial and descending by its width. Marginal pores equally spaced are present on both sides of the cingulum (Fig. 2, 15). The sulcus is narrow, indented and widened toward the posterior (Fig. 1, 4, 8). The rectangular plates comprise six plates (1′′, 2′′, 3′′, 4′′, 5′′ and 6′′). The third and fourth precingular plates are the smallest, whereas the second, fifth and sixth plates are of the same size (Fig. 1, 7). The hypotheca is made up of seven plates: five postcingular plates (1′′′, 2′′′, 3′′′, 4′′′ and 5′′′), one posterior intercalary plate (1p) and one antapical plate (1′′′′) (Fig. 2, 10 to 14). Plate 1′′′ is three-sided and the smallest in the series of postcingular plates, the other plates (2′′′, 3′′′, 4′′′ and 5′′′) are large (Fig. 2, 10, 11, 13). Plate 1p is very small and elongated (Fig. 1, 4, 8). Plate 1′′′′ is broad, six-sided and positioned in the middle of the hypotheca, 18.7 μm long, with several spines (3–5 spines) arising from the antapical margins (Fig. 2, 14). From the original descriptions and above comparisons, specimens of our present study have been described and identified as *C. malayensis*. However, our specimens seem to exhibit more pronounced antapical spines in comparison with those of *C. malayensis* as described in the study of Luo *et a*l. (2020), which is also a different characteristic between Viet Nam type and original type from Rawa Island, Terengganu, Malaysia.

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References

Carbonell-Moore, M. 1996. Ceratocorys anacantha, sp. nov., a new member of the family Ceratocoryaceae Lindemann (Dinophyceae). *Bot. Mar.,* 39: 1-10.

Faust, M. A. 1995. Benthic, toxic dinoflagellates: An overview. In: P. Lassus, G. Arzul, E. Erard, P. Gentien and C. Marcaillou (Eds.). Harmful Marine Algal Blooms. Technique at Documentation–Lavoisier, Intercept Ltd., p. 847–854.

Graham, H. W. 1942. Studies in the morphology, taxonomy, and ecology of the Peridiniales. Scientific Results Cruise VII Carnegie Biology Series, 3: 1–129.

Ho, V. T. and H'Y. Niê Bing. 2021. Study of marine sand-dwelling dinoflagellate with four new records from the central south coast of Viet Nam. *Bangladesh J. Plant Taxon.,* 28(2): 367–378

Ho, V. T. and H'Y. Niê Bing. 2019. First report of Gambierdiscus caribaeus and G. carpenteri (Dinophyceae) from Nha Trang Bay, South Central Vietnam. *J. Mar. Biol. Ass. India*, 60(2): 5–11.

Ho, V. T. and N. L. Nguyen. 2014. Morphology and distribution of the three epiphytic dinoflagellate species *Coolia monotis, C. tropicalis* and *C. canariensis* (Ostreopsidaceae, Gonyaulacales, Dinophyceae) from Vietnamese coastal waters. *Ocean Sci. J.,* 49(3): 211–221.

Ho, V. T., N. L. Nguyen and N. H. Doan. 2010. Benthic dinoflagellates in Vietnamese waters. Publishing House for Science and Technology, Ha Noi. 138 pp.

Hoppenrath, M., S. A. Murray, N. Chomérat and T. Horiguchi. 2014. Marine benthic dinoflagellates–Unveiling their worldwide biodiversity. Kleine Senckenberg-Reihe 54, Druckerei Lokay e.K., Reinheim, Germany, p. 1–276

Lehane, L. and R. J. Lewis. 2000. Ciguatera: recent advances but the risk remains. *Int. J. Food Microbiol.*, 61: 91-125.

Luo, Z., Z. F. Lim, K. N. Mertens, B. Krock, S. T. Teng, T. H. Tan, C. P. Leaw, P. T. Lim and H. Gu. 2020. Attributing *Ceratocorys, Pentaplacodinium* and *Protoceratium* to Protoceratiaceae (Dinophyceae), with descriptions of *Ceratocorys malayensis* sp. nov. and *Pentaplacodinium usupianum* sp. nov. Phycologia, 59(1): 6-23.

Nguyen, N. L. and J. Larsen. 2004. Gonyaulacales. In: J. Larsen and N. L. Nguyen (Eds.). Guide to the Identification of Potentially Toxic Microalgae in Vietnamese Waters. Opera Botanica 140, Copenhagen, p. 73-116.

Salgado, P., S. Fraga, F. Rodríguez, P. Riobvó and I. Bravo. 2018. *Ceratocorys mariaovidiorum* sp. nov. (Gonyaulacales), a new Dinoflagellate species previously reported as *Protoceratium reticulatum. J. Phycol.,* 54: 126-137.

Tester, P. A., S. R. Kibler, W. C. Holland, G. Usup, M. W. Vandersea, C. P. Leaw, P. T. Lim, J. Larsen, N. Mohammad-Noor, M. A. Faust and R. W. Litaker. 2014. Sampling harmful benthic dinoflagellates: Comparison of artificial and natural substrate methods. *Harmful Algae*, 39: 8-25.

Trick, G. C., L. Anderson, D. Beausoleil, E. Berdalet, W. Cochlan, P. Wang, M. L. Wells. 2020. An economic assessment of ciguatera outbreaks–An island model. PICES Scientific Report No. 59: 55-65.

Xu, Y., X. He, W. H. Lee, L. L. Chan, D. Lu, P. Wang, X. Tao, H. Li and K. Yu. 2021. Ciguatoxin-Producing Dinoflagellate *Gambierdiscus* in the Beibu Gulf: First Report of Toxic *Gambierdiscus* in Chinese Waters. *Toxins, **13***: 643.

Wang, P. 2021. Harmful Algal Blooms, In: Cui, W., Fu, S., Hu, Z. (Eds.), *Encyclopedia of Ocean Engineering*. Springer Singapore, p. 1-7.