NEW RECORD FOR ASIA-PACIFIC OF Protoperidinium anomaloplaxum (Peridiniales, Dinophyceae) FROM VIETNAMESE WATERS

Phan Tan Luom¹²*, Nguyen Ngoc Lam², Doan Nhu Hai²

¹Graduate University of Science and Technology, VAST, Vietnam
²Institute of Oceanography, VAST, Vietnam

Received 29 February 2020, accepted 10 June 2020

ABSTRACT

Minusculum (Lebour) Balech is one of four subgenera of the genus Protoperidinium Bergh 1881. Only five species of this subgenus have been discovered worldwide, most of which are distributed in cold waters. In this study, Protoperidinium anomaloplaxum (Balech) Balech is reported from Vietnam and thus for the first time from Asia-Pacific waters. This species is illustrated with line drawing, light and scanning electron microscopic photographs and described details of the ornamentation of the thecal plates as well as its geographic distribution.

Keywords: Minusculum, Protoperidinium, Asia Pacific Ocean, distribution, new record, Vietnam.

Citation: Phan Tan Luom, Nguyen Ngoc Lam, Doan Nhu Hai, 2020. New record for Asia-Pacific of Protoperidinium anomaloplaxum (Peridiniales, Dinophyceae) from Vietnamese waters. Academia Journal of Biology, 42(2): 117–122. https://doi.org/10.15625/2615-9023/v42n2.14859.

*Corresponding author email: luom.dt@gmail.com

©2020 Vietnam Academy of Science and Technology (VAST)
INTRODUCTION

*Protoperidinium* is the largest genus of dinoflagellates and occurs in all the oceans of the world (Balech, 1988). Balech (1974), when re-instating the genus *Protoperidinium* Bergh (1881), had transferred 231 marine species of *Peridinium* Ehrenberg (1830) to the *Protoperidinium*. He further subdivided the genus *Protoperidinium* into three subgenera based on the number of anterior intercalary plates and precingular plates: *Minusculum* (6 precingular and 3 intercalary plates); *Archaeperidinium* (7 precingular, 2 intercalary plates); and *Protoperidinium* (7 precingular, 3 intercalary plates). Faust (2006) later erected the subgenus *Testeria* Faust which has 7 precingular plates and 1 intercalary plate and no apical pore, for the *Protoperidinium* species.

The subgenus *Minusculum* comprises only five species: *P. adulterum* and *P. defectum* are endemic species to the Antarctic (Balech, 1974, 1988), *P. bipes* occurs in the Western Atlantic Ocean and Subantarctic waters (Balech, 1988), and *P. anomaloplaxum* found in Argentinean (Balech, 1988) and Brazilian waters (Jardim & Cardoso, 2013). Recently, *Protoperidinium smithii*, a new species belonging to the subgenus *Minusculum*, has been described from the Ross Sea in Antarctica (Phan-Tan et al., 2018).

There were a number of studies on the genus *Protoperidinium* in Vietnamese waters. Species diversity of the subgenus *Protoperidinium* (sections *Conica*, *Tabulata*, and *Oceanica*) and subgenus *Archaeperidinium* has been studied by Phan-Tan et al. (2016a,b, 2017). The ecology of the genus *Protoperidinium* (Nguyen Luong Tung et al., 2017) was done for Con Dao Island.

In this paper, *P. anomaloplaxum* is reported for the first time from Vietnamese waters and it is also the first report of the species of the subgenus *Minusculum* from tropical waters. We present light and scanning electron microscopy of *P. anomaloplaxum* and describe details of the ornamentation of the thecal plates.

MATERIALS AND METHODS

Sampling

Phytoplankton samples were collected with vertical net hauls (20 µm mesh size and net diameter 30 cm) from near the ocean floor to the surface in different locations of Vietnamese coastal waters. Samples were fixed with formaldehyde to a final concentration of approximately 5% and then stored in 25 ml dark glass bottles, reserved at the Institute of Oceanography, Nha Trang, Viet Nam.

Analyses of samples

The samples were examined under a Leica LDMB light microscope and by scanning electron microscopy (SEM). Observations of plate patterns were made with Calcofluor White M2R according to Fritz & Triemer (1985). Digital camera Olympus DP71 was used for light and epifluorescence microphotography.

For SEM observation, cells of *Protoperidinium* were isolated from preserved samples and placed on a 5 µm carbon membrane filter, rinsed with distilled water, dehydrated through an ascending ethanol series (15, 30, 50, 70, 2x absolute ethanol) and air dried. The filter was mounted onto an aluminum stub with carbon tape and finally sputter coated with gold. The stubs were examined on a Hitachi FM-SEM (model S4800 Field Emission-Scanning Electron Microscope) at the National Institute of Hygiene and Epidemiology (NIHE), Ha Noi, Vietnam.

RESULTS AND DISCUSSION

Systematics

**Class Dinophyceae Pascher, 1914**

**Order Peridiniales Haeckel, 1894**

**Family Protoperidiniaceae Balech, 1988**

**Genus Protoperidinium Bergh, 1881**

**Subgenus Minusculum** (Lebour, 1925)

Balech, 1974

*Protoperidinium anomaloplaxum* (Balech, 1964) Balech, 1974
Members of this subgenus are characterized by their small size, strongly asymmetrical epitheca with four apical plates, three anterior intercalary plates, and only six precingular plates. The 6" plate is large and extends to the dorsal side of the cell and overlaps partially or totally the 5" plate (Balech, 1974, 1976, 1988).

**Figure 1. Protochrysalis anomaloplaxum:** a (LM), b (Epi) & g (SEM): a cell in ventral view showing the descending cingulum, plate pattern of thecal plates, right antapical wing spine (arrow), and left sulcal list (arrowhead), ornamentation of the thecal plates, narrow membrane along the sutures of apical plates (arrows), and wide striated intercalary bands; c (Epi): showing plate patterns of epitheca in apical view; d (Epi): showing the epitheca plate patterns in ventral view; e & f (Epi): showing the intercalary plates (1a, 2a, and 3a) in lateral view; h: (SEM): part of the theca with reticulation, pores of the varying size (arrows and arrowheads) and canal plate (x). Epi: epifluorescence, LM: light microscope, and SEM: Scanning electron micrograph.
Redescription of species

**Protoperidinium anomaloplaxum** (Balech, 1964) Balech, 1974 (Figure 1a–1h, 2a–2c)

**Basionym:** *Peridinium anomaloplaxum* Balech, 1964

Balech, 1964: p. 28, pl. III (34-46); Balech, 1974: p. 53; Balech, 1988: p. 82, pl. 22, Figs. 9, 11-13; Jardim & Cardoso, 2013: 634, Fig. 1H & I.

**Description:** The cells have napiform, wider than long (Figs. 1a, b, g, 2a, b) with a total length (including antapical spine) of 43-47 µm, 38–40 µm length, 40–45 µm wide, and 30–32 µm dorso-ventrally. The epitheca has short apical neck without an apical horn (Figs. 1a, 1b, 1g, 2a, 2b). There is a membrane along the sutures of apical plates (Figs. 1g, 2a, 2b). Plate 1' has five sides (meta-type), long and narrow, very asymmetrical, with the right posterior side being strongly concave (Figs. 1b–1d, 1g, 1h, & 2a–2c). There are six precingular plates, the plate 6” is exceptionally large, and extends onto the dorsal side of the cell (Figs. 1c–1e, 1g, 2a–2c). There are three anterior intercalary plates with the plate 2a of the penta-type. Due to the asymmetrical tabulation the intercalary plates lie on the left side of the cell (Figs. 1c, 2c). The cingulum descends about one girdle width (Figs. 1a, 1b, 1g, & 2a, 2b) and is bordered by wide lists supported by spines (Figs. 1e–1g, 2c). The cingular plate C1 very narrow, plate C3 is narrow (Figs 1b, 2b) or wide (Figs 1g, 2a), and plate C2 is wide and surrounding more or less the whole cell (Figs 1b & 1g, 2b). The hypotheca is hemispherical with only one antapical wing-spine on the right and a left sulcal list extended looking as a spine (Figs. 1a, 1g, 2a, 2b). The sulcus expands distally more towards the right than towards the left (Figs. 1b, 1g, & 2a, 2b). The surface of the thecal plates is ornamented with reticulation and pores of the varying size (Figs. 1g, 1h). Our observations showed that the sutures with wide striated intercalary bands (Figs. 1g–1h).

**Morphological notes**

The shape and tabulation of the Vietnamese material of *Protoperidinium anomaloplaxum* is identical to the type description, *Peridinium anomaloplaxum* Balech, 1964. The cingular plates C1 and C3 were very narrow (Figs. 1b & 2b) (Balech, 1964, p. 29, pl. III, Figs. 34, 41; Balech 1988, pl. 22, Fig. 9). However, in a few cases, cells have wide cingular plate C3, nearly equal to the fifth postcingular (5”) plate (Figs. 1g & 2a). *Protoperidinium anomaloplaxum* is similar to *P. adulterum* with regard to the shape of the cell. However, the present species has a 2a-plate of the “penta-type”, one antapical spine and a list lining the left side of the sulcus; whereas *P. adulterum* has a 2a-
plate of the “quadra-type” and two antapical spines in addition to a sulcal list (Balech, 1974, 1988).

Yamaguchi et al. (2007) questioned the taxonomic status of the subgenus Minusculum as molecular data suggested that Protoperidinium (Minusculum) bipes should be included in the subgenus Protoperidinium. However, there are distinct morphological differences between the two subgenera (Phan-Tan et al., 2016b, 2017, 2018). The molecular data presented by Yamaguchi et al. (2007) also suggested that P. pentagonum which appears to morphologically belong to the Conica-group is related closer to the Divergentia-group. In our opinion, these discrepancies between the molecular data and the morphology of the species need to be clarified further before taxonomic conclusions can be drawn.

Ecology and Distribution

According to Balech (1988), P. anomaloplaxum has a particular distribution occurring between 37°39’S-38°42’S and 53°33’W-57°20’W in the waters off Mar del Plata, Argentina at temperatures from 14.6 to 18.0°C, and salinities from 35.0 to 36.114 psu. Jardim & Cardoso (2013) found P. anomaloplaxum in the Rio Grande do Sul, Brazil (29°59’05” S, 50°08’01” W) at temperatures from 14.5 to 23°C, salinities from 21.5 to 27.8 psu. In this study, P. anomaloplaxum has been found in Vietnam in the waters off Da Nang, Nha Trang Bay, and in the coastal waters of Con Dao Island at temperatures from 26 to 29°C, and salinities from 33 to 34 psu.

CONCLUSION

P. anomaloplaxum of the subgenus Minusculum is reported for the first time in Vietnamese waters and also the first report in tropical waters. The species was previously only found in temperate waters of Argentina and Brazil and now in tropical waters showing its wide distribution and would be found in other waters. However, since it was only reported three times, this species may be considered as a rare species. Our finding is presently contributing to knowledge on the morphology and distribution of the species in the world.

Acknowledgements: This research is funded by the Graduate University of Science and Technology under grant number GUST.STS.DT2017-KHB01. Authors were also financed by the National Foundation for Science and Technology Development (NAFOSTED), Vietnam Ministry of Science and Technology via grant number: 106-NN.06-2017.305.

REFERENCES

Balech E., 1964. El plancton de Mar del Plata durante el período 1961-1962 (Buenos Aires, Argentina). Boletín del Instituto de Biología Marina, 4: 1–49.

Balech E., 1974. El género Protoperidinium Bergh, 1881 ("Peridinium", Ehrenberg, 1831, partim). Revista del Museo Argentino de Ciencias Naturales "Bernardino Rivadavia" Instituto Nacional de Investigación de las Ciencias Naturales, Hidrobiología, 4(1): 1–79.

Balech E., 1976. Clave ilustrada de dinoflagelados antárticos. Publ. Inst. Antártico Argentina, 11: 1–99.

Balech E., 1988. Los dinoflagelados del Atlántico Sudoccidental. Ministerio de Agricultura Pesca y Alimentación, Inst. Esp. Oceanogr. Sp. Pub. 1, Madrid, 310 pp.

Faust M. A., 2006. Creation of the subgenus Testeria Faust subgen. nov. Protoperidinium Bergh from the SW Atlantic Ocean: Protoperidinium novella sp. nov. and Protoperidinium conicinna sp. nov. Dinophyceae. Phycologia, 45: 1–9.

Fritz L., Triemer R. E., 1985. A rapid simple technique utilizing Calcofluor White M2R for the visualization of dinoflagellate thecal plates. Journal of Phycology, 21: 662–664.

Jardim P. F. G., de Souza Cardoso L., 2013. New distribution records of Dinophyta in Brazilian waters. CheckList, 9 (3): 631–639.
Phan Tan Luom, Nguyen Ngoc Lam, Doan Nhu Hai, 2016a. Taxonomy of dinoflagellates, the genus *Protoperidium* (*Archaeperidinium*), in coastal waters of Vietnam. *Journal of Biology*, 38(1): 39–52. https://doi.org/10.15625/0866–7160/v38n1.7596 (in Vietnamese with English summary).

Phan–Tan L., Nguyen–Ngoc L., Doan–Nhu H., 2016b. Species diversity of sections *Conica* and *Tabulata* in the genus *Protoperidinium* (*Dinophyceae*) from tropical waters of the South China Sea. *Nova Hedwigia*, 103(3–4): 515–545. http://dx.doi.org/10.1127/nova_hedwigia/2016/0369. ISSN 0029–5035.

Phan–Tan L., Nguyen–Ngoc L., Doan–Nhu H., Raine R. and Larsen J., 2017. Species diversity of the dinoflagellate genus *Protoperidinium* section *Oceanica* (*Dinophyceae*, *Peridiniales*) in Vietnamese waters, with description of a new species–*P. larsenii* sp. nov. *Nordic Journal of Botany*, 35: 129–146. https://doi.org/10.1111/njb.01230. ISSN 1756–1051.

Phan–Tan L., Nguyen–Ngoc L., Smith W. O., Jr. & Doan–Nhu H., 2018. A new dinoflagellate species, *Protoperidinium smithii* H. Doan–Nhu, L. Phan–Tan et L. Nguyen–Ngoc sp. nov., and an emended description of *Protoperidinium defectum* (Balech 1965) Balech 1974 from the Ross Sea, Antarctica. *Polar Biology*, 41: 983–992. https://doi.org/10.1007/s00300–018–2262–0.

Nguyen Luong Tung, Phan Tan Luom, Nguyen Thi Tuong Vi, 2017. Species composition and abundance of genus *Protoperidinium* (dinoflagellate) in Con Dao coastal waters, Ba Ria–Vung Tau. *Journal of Science and Technology of the University of Da Nang*. ISSN 1859–1531, 01(110): 131–135 (in Vietnamese with English summary).

Yamaguchi A., Kawamura H., Horiguchi T., 2007. The phylogenetic position of an unusual *Protoperidinium* species, *P. bipes* (*Peridiniales*, *Dinophyceae*), based on small and large subunit ribosomal RNA gene sequences. *Phycology*, 46(3): 270–276. DOI: 10.2216/06–82.1.