

# Dinophysis (Dinophyceae) in Vietnamese waters

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**Abstract**—This study aims to update species list of *Dinophysis* in Vietnamese waters using an updated view on the implication of morphological criteria. Samples were collected from various areas of Vietnamese waters and analyzed for morphological characteristics, such as shape of cells and their thecal plates in detail, and were compared with the images and diagnoses described in the original description of each species. Twenty-four *Dinophysis* species were identified and seven of them were recorded in Vietnamese waters for the first time. Their light-microscope and SEM images were presented.

**Key words:** *Dinophysis*, morphology, dinoflagellate, Vietnamese water

## Introduction

*Dinophysis* is a well known genus of dinoflagellate, as it contains diarrhoeic shellfish poisoning (DSP) toxin producing species. Their classification is, however, very problematic. One of the reasons leading to the ambiguity is unclear species boundary, mostly derived from the lack of sufficient understanding on their morphological variability. Original descriptions of *Dinophysis* species are often based on observation of very few specimens, in most cases only a single specimen being found in the type locality. Ranges of morphological variation are therefore mostly unknown. This condition has led to difficulty in species identification, and then produced another new species based on an intermediate morphotype with very unclear morphological characteristics again. To overcome the problem, a meaningful approach is to grasp their morphological variability in various areas.

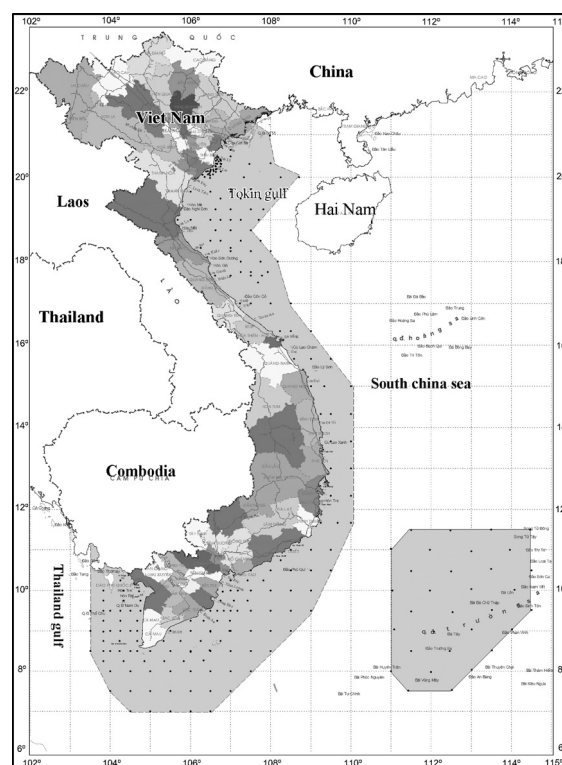
For the central and western Pacific region, Nguyen et al. (2008) compiled a mini monograph on various *Dinophysis*, based on critical morphological identification. The present paper presents similar findings on this genus in the coastal waters of Vietnam.

## Materials and Methods

Plankton samples were collected through various projects carried out by the Research Institute for Marine Fisheries of Vietnam in Vietnamese waters (Fig. 1) during 1998–2008, using plankton-nets of 20  $\mu\text{m}$  or 60  $\mu\text{m}$  mesh sizes. *Dinophysis* cells were isolated using a capillary pipette before transferred to a chamber made of a vinyl frame and

glass slide following Horiguchi et al. (2000) and covered with a coverslip for detailed observation.

Morphological characteristics were observed under an Olympus BX60 microscope at total magnifications of 100 to 1000 times. Images of cells were recorded by a DP 25 Digital Camera accompanied by DP2-BSW software (Olympus). Classification of all species was based on original descrip-



**Fig. 1.** Map showing the sampling sites (collected by various projects carried out by the Research Institute for Marine Fisheries during 1998–2008).

tions, except the case of *Dinophysis caudata*, which was based on successive major taxonomic accounts, namely Jorgensen (1923), Kofoid and Skogsberg (1928), Abé (1967) and Taylor (1976). Systems of grouping of *Dinophysis* species and measurement of morphological metric parameters followed Kofoid and Skogsberg (1928).

In addition to the light microscope observation, almost all species was also observed under a scanning electron microscope (JSM 5410 LV). For SEM observation, *Dinophysis* cells were isolated using a capillary pipette and rinsed with distilled water several times. The cells were then placed on a Millipore membrane filter and dried in the air before gold coating.

## Results and Discussion

Totally, 24 *Dinophysis* species were recorded, belonging

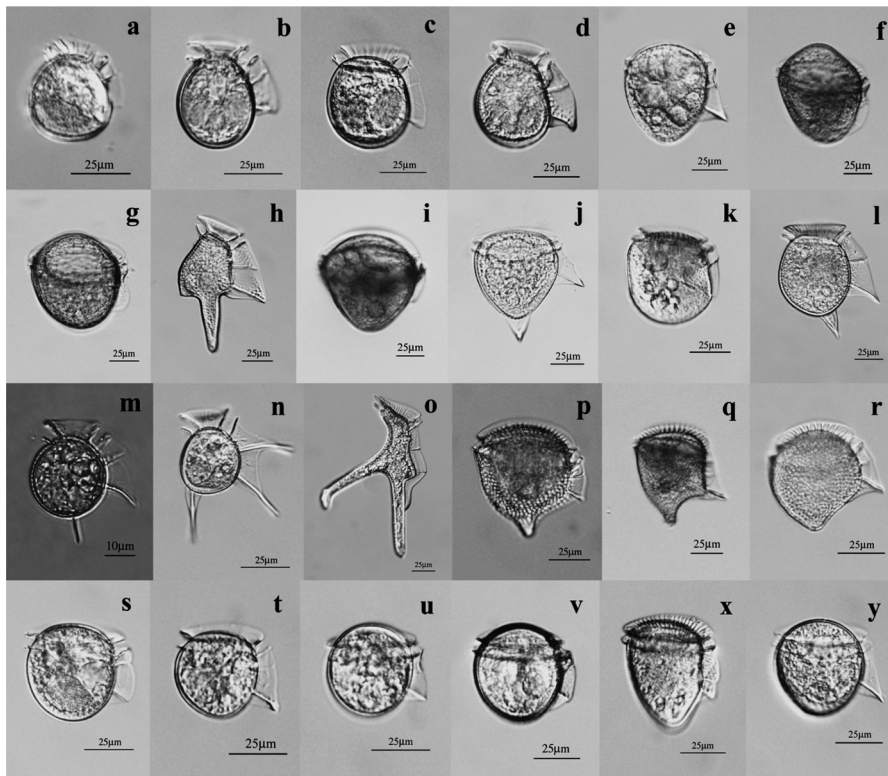
to 10 morphological groups (Table 1). Their LM and SEM images are shown Figs. 2 and 3, respectively. The number of *Dinophysis* species found in Vietnamese water (24) was lower than those found in the Pacific Ocean (33 species: Nguyen et al. 2008), and it was reasonable as the sampling area is much narrower.

Among them, seven species were recorded for the first time in Vietnamese water, namely *D. ovum*, *D. similis*, *D. apicata*, *D. argus*, *D. expulsa* and two unidentified species, *Dinophysis* sp. 2 and 3. The most morphologically closely related species of *Dinophysis* sp. 2 was *D. elongata* described by Jorgensen (1923) as *Phalacroma elongata*. However, the sp. 2 had a lower epitheca and more pointed hypotheca compared to *D. elongata* (Fig. 4). *Dinophysis* sp. 3 fell into the “rotundata” group in the system of Kofoid and Skogsberg (1928). However, *Dinophysis* sp. 3 had a considerably symmetrical shape and the sulcal lists was more delicate, comparing to that of the species in “rotundata” group. Its 3<sup>rd</sup> rib

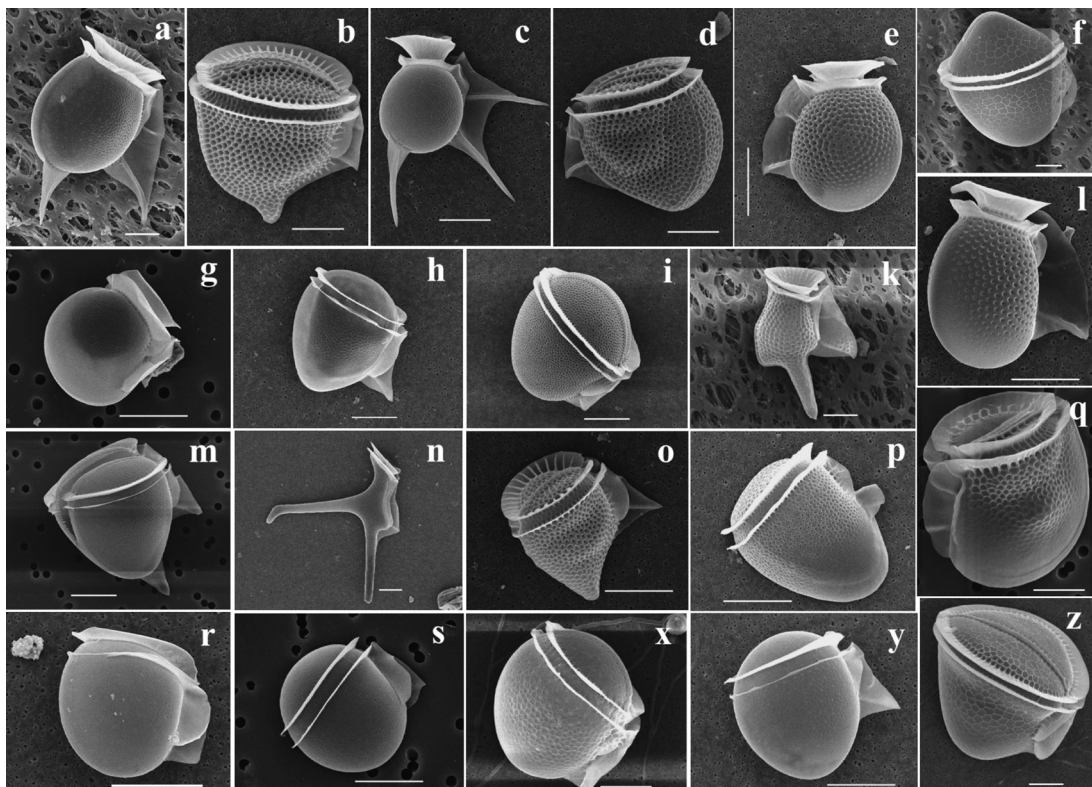
**Table 1.** List of *Dinophysis* species found in South China Sea.

Species	Main references used for identification
<b>I. Acuta group</b>	
1. <i>Dinophysis infundibula</i> (Schiller) sensu Taylor	Taylor, 1976
2. <i>Dinophysis ovum</i> Schuett	Schuett, 1859
3. <i>Dinophysis similis</i> Kofoid & Skogsberg	Kofoid and Skogsberg, 1928
4. <i>Dinophysis</i> sp.1	
<b>II. Argus group</b>	
5. <i>Dinophysis amandula</i> (Balech) Sournia	Schuett, 1859; Sournia, 1973
6. <i>Dinophysis apicata</i> (Kofoid & Skogsberg) Sournia	Kofoid and Skogsberg, 1928; Sournia, 1973
7. <i>Dinophysis argus</i> (Stein) Abé	Stein, 1883; Abé, 1967
<b>III. Caudata group</b>	
8. <i>Dinophysis caudata</i> Saville–Kent	Kofoid and Skogsberg, 1928*
<b>IV. Cuneus group</b>	
9. <i>Dinophysis cuneus</i> (Schuett) Abé	Schuett, 1859; Abé, 1967
<b>V. Doryphora group</b>	
10. <i>Dinophysis doryphora</i> (Stein) Norris & Berner	Stein, 1883; Norris and Berner, 1970
<b>VI. Expulsa group</b>	
11. <i>Dinophysis expulsa</i> Kofoid & Michener	Kofoid and Michener, 1911
<b>VII. Hastata group</b>	
12. <i>Dinophysis hastata</i> Stein	Stein, 1883
13. <i>Dinophysis pusilla</i> Jorgensen	Jorgensen, 1923
14. <i>Dinophysis schuetti</i> Murray & Whitting	Murray and Whitting, 1899
<b>VIII. Miles group</b>	
15. <i>Dinophysis miles</i> Cleve	Cleve, 1900
<b>IX. Rapa group</b>	
16. <i>Dinophysis favus</i> (Kofoid & Michener) Abé	Kofoid and Michener, 1911; Abé, 1967
17. <i>Dinophysis mitra</i> (Schuett) Abé	Schuett, 1859; Abé, 1967
18. <i>Dinophysis rapa</i> (Stein) Abé	Stein, 1883; Abé, 1967
19. <i>Dinophysis</i> sp.2	
<b>X. Rotundata group</b>	
20. <i>Dinophysis lativelata</i> (Kofoid & Skogsberg) Balech	Kofoid and Skogsberg, 1928; Balech, 1967
21. <i>Dinophysis parvula</i> (Schuett) Balech	Schuett, 1859; Balech, 1967
22. <i>Dinophysis rotundata</i> Claparede & Lachmann	Claparede and Lachmann, 1859
23. <i>Dinophysis whittingae</i> (Murray & Whitting) Balech	Murray and Whitting, 1899; Balech, 1967
24. <i>Dinophysis</i> sp.3	

\* based on successive taxonomist

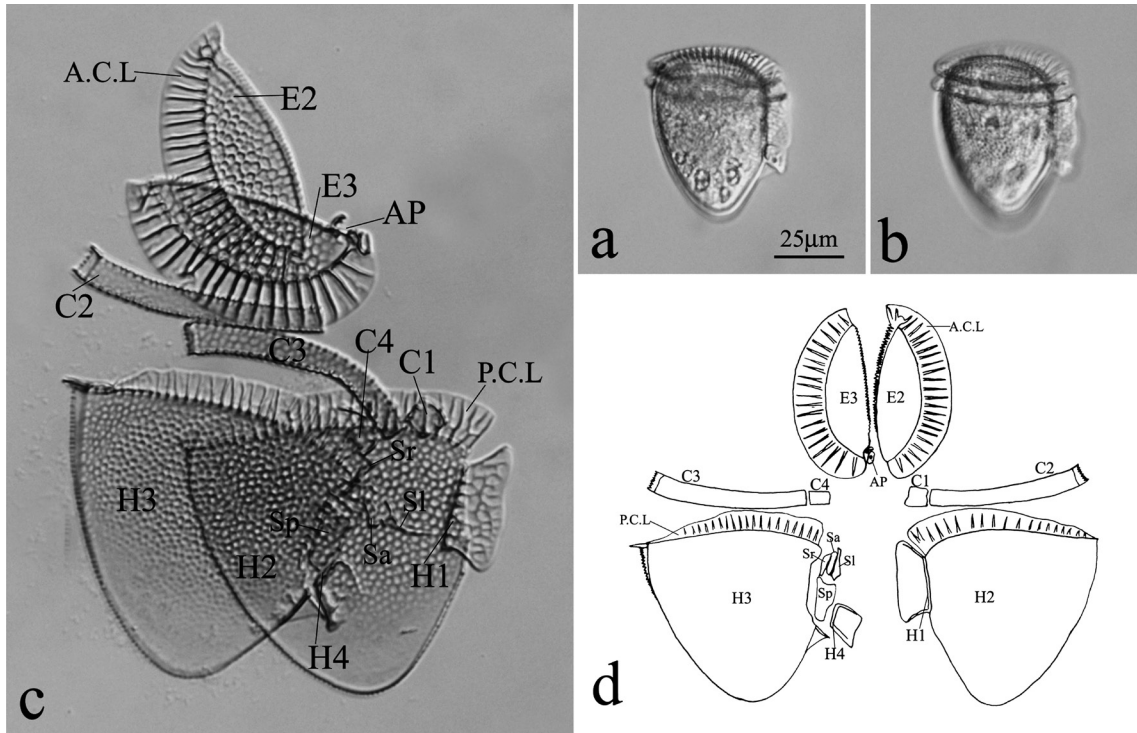


**Fig. 2.** LM images of *Dinophysis* species found in Vietnamese water. (a) *D. infundibula*, (b) *D. ovum*, (c) *D. similis*, (d) *D. sp1.*, (e) *D. amandula*, (f) *D. apicata*, (g) *D. argus*, (h) *D. caudata*, (i) *D. cuneus*, (j) *D. doryphorum*, (k) *D. expulsa*, (l) *D. hastata*, (m) *D. pusilla*, (n) *D. schuetti*, (o) *D. miles*, (p) *D. favus*, (q) *D. rapa*, (r) *D. mitra*, (s) *D. rotundata*, (t) *D. lativelata*, (u) *D. parvula*, (v) *D. whittingea*, (x) *D. sp. 2*, (y) *D. sp. 3*.

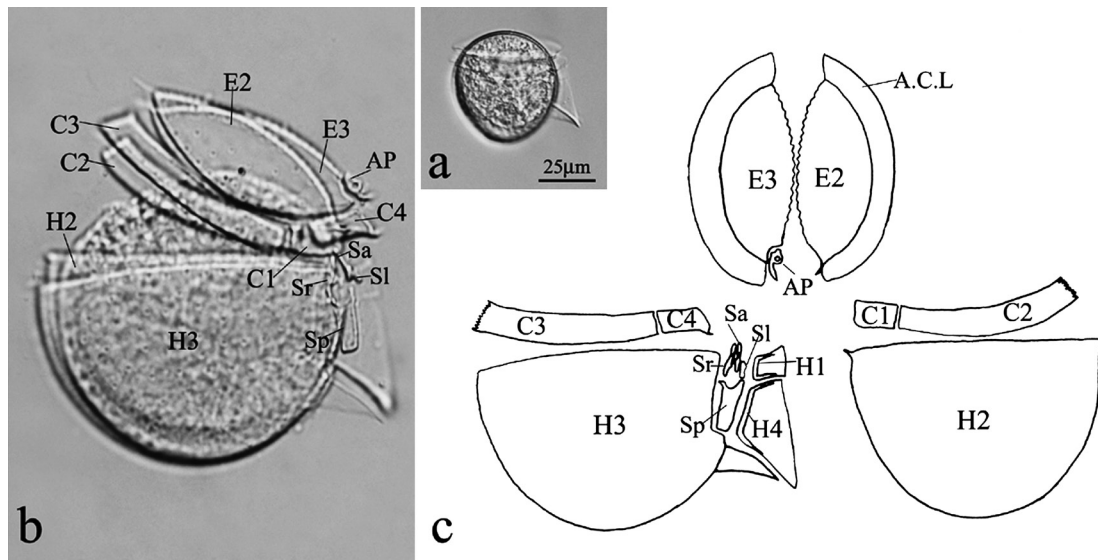


**Fig. 3.** SEM images of *Dinophysis* species found in Vietnamese water. (a) *D. hastata*, (b) *D. favus*, (c) *D. schuetti*, (d) *D. mitra*, (e) *D. ovum*, (f) *D. apicata*, (g) *D. similis*, (h) *D. amandula*, (i) *D. argus*, (k) *D. caudata*, (l) *D. SP.1*, (m) *D. doryphora*, (n) *D. miles*, (o) *D. rapa*, (p) *D. sp. 2*, (q) *D. expulsa*, (r) *D. rotundata*, (s) *D. parvula*, (x) *D. whittingea*, (y) *D. sp. 3*, (z) *D. cuneus*. Scale bars=25 µm.





**Fig. 4.** Thecal plates of *Dinophysis* sp. 2. (a, b) cell shape, (c) thecal plates structure, and (d) diagrammatic of thecal plates. E1 (left ventral), E2 (left dorsal), E3 (right dorsal), E4 (right ventral); the four circular plates, C1 (left ventral), C2 (left dorsal), C3 (right dorsal), C4 (right ventral); the four hypothecal plates, H1 (left ventral), H2 (left dorsal), H3 (right dorsal), H4 (right ventral); and the four sulcal plates, Sl (left sulcal), Sa (anterior sulcal), Sr (right sulcal), Sp (posterior sulcal) and AP (apical pore).



**Fig. 5.** Thecal plates of *Dinophysis* sp. 3. (a) cell shape, (b) thecal plates structure, and (c) diagrammatic of thecal plates. E1 (left ventral), E2 (left dorsal), E3 (right dorsal), E4 (right ventral); the four circular plates, C1 (left ventral), C2 (left dorsal), C3 (right dorsal), C4 (right ventral); the four hypothecal plates, H1 (left ventral), H2 (left dorsal), H3 (right dorsal), H4 (right ventral); and the four sulcal plates, Sl (left sulcal), Sa (anterior sulcal), Sr (right sulcal), Sp (posterior sulcal) and AP (apical pore).

was longer and more pointed than that of the “rotundata” group (*D. rotundata*, *D. parvula*, *D. lativelata* and *D. whittin-gae*) (Fig. 5). These characteristics are important criteria for classification at species level (Nguyen 2009).

*Dinophysis* sp. 1, which was quite common in Viet-

namese water, is morphologically very similar to *D. fortii*. However, its morphological features, including the rate of the cell height to cell length and cell shape, did not fit the original description of *D. fortii* Pavillard (1916). *Dinophysis* sp.1 has a more rounded body, the dorsal margin of the hypotheca

is more convex and epitheca is smaller than that of the materials described in the original description, or the materials from Japanese waters (Nguyen et al. 2008). From these reasons, the morphotype sp.1 was referred to as an unidentified species in the purpose to highlight its questionable classification. Further study, preferably with comparison of both morphological and genetic characteristic of these samples with that of *D. fortii* from other areas, including type locality, are needed before any better statements on classification of this complex can be made.

It should be reminded that the two species, *D. amandula* and *D. whittingae*, are frequently assigned by researchers under the invalid names, *D. ovum* and *D. rudgei*, respectively, for instance by Abé (1967), Dang (2003) and Gárate-Lizarraga et al. (2007) (see Nguyen et al. 2008 for further explanation).

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