Acta Bot. Croat. 66 (1), 75–79, 2007
CODEN: ABCRA 25
ISSN 0365–0588

Short communication

Observations on an H-shaped dinoflagellate. An example of the projection of body extensions in gymnodiniacean cells

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Little is known about the morphological versatility of the unarmoured dinoflagellates. The morphology of an unarmoured dinoflagellate with a distinctive H-shaped contour is described from sub-surface waters of the Strait of Gibraltar (NE Atlantic) and the northern Philippine Sea (NW Pacific). The cell body was slightly hexagonal with two rounded-tip apical arms and two antapical sharp-pointed horns. A carina with a straight groove was located between the two apical arms. The cingulum was excavated, with a descending displacement of more than one-half body length and had an overhang. A round nucleus was located in the left hyposome. These forms may correspond to a gymnodiniacean cell that is able to project body extensions under unfavourable environmental conditions.

Key words: *Gyrodinium*, *Karenia*, dinoflagellate, Dinophyceae, phytoplankton, microalgae, Atlantic, Pacific

Introduction

During the routine microscopical analysis of several thousand phytoplankton samples from the Atlantic, Mediterranean and Pacific waters, two similar specimens of an unknown but distinctive dinoflagellate were observed. The present study describes the morphology of this interesting dinoflagellate from two distant geographical areas.

Materials and methods

Samples from the Atlantic Ocean were collected during a cruise aboard R/V Thalassa (2–9 September 1997) in the Strait of Gibraltar (Mediterranean Sea-Atlantic Ocean) (Fig. 1). Eight stations were visited and samples were collected at 9–11 depths at each station and 2.5 L seawater from Niskin bottles was filtered through 5-µm pore size mesh and the retained particles were carefully washed out, placed in glass bottles and preserved with acidified Lugol's solution. Sub-samples (10–100 mL) were allowed to settle for 24–48 h in Utermöhl chambers (GÓMEZ et al. 2000, GÓMEZ 2003). The specimen was photographed on

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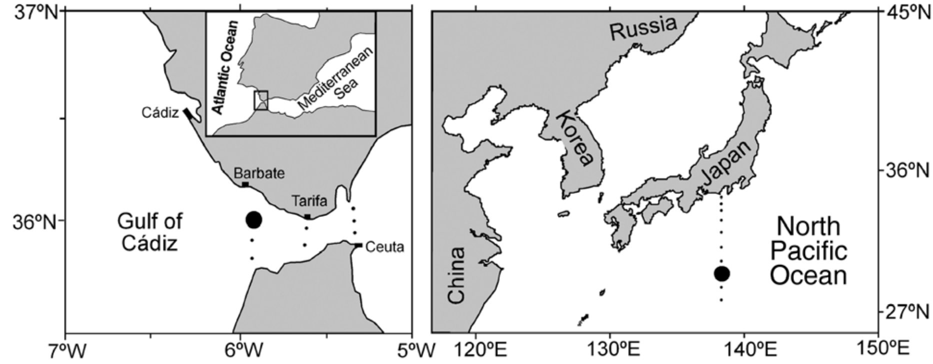


Fig. 1. Position of stations in the Atlantic and Pacific Oceans. Larger circles indicate locations where H-shaped dinoflagellate has been recorded.

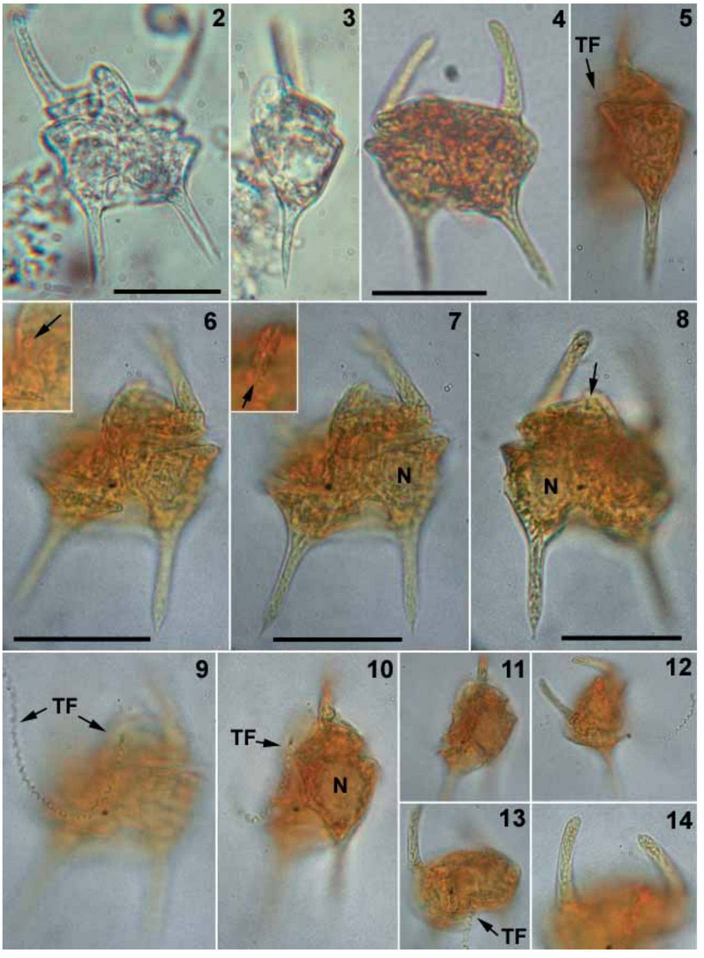
an inverted microscope connected to a Leica Wild camera. The specimen showed the entire cell contents during the first microscopic observation. However, the cell body appeared empty after a re-examination several months later.

Samples from the Pacific Ocean were collected during a cruise aboard R/V *Soyo-Maru* (13–20 May 2002) in the Kuroshio Current and the northern Philippine Sea (Fig. 1). Seawater samples were collected using Niskin bottles at nine stations along the meridian 138°E from 28°0'N to 34°20'N, at 15 depths ranging between 5 to 200 m. Sample treatment and microscopic observations as in GÓMEZ et al. (2005).

Results

Two specimens of this highly distinctive dinoflagellate were observed from samples collected from Atlantic and Pacific waters (GÓMEZ 2003, 2006; GÓMEZ et al. 2005). The first specimen was collected in the Atlantic side of the Strait of Gibraltar at 65 m depth (2 September 1997; 35°58'N, 5°55'W; bottom depth 160 m). The phytoplankton assemblage was dominated by the diatom *Pseudo-nitzschia* spp. with a marked sub-superficial maximum at 40 m depth. The second specimen was collected in the northern Philippine Sea at 150 m depth (16 May 2002; 30°N, 138°E; bottom depth 4050 m). The plankton assemblage at that depth was dominated by naked ciliates (<100 cells L^{-1}).

The maximal length of the H-shaped specimens was 52 and 55 µm and the width at the level of the cingulum was 25 and 27 µm for the Atlantic and Pacific specimens, respectively. The contour of the cell body in ventro-dorsal view was slightly hexagonal (Figs. 2, 4, 6–8). The apex showed a carina or crest with a straight apical groove (Figs. 7, 8). The excavated cingulum was descending and displaced by one-half of the body length and had an overhang (Fig. 6). The sulcus swung to the left before meeting the returning end of the cingulum. The intercingular region the cingulum and sulcus was Z-shaped (Figs. 6, 7). A pore was observed near the beginning of the cingulum. This may correspond to a periflagellar pore where one or both flagella emerged (Fig. 6). The specimen was shaken until the transverse flagellum was separated from the cingulum (Fig. 9). The flagellum arose probably from the periflagellar pore shown in figure 6. The nucleus was round and located in the left side of the hyposome (Figs. 7, 8, 10).



Figs. 2–14. Photomicrographs of the H-shaped dinoflagellate, non-reversed images in bright field optics. Figs. 2–3. Specimen from the Atlantic Ocean. Dorsal and left lateral views, respectively. Figs. 4–14. Specimen from the Pacific Ocean. Figs. 4–5. Dorsal and left lateral views, respectively. Fig. 6. Ventral view. See the Z-shaped intercingular region. The inset illustrates a tentative periflagellar pore. Fig. 7. Ventral view. The arrow in the inset indicates the straight groove in the carina. Fig. 8. Dorsal view. The arrow indicates the contour of the apical groove. Fig. 9. Ventral view. The specimen was shaken until the transverse flagellum was separated from the cingulum. Figs. 10–11. Left latero-ventral view. See the round nucleus. Figs. 12–13. Apical views. Fig. 14. Detail of the tips of the apical extensions. N=nucleus; TF=transverse flagellum. The black spot in the photographs is not related to the cell. Scale bars denote 20 μm.

The specimens showed four extensions of ~20 μm long radiating from the cell body. This resulted in the distinctive H-shaped contour (Fig. 4). Two curved flattened apical extensions with rounded tips projected from the episome (Fig. 14). The apical arms were in a different focal plane (Figs. 6–8, 12–13). The right apical arm was more dorsally located than the left (Figs. 7, 8). The angle of the apical arms with respect to the episome was variable because the junctions were flexible (Figs. 2, 4, 6–7). The two antapical extensions were straight and with acute ends. The left horn formed a right angle with the basis of the hyposome, whereas the right horn slightly diverged (Fig. 7).

In left lateral view, the cells showed an elongate bi-conical contour with the episome smaller than the hyposome (Figs. 3, 5, 10). The round nucleus was visible in lateral view as a pale region (Figs. 10, 11). The Pacific specimen, observed in a better stage of conservation, showed a green pigmentation. However, no presence of chloroplasts was discernible (Figs. 6–8).

Discussion

Neither tabulation nor apical pore was observed. The forms of this study correspond to an unarmoured dinoflagellate (Figs. 15–17). The groove along the carina recalls the straight apical groove that can be found in species belonging to the genera *Brachidinium* F.J.R. Taylor, *Asterodinium* Sournia, *Microceratium* Sournia and *Karenia* G. Hansen *et* Moestrup (GÓMEZ et al. 2005, GÓMEZ 2006). Flexible arms with rounded tips can be found in gymnodiniaceans such as *Brachidinium* or *Asterodinium* (GÓMEZ et al. 2005). However, the brachidiniaceans have strongly dorso-ventral flattened cells with a fucoxanthine-derived pigmentation. The forms of the present study were slightly dorso-ventrally compressed and the pigmentation seems to be closer to a typical peridinine-containing dinoflagellate. The shape of the intercingular region, descending and with an overhand, is similar to numerous species described under the genus *Gyrodinium* Kofoid et Swezy.

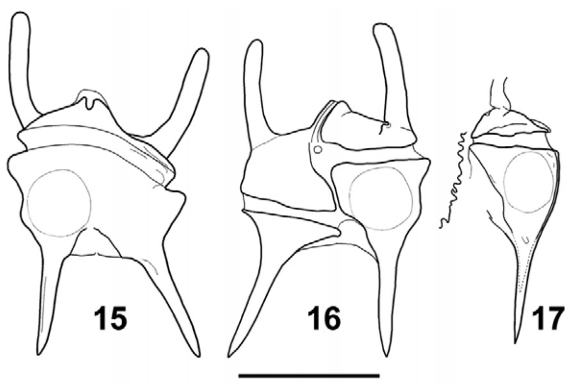


Fig. 15–17. Line drawings of the H-shaped dinoflagellate. Ventral, dorsal and left lateral view, respectively. Scale bar = 20 μm.

The two apical arms and the two antapical horns are most distinctive characters of the specimens. The projection of body extensions has been described as a strategy for the reduction of sinking speed in thecate species such as *Ceratocorys horrida* Stein (ZIRBEL et al. 2000). Little is known about the morphological versatility of the unarmoured dinoflagellates. The two specimens of the present study were found near the bottom of the euphotic zone at each location and predominating phytoplankton post-bloom conditions. It is hypothesized that the H-shaped forms corresponded to a stage of a versatile dinoflagellate that is able to project body extensions under unfavourable environmental conditions.

Acknowledgements

The study in the Atlantic Ocean was supported by EU project CANIGO (MAS3--CT96-0060) and in the Pacific Ocean by a Grant-in-aid for Creative Basic Research (12NP0201, DOBIS) from the MEXT, Japan. I was supported by a fellowship of the European Commission (ICB2-CT-2001-80002) held at the University of Tokyo with Prof. K. Furuya as host.

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