

Redescription of *Gymnodinium heterostriatum* Kofoid et Swezy 1921 (Dinophyceae)

M. Elbrächter*

*Biologische Anstalt Helgoland, Wattenmeerstation Sylt; Postfach 60, D-25989 List,
Germany*

ABSTRACT: The dinoflagellate *Gymnodinium heterostriatum* Kofoid et Swezy is described anew from live material of the upwelling region off the NW African coast. The characteristics that distinguish it from *Gymnodinium striatissimum* Hulburt, a species with which it has been mistaken since the original description, are discussed.

INTRODUCTION

There have been mistakes in the past concerning the application of the name *Gymnodinium heterostriatum* Kofoid et Swezy. In 1921, Kofoid and Swezy described and illustrated in their monograph of the unarmoured dinoflagellates a species which they named *Gymnodinium heterostriatum* (Kofoid & Swezy, 1921: p. 221–223; Pl. 2, Fig. 24 and Textfig. Y, 7). It was redescribed by Kofoid (1931, p. 14, Fig. F). Erroneously, Kofoid & Swezy (1921) regarded the species that Dogiel (1906) had illustrated as *Gymnodinium spirale* var. *obtusum* (see Dogiel's Plate 2, Figs 50–56) as conspecific with *G. heterostriatum*. *Gymnodinium spirale* Bergh var. *obtusum* Schütt 1895 is now known as *Gyrodinium obtusum* (Schütt) Kofoid et Swezy 1921 and is quite different from the taxa depicted by Dogiel (1906), Kofoid & Swezy (1921: Pl. 2, Fig. 24 and Textfig. Y, 7), and Kofoid (1931). Elbrächter (1979) identified the species Dogiel had described and depicted in 1906 as *Gymnodinium striatissimum* Hulburt 1957. Unfortunately, Kofoid & Swezy (1921) illustrated on Plate 5, Fig. 56, under the name *G. heterostriatum*, a specimen apparently conspecific with that described and illustrated in detail as *G. spirale* var. *obtusum* by Dogiel (1906), which is now known as *Gymnodinium striatissimum*. Subsequently, *G. heterostriatum* and *G. striatissimum* have been regarded as conspecific. Elbrächter (1979), however, demonstrated that they are two separate taxa. He provided a detailed description of *Gymnodinium striatissimum*, including a discussion on the nomenclatural problems. During cruise Nr. 44 of the R. V. Meteor, *G. heterostriatum* was discovered and will be described in more detail below.

*Member of the Taxonomy Group at the Biologische Anstalt Helgoland

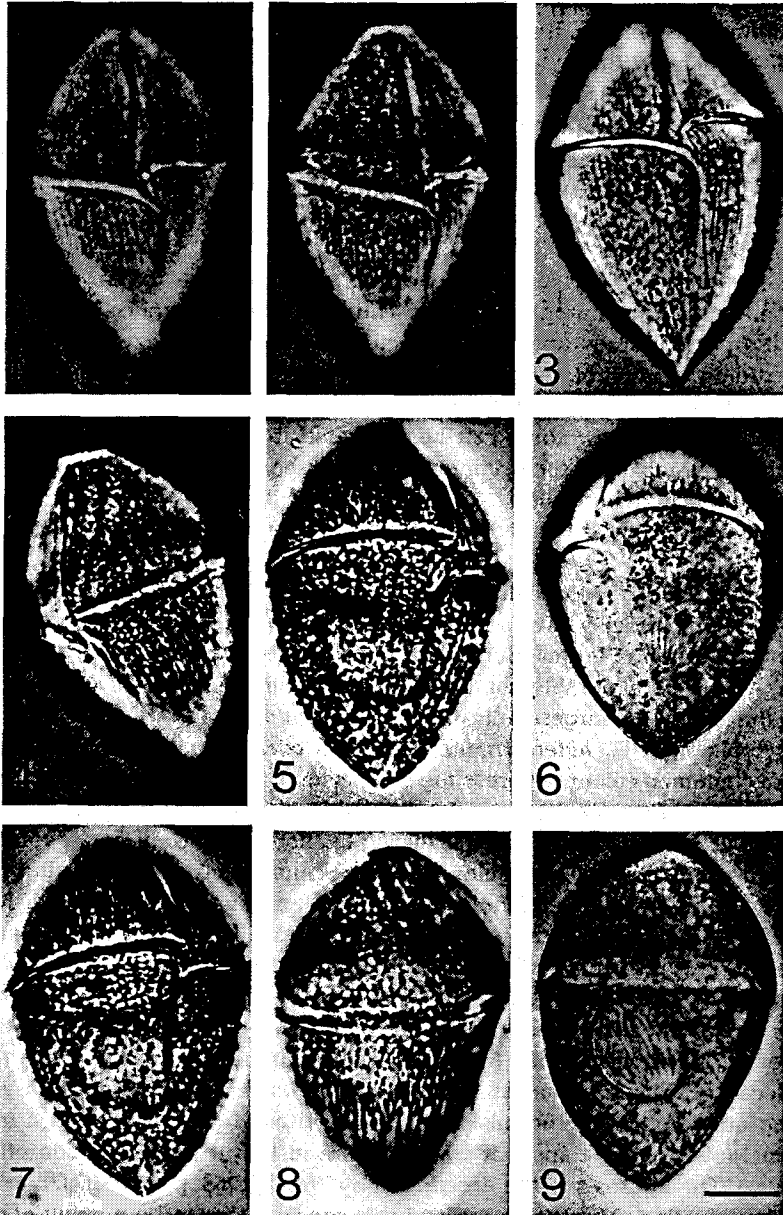
MATERIAL AND METHODS

Surface samples were taken using a 20- μm mesh net during cruise Nr. 44 of the R. V. Meteor in January and February 1977 in the upwelling region off the NW African coast. At Station 72 (19° 10' N, 16° 5' W) on 2nd February, 7 live specimens of *G. heterostriatum* were observed in sub-samples in Petri dishes under the dissecting microscope and were then transferred, by micropipetting, to the light microscope (Wild M20). Observations were made at 400 \times magnification and documented by colour slides (Ektachrome 64) and line drawings. The presence or absence of chloroplasts was examined by UV-induced autofluorescence of chlorophyll.

DESCRIPTION

G. heterostriatum is a medium-sized, elongate species which is circular in cross section or slightly compressed dorsoventrally. In living specimens the episoma is trapezoid in ventral view and domed in lateral view (Figs 1–4). The hyposoma is triangular in ventral view with an acute antapex and slightly convex sides (Figs 1–9). The cingulum is slightly premedian; the episoma is therefore slightly smaller than the hyposoma. This feature changes after a few minutes of observation under the cover slip. The acute antapical region rounds up to a greater extent than the apical region. Thus, in stressed specimens the hyposoma appears shorter than the episoma; the cingulum is located in a postmedian position, as shown by Kofoid & Swezy (1921, Pl. 2, Fig. 24). The cingulum is narrow, deeply impressed, slightly more than one circumference in length, nearly circular and slightly descending. The sulcus begins at or near the apex and runs as a deep, straight furrow from the apical region to the cingulum. It deflects to the right just before joining the cingulum. On the hyposoma, the sulcus is narrower and fades away towards the antapex. Details of cingulum and sulcus are shown in Figures 1–7. The surface of the episoma is distinctly striated, and in ventral view about 12 to 15 striae are visible. One or two faint striae are present between pairs of prominent striae. The surface of the hyposoma has a similar pattern but possesses one and a half to two times as many striae as the episoma. As cells round off during microscopical observations, the faint striae become broken lines and then completely disappear. The cell surface may appear smooth shortly before death.

At the junction of the cingulum and sulcus, a small sack-like pusule, directed towards the posterior pole of the cell, is always present. A second pusule may be present directed towards the anterior pole. The former can be seen in Figures 6–8, the latter in Figure 2. The nucleus is elongated, has distinct strands of chromatin and a nuclear envelope which can be discerned under the light microscope (Fig. 9). It may be situated in the hyposoma (Fig. 9), or in the episoma as described by Kofoid & Swezy (1921) and Kofoid (1931). Chloroplasts are absent when checked by fluorescence microscopy. The cytoplasm is somewhat granular and is a pale chalcedony yellow or pinkish cinnamon colour. Cell length was 93 to 106 μm before rounding off, and subsequently between 75 and 84 μm . Width remained constant between 50 and 56 μm .



Figs 1-9. *Gymnodinium heterostriatum*, live cells from the Northwest African upwelling region. Scale bar: 10 μ m. 1-3: ventral view, showing cingulum and sulcus; 4-7: ventrolateral view; 8-9: lateral view, optical section, showing position of nucleus and nuclear envelope

DISCUSSION

The specimens found in the upwelling region off the NW African coast agree with the description of *Gymnodinium heterostriatum* as given by Kofoid & Swezy (1921) and Kofoid (1931). In shape, the living cells closely resemble the specimen shown in Figure Y, 7 of Kofoid & Swezy (1921), but the latter specimen is apparently slightly rounded off, lacking the acute antapex observed during this investigation (see Fig. 3). Kofoid & Swezy (1921, Pl. 2, Fig. 24) and Kofoid (1931, Fig. F) apparently depict cells shortly before disintegration as concluded from the shape. In this condition, the faint striae between the prominent ones are seen as broken lines before they disappear completely. The broken lines are depicted by Kofoid & Swezy (1921) and by Kofoid (1931). In several members of the Gymnodiniales, the nucleus can move from the hyposoma to the episoma or vice versa, depending on phagotrophic feeding. Thus, the slight difference between the cells found in the present study and those depicted by Kofoid & Swezy (1921) and Kofoid (1931), including location of nucleus, shape of hyposoma, and total length of the cell, is probably related to the physiological state of the cells during observation.

Gymnodinium heterostriatum can be separated from *Gymnodinium striatissimum*, with which it was mixed in the original description and by subsequent authors, by the following features in living cells:

- (1) The antapex is clearly pointed in *G. heterostriatum* but is rounded in *G. striatissimum*;
- (2) *G. heterostriatum* always has a sack-like pusule at the junction of sulcus and cingulum and may also have a second one; *G. striatissimum* never has a pusule;
- (3) *G. heterostriatum* is larger than *G. striatissimum*. Only following a change of cell shape, due to unfavourable conditions, may the smallest cells of *G. heterostriatum* reach the size of the largest cells of *G. striatissimum*;
- (4) The cytoplasm of *G. heterostriatum* is always either a pale chalcedony yellow or pinkish cinnamon colour, whereas the clear cytoplasm of *G. striatissimum* is greenish or greyish, and the cells appear refractive under the dissecting microscope.

The shape of *G. heterostriatum* changes during fixation and becomes more rounded than in the living stage. It then resembles *G. striatissimum*. This change is due mainly to changes of the hyposoma, and the relation between length of episoma to hyposoma changes. In living specimens, the episoma is slightly smaller than the hyposoma, as in *G. striatissimum*, but in fixed cells the episoma is somewhat larger than the hyposoma, in contrast to fixed cells of *G. striatissimum*.

Gymnodinium heterostriatum seems to be rare and has been recorded apparently only three times, the first record being from Californian waters, described by Kofoid & Swezy (1921). Because of the confusion with *Gymnodinium striatissimum*, their statement concerning abundance may be misleading. Later, Kofoid (1931) reported a few specimens from Mutsu Bay in Japan. It was also rare in the upwelling region off the NW African coast. The figures and the description by Wood (1963, p. 26, Fig. 87) do not allow positive identification. All other records of this species seem to be a result of confusion with *G. striatissimum*, which is a common species, at least in neritic waters. A detailed description of *G. striatissimum* is provided by Elbrächter (1979) and includes figures and a discussion of synonyms.

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