

## New Records for the Genus *Heterodinium* Kofoid (*Dinophyceae*) from Turkish Coastal Waters (North-eastern Mediterranean)

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**Abstract:** Three species of the genus *Heterodinium* Kofoid are reported for the first time in Turkish coastal waters, in the north-eastern Mediterranean. The identified species are *Heterodinium mediocre* Kofoid, *H. angulatum* Kofoid & Michener and *H. inaequale* Kofoid. The morphological characteristics of these three species are described and information about their distribution is given.

**Key Words:** *Heterodinium*, dinoflagellata, phytoplankton, north-eastern Mediterranean.

### Türkiye Kıyısı Sularında (Kuzeydoğu Akdeniz) *Heterodinium* Kofoid (*Dinophyceae*) Cinsi İçin Yeni Kayıtlar

**Özet:** Dinoflagellat'lardan *Heterodinium* Kofoid cinsine ait üç tür Türkiye kıyısı sularında (kuzeydoğu Akdeniz) ilk kez rapor edilmiştir. Tanımlanan türler, *Heterodinium mediocre* Kofoid, *H. angulatum* Kofoid & Michener ve *H. inaequale* Kofoid türleridir. Bu üç türün karakteristik yapısal özellikleri tanımlanmış ve dağılımları ile ilgili bilgiler verilmiştir.

**Anahtar Sözcükler:** *Heterodinium*, dinoflagellat, fitoplankton, kuzeydoğu Akdeniz.

#### Introduction

Dinoflagellates are a very interesting group in terms of their morphological structure, nutritional characteristics and ecological distribution; they comprise an important part of marine phytoplankton. *Heterodinium* Kofoid is a rare and distinctive genus of this group.

The species of the genus are distributed in tropical and subtropical seas. In respect of bio-geographical distribution, 11 species from the Indian Ocean (Taylor, 1976), six species from the south-west Atlantic Ocean (Balech, 1988), 14 species from the Mediterranean (Rampi & Bernhard, 1980) and 12 species from the Caribbean Sea and adjacent areas (Wood, 1968) are recorded. Two uncertain taxa were reported as *Heterodinium* sp. (Metin & Cirik, 1999) and *Heterodinium* cf. *milneri* (Murray & Whitting) Kofoid in Turkish coastal waters by Eker and Kideyş (2000).

In this study, three species of the genus *Heterodinium* are reported for the first time in Turkish coastal waters. These records will contribute to the microplankton checklist of Turkish seas (Koray et al., 1999).

#### Materials and Methods

The samples were collected from the north-eastern Mediterranean coast of Turkey (Babadıllımanı Bight, Silifke-İçel) (lat. 36°06' N and 36°07' N, long. 33°28' E and 33°32' E). The location of the study area is shown in Figure 1. Sampling was performed in February 2000. The phytoplankton samples were taken from surface water using a standard plankton net with a 55 µm mesh size. The samples were preserved in 4% formaldehyde solution. An Olympus BX-50 phase-contrast microscope was used for the identification of the species and photomicrography.

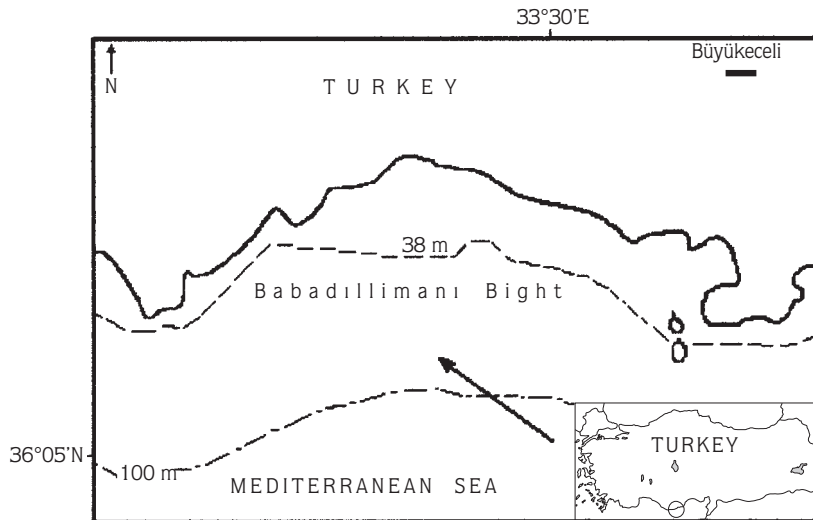


Figure 1. The location of the sampling area.

The identification and taxonomy were carried out according to Kofoid & Adamson (1933), Schiller (1933), Wood (1968), Taylor (1976, 1987), Rampi & Bernhard (1980), Balech (1988), Fensome et al., (1993) and Tomas (1997).

## Results and Discussion

All of the species of *Heterodinium* Kofoid 1906 identified in this study were found during late winter and were quite rare in surface water. The taxonomy of these species is as follows:

Division: *Dinoflagellata* (Bütschli 1885) Fensome et al., 1993

Subdivision: *Dinokaryota* Fensome et al., 1993

Class: *Dinophyceae* Pascher 1914

Subclass: *Peridiniphycidae* Fensome et al., 1993

Order: *Gonyaulacales* F.J.R. Taylor 1980

Family: *Heterodiniaceae* Lindemann 1928

Genus: *Heterodinium* Kofoid 1906

In this genus, the cell is dorsoventrally compressed or subspheroidal; it is usually slightly asymmetrical, but the sulcus is midventral. The epitheca may taper towards the apex or it may be distinctly rounded (Fensome et al., 1993). The epitheca and hypotheca are subequal and the girdle tends to be quite oblique (Kofoid & Adamson, 1933). The hypotheca is conical and usually with unequal

antapical spines (Wood, 1968). There are six precingular and six postcingular plates. The ventral pore is distinctively situated on a small platelet. The platelet may be homologous with the standard gonyaulacalean first apical plate, which bears the ventral pore in other gonyaulacaleans (Fensome et al., 1993). The cells are armoured and the theca has a characteristic reticulate and porulate structure. Heterodiniaceans are mainly non-photosynthetic dinoflagellates (Fensome et al., 1993).

### *Heterodinium mediocre* Kofoid

This is a large species with a subsymmetrical body. The epitheca is rounded. The hypotheca is large, its sinistral lobe is not prominent and it is usually bidentate. In ventral view, it seems more asymmetrical due to the sinistral lobe. It bears one or two small acute denticulations, one of which is on the anterior of the suture. The other denticulation is on the posterior of the suture and is less regularly present. The antapical horns are unequal and conical in outline (Kofoid & Adamson, 1933). The total length of the cells is 120-130  $\mu\text{m}$  and the width is 72.5-75  $\mu\text{m}$  (Fig. 2,a).

### *Heterodinium angulatum* Kofoid & Michener

This is a small species which has a quadrilateral body. The epitheca is almost rectangular, tapering into a short apical horn and expanding to the girdle. The hypotheca is about the same size as the epitheca and is almost

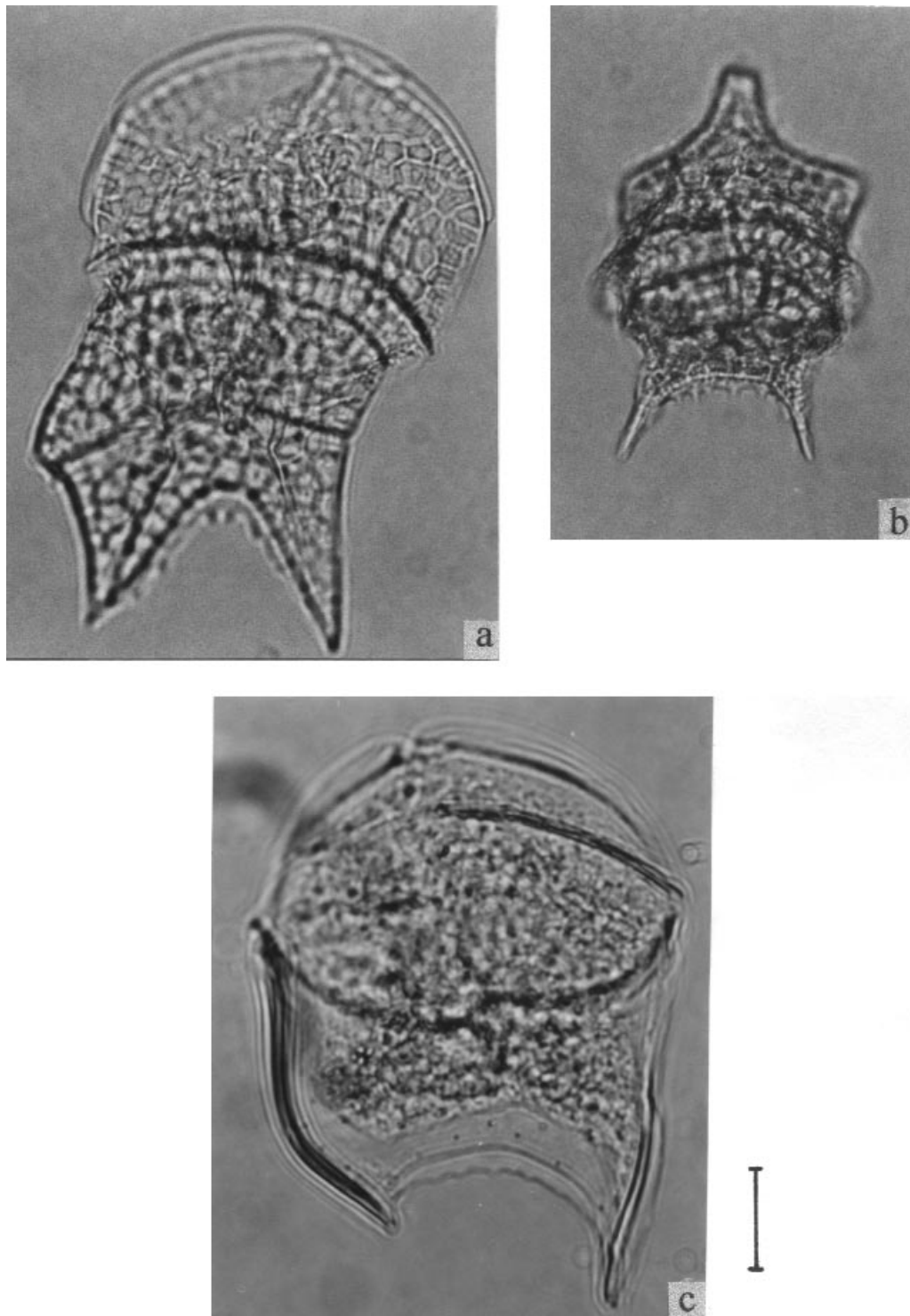


Figure 2. Microscopic photographs of *Heterodinium* species, a. *H. mediocre*, b. *H. angulatum*, c. *H. inaequale* (scale 20  $\mu\text{m}$ ).

rectangular with tapering convex sides. The hypotheca bears two antapical horns. The surface of the plates is strongly reticulate (Wood, 1968). It is one of the rarest

species of the genus *Heterodinium* (Kofoid & Adamson, 1933). Cells are 80-85  $\mu\text{m}$  long and 52-55  $\mu\text{m}$  wide (Fig. 2,b).

### *Heterodinium inaequale* Kofoid

This is a large species with a broad and very oblique girdle. The epitheca has a rounded structure. The antapical horns are incurved and unequal. The cell surface is smooth and porulate (Wood, 1968). The postmargin area between the antapical horns bears serrated fins. The total length is 112-120 µm and the width is 80-85 µm (Fig. 2.c). This species closely resembles *H. asymmetricum* but differs from it in being larger. The total length of *H. asymmetricum* is 85-104 µm (Kofoid & Adamson, 1933).

The species of the genus *Heterodinium* are mainly distributed in tropical waters (e.g. the tropical Atlantic and Pacific oceans), although a few species are found in temperate regions. The spatial occurrence of this genus was defined as generally below 100 m (Taylor, 1976). This characteristic of the genus may explain the rarity of the species in the surface samples. The presence of the species in the surface samples may be explained by a

vertical mixing of the water, which causes the transportation of the cells to the surface in late winter. There are some records on this genus in the Mediterranean Sea (Kimor & Wood 1975; Rampi & Bernhard 1980), and of two uncertain taxa from the eastern coast of the Aegean Sea by Metin & Cirik (1999) and the north-eastern Mediterranean by Eker & Kideys (2000).

The absence of these species from previous studies suggests that they have recently been transported into the Levantine Basin with subtropical characteristics such as extreme oligotrophy, and a tolerance to high temperature and high salinity (Lakkis, 2001). The conditions in this area could be favourable for species of *Heterodinium* due to their tropical affinity. The migration of species from the Red Sea through the Suez Canal could contribute to an increase in the diversity of the species, especially in the eastern Mediterranean.

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